A Systems and Cybernetic Perspective on Complex Problem Solving

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SUMMARY

This thesis is concerned with Organisational Problem Solving. The work reflects the complexities of organisational problem situations and the eclectic approach that has been necessary to gain an understanding of the processes involved.

The thesis is structured into three main parts. Part I describes the author's understanding of problems and suitable approaches. Chapter 2 identifies the Transcendental Realist (TR) view of science (Harré 1970, Bhaskar 1975) as the best general framework for identifying suitable approaches to complex organisational problems. Chapter 3 discusses the relationdhip between Checkland's methodology (1972) and TR. The need to generate iconic (explanatory) models of the problem situation is identified and the ability of viable system modelling to supplement the modelling stage of the methodology is explored in Chapter 4.

Chapter 5 builds further on the methodology to produce an original iconic model of the methodological process. The model characterises the mechanisms of organisational problem situations as well as desirable procedural steps. The Weltanschauungen (W's) or "world views" of key actors is recognised as central to the mechanisms involved.

Part II describes the experience which prompted the theoretical investigation. Chapter 6 describes the first year of the project. The success of this stage is attributed to the predominance of a single W. Chapter 7 describes the changes in the organisation which made the remaining phase of the project difficult. These difficulties are attributed to a failure to recognise the importance of differing W's.

Part III revisits the theoretical and organisational issues. Chapter 8 identifies a range of techniques embodying W's which are compatible with the framework of Part I and which might usefully supplement it. Chapter 9 characterises possible W's in the sponsoring organisation.

Throughout the work, an attempt is made to reflect the process as well as the product of the author's leaving.

KEYWORDS

METHODOLOGY PROBLEM-SOLVING REALISM VIABILITY WELTANSCHAUUNG

ACKNOWLEDGEMENTS

The research leading to this thesis has been quite difficult and rewarding. I am indebted to my wife who has shared most of the difficulties but few of the rewards.

Many people have helped in the course of the work. I am especially grateful to George Ellison Ltd. who sponsored much of the project, and members of the O.R.S.A. Group in Aston's Management Centre, who provided intellectual support at a crucial stage.

My special thanks are due to Mr. P.F. Swain, Mr. D.M. Brawn, Mr. B.J. Evans and Mr. J.C. Watt, all of whom have gone beyond their formal commitment to support this work.

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PREFACE

In 1975, the author joined the Interdisciplinary Higher Degrees Scheme (IHD) at the University of Aston with the intention of doing a reasonably straightforward piece of practical work for a sponsor, George Ellison Ltd (GE). A central objective was to emerge at the end of the process with a PhD degree, and the prospect of a reasonably good career. At the time, all the ingredients seemed right. The IHD Scheme offered an opportunity to develop both intellectually and in terms of practical experience. The sponsor seemed to be forging a new and successful future after a troubled history and a change of ownership. The top management were enthusiastic about the Scheme and they saw several areas that they would be happy for the author's project to develop into. The Ellison management also made it clear that they were participating in the scheme with a view to introducing and developing suitable people to meet the company's future management needs.

For the first year, the project developed satisfactorily. After several investigations of such things as time lags and conversion rates, quotations and orders, the author was able to suggest that there were discrepancies between a number of variables and the beliefs which managers held about them. Broadly speaking, the author's ideas and the suggested programme of work for the remainder of the project were accepted by the company and all supervisors. At this stage, everyone, including the author, was satisfied with the development of the project and its prospects.

Despite this good start, the author was to find himself a few years later in a completely changed situation. The project had not achieved a consistent contribution to any single area of the company's activity. There had been a number of good contributions to individual areas such as the outwork department and the sales forecasting procedure , but these did not hang together comfortably for the purpose of writing a PhD thesis. To the author, the prospects seemed grim, with little chance of getting a PhD.

The author's problems with thesis writing were, to a large extent, symptomatic of the grim situation within GE at that time (1978). The optimism of 1975 had completely evaporated as a result of the extreme financial difficulties in the previous 12-18 months. The company had become insolvent in the Spring of 1977, being saved by a combination of Government aid and private help. Redundancy, reorganisation and a good deal of turmoil followed. This was responsible for an extremely difficult experience for the author and most other employees.

Faced with the prospects of producing a thesis with poor academic content and very little consistent theme, the author abandoned any attempt to write up the project as it stood at that stage. This, and the project experience, left the author with two serious problems. The first consisted of a personal need to understand the extremely difficult situations and processes that had led to such an unsatisfactory outcome. The second was the need to produce a thesis.

The only sensible course of action seemed to be to attempt to understand the difficulties of <u>organisational problem solving</u> (OPS), and to make this a control theme in any thesis. The author feels that he has been able to substantially increase his understanding of the difficult situations and processes experienced at GE. Taken together the practical and theoretical work leading to this thesis have proved to be a valuable experience for the author which has been extremely rich in personal development. This thesis is an attempt to share both the experiences and some of the lessons learned, with the reader at several different levels.

The results of the author's work have given him a thesis to write, but it is, by its nature, extremely difficult to handle. It is not just a theoretical story of the author's ideas on OPS and it could not simply be a story of the author's involvement with GE : it is both. The difficulties of putting the two aspects together in a useful way have led the author to conclude that there is no right way to write this thesis, and that must mean that there is no right way to read it.

However, one must start and finish somewhere but the linear process entailed by this can be destructive of ideas when writing and obstructive of understanding when reading. The thesis that follows represents one way through this complex of ideas and experiences. There are other ways, many of which may represent a better structure than that embodied in the pages below. The reader is therefore urged to select his own path, and the notes that follow are intended to facilitate this.

A READER'S GUIDE

This section is intended to equip the reader with sufficient knowledge of the structure of this thesis to enable a suitable path through the work to be selected. This knowledge is also important for those readers who wish to deal with the material by following the structure given. The material covered is a complex of ideas and experience which is wide-ranging and varied in difficulty. Without a knowledge of the thesis structure, it will be difficult for the reader to appreciate the role of some chapters in the overall work.

This thesis attempts to say something useful about organisational problem solving. The author has found it necessary to investigate OPS as a result of some collaborative work with George Ellison Ltd. In the course of this work the author came to feel that the methods and approach implicit in the role he was attempting to play were inadequate for the more complex and difficult problems encountered.

The need to understand the failure of attempts to "put things to rights" and a desire to find more suitable approaches have prompted the author to think about aspects of OPS. These aspects range from the philosophical through to the level of implementation. It could never be possible to cover everything that might be relevant or important to OPS, but an attempt is made to deal with some aspects which have come to seem important to the author.

The experiences leading to this thesis have been both difficult and enriching for the author. The practical work with GE and the theoretical and methodological ideas that have been developed following it are both important to the author, and the structure chosen attempts to blend these two aspects in a useful way. There are different ways in which these aspects may be explored and the structure embodied in the pages below represent any one path through this network of ideas and experiences.

The thesis is structured into three parts. The first part concentrates upon the most theoretical aspects. The second part describes some of the collaborative experience which prompted the investigation recorded in Part I. The final part is a blend of the theoretical and the practical. The author's methodological framework is refined and some aspects of GE are discussed in terms of some of the ideas developed in the previous parts. The sections are recorded one after another, but the possibility exists to view the material of one section in the light of another. This is particularly true of Parts 1 and 2, so that the presentation of theory before the treatment of project experience reflects only the author's preference. A reader who wishes should feel free to take these sections in reverse order. However, a good understanding of the author's ideas and their development is unlikely to come about until these two parts have been completed. This is illustrated in Figure P.1.

The project experience gave rise to the theoretical work. The theoretical framework helps to explain the difficulties experienced in GE. The complementarity is completed by the way in which the practical experience provides examples and illustrations of important points derived within the theoretical section.

At this point, the thesis could have stopped, but there needed to

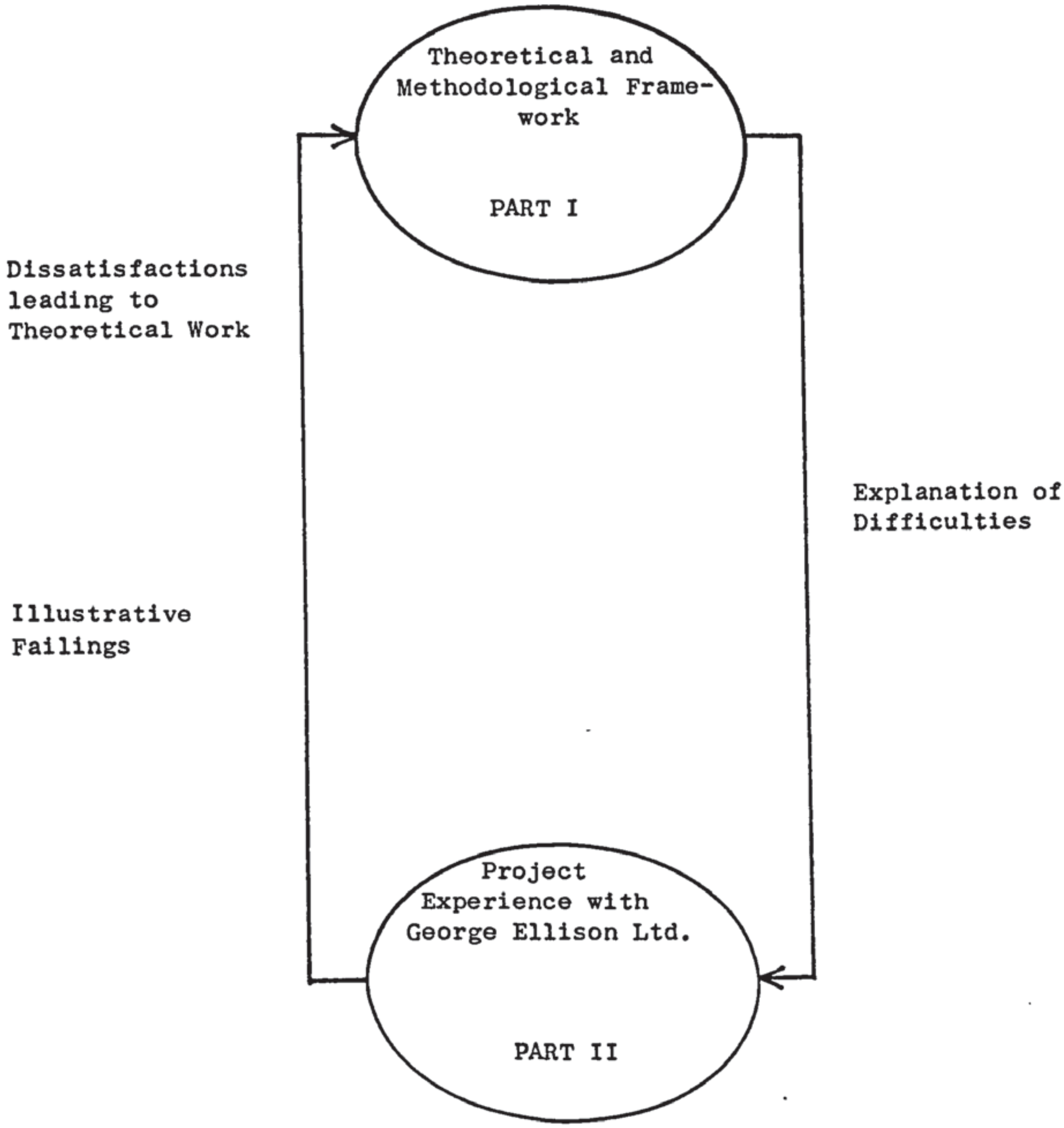

Figure P.1.

The Relationship between the First Two Parts of the Thesis be a final section. Parts 1 and 2 are mutually supportive with the more theoretical and the practical aspects separated. Part 3 attempts to build upon the lessons learned. This requires that the theoretical and organisational aspects are revisited. The relationship between all three parts is shown in Figure P.2.

The broad structure has been described, but it will be impossible for a reader to select a preferred path through this work without some knowledge of content. The content of each chapter is outlined in Chapter 1, but it may be useful to briefly cover the content of each of the main parts here.

Section 1 is concerned with the most theoretical and methodological ideas. It records the work that was undertaken as a result of the organisational experience with GE. The section begins by seeking an understanding of problems and moves through a number of levels to identify a suitable framework for dealing with problems. Chapter 2 stresses the subjective and variable nature of problems and identifies a school of realist philosophy of science (Harré, 1970) as offering the best broad framework for dealing with them.

Chapter 3 intorduces Checkland's methodology (1972) as a more specific approach. Checkland's methodology is examined in the context of the philosophical framework, and areas where strengthening is required are identified. A principal area requiring attention is that of conceptual modelling and Chapter 4 examines the ways in which viable system modelling could strengthen this. The key to improvement is to use modelling techniques which can impart explanatory power, so that there is a range of techniques which could strengthen the methodology.

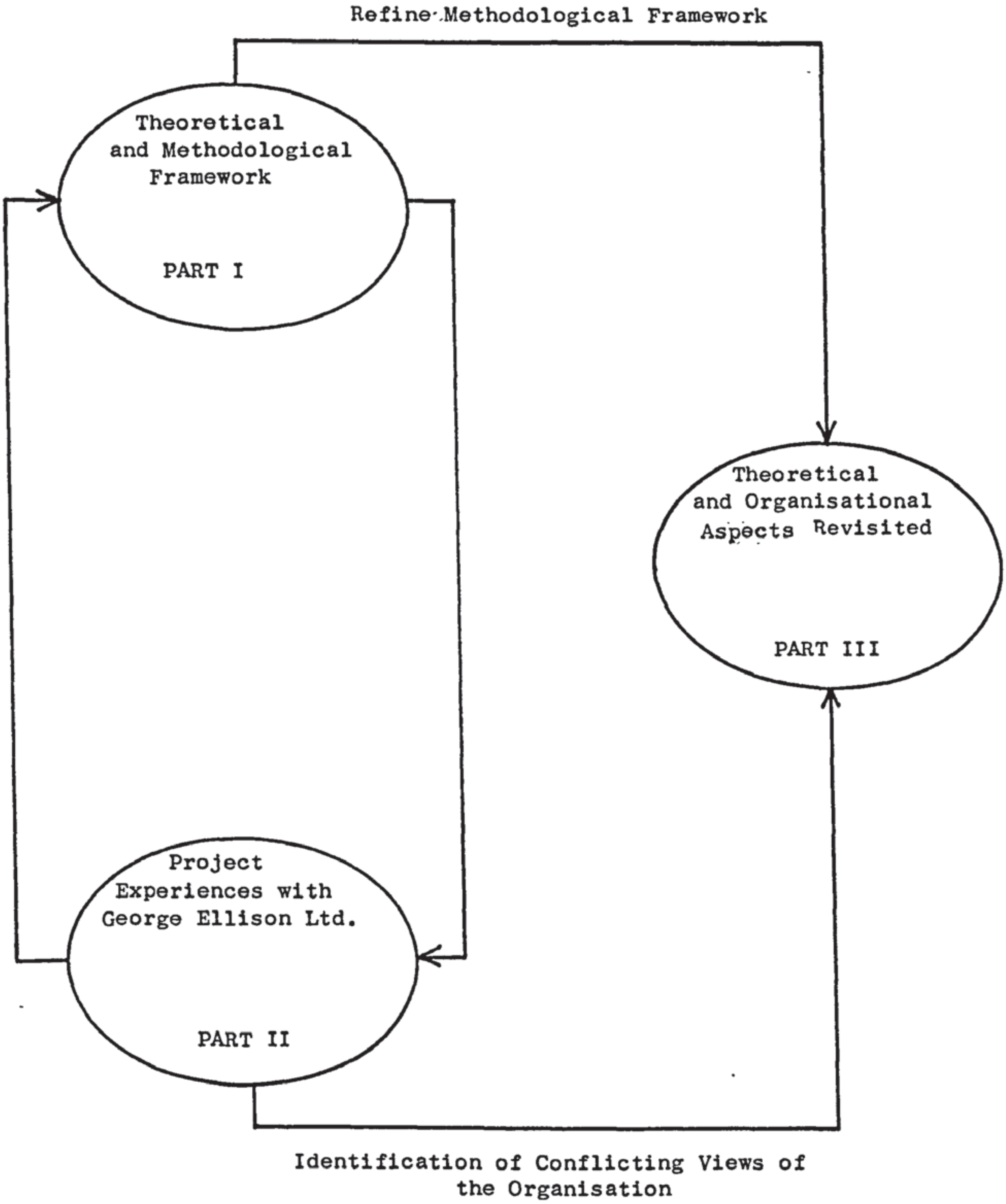

Figure P.2.

The Complete Structure of the Thesis

The section is concluded in Chapter 5 with a review of the methodological process. A model of this process is derived which is not only descriptive and prescriptive, but also explanatory of some of the underlying mechanisms in OPS. What is particularly important about this model is the way in which it illuminates the role played by differing world views (Weltanschauungen, or W's). It does not just say that they are important : it shows why.

Having achieved the major objective of identifying a suitable approach to OPS in Part I, Part II moves on to examine some of the organisational experiences that led to the author's need to examine OPS at a theoretical level. This is dealt with in two chapters. Chapter 6 deals with the first year of the project when the company situation was stable. The author's activity is characterised as concentrating on correspondence relationships. This involved investigating aspects of GE's operation, and identifying either discrepancies between the "facts" and managers' beliefs, or the need to change operations, given company policy, manager objectives, etc. The reasons why this worked well are identified.

Chapter 7 deals with the remaining activities of the project in which the organisation environment was unstable and rapidly changing. The failure of the "correspondence approach" is illustrated in a way that attempts to transmit some feeling for the richness of the situation and the inherent tensions. The author's theoretical framework is useful at this stage to underline the need to examine the coherence between the views and the W's of key people in the problem situation. It is suggested that the author's failure to do this made a significant contribution to the author's difficulties.

Part III is necessary to refine the theoretical framework described in Chapter 5, and to revisit some of the organisational issues to see how they might have looked if a more suitable approach had been employed. Although these tasks are dealt with in separate chapters, (8 and 9), they do have a common theme.

The work of the previous sections emphasises the importance and role of W's in OPS situations. This, and several associated ideas, are built into the author's explanatory model in Chapter 5. It is stressed that when one adopts a particular methodology, one is adopting a W. In Part II, the key is the way in which the author adopted a single W and was not aware of others. Part 3 is specifically looking at W's.

Chapter 8 looks at W's which can be brought into the author's methodology to strengthen it and make it more flexible. Those which are suitable, in the sense that they allow different W's to be accommodated include Conversation Theory (Pask 1975), Construct Theory (Kelly 1955) and several others.

Chapter 9 takes a look at some organisational issues which seem to be difficult because of different W's. The potential of this analysis must necessarily be limited since the attempts at modelling have taken place after involvement with GE. However, the author feels that the exercise is useful and illustrative of the approach the author now advocates. The relationship between the content described and the general structure given in Figures P.1. and P.2. is illustrated in Figure P.3.

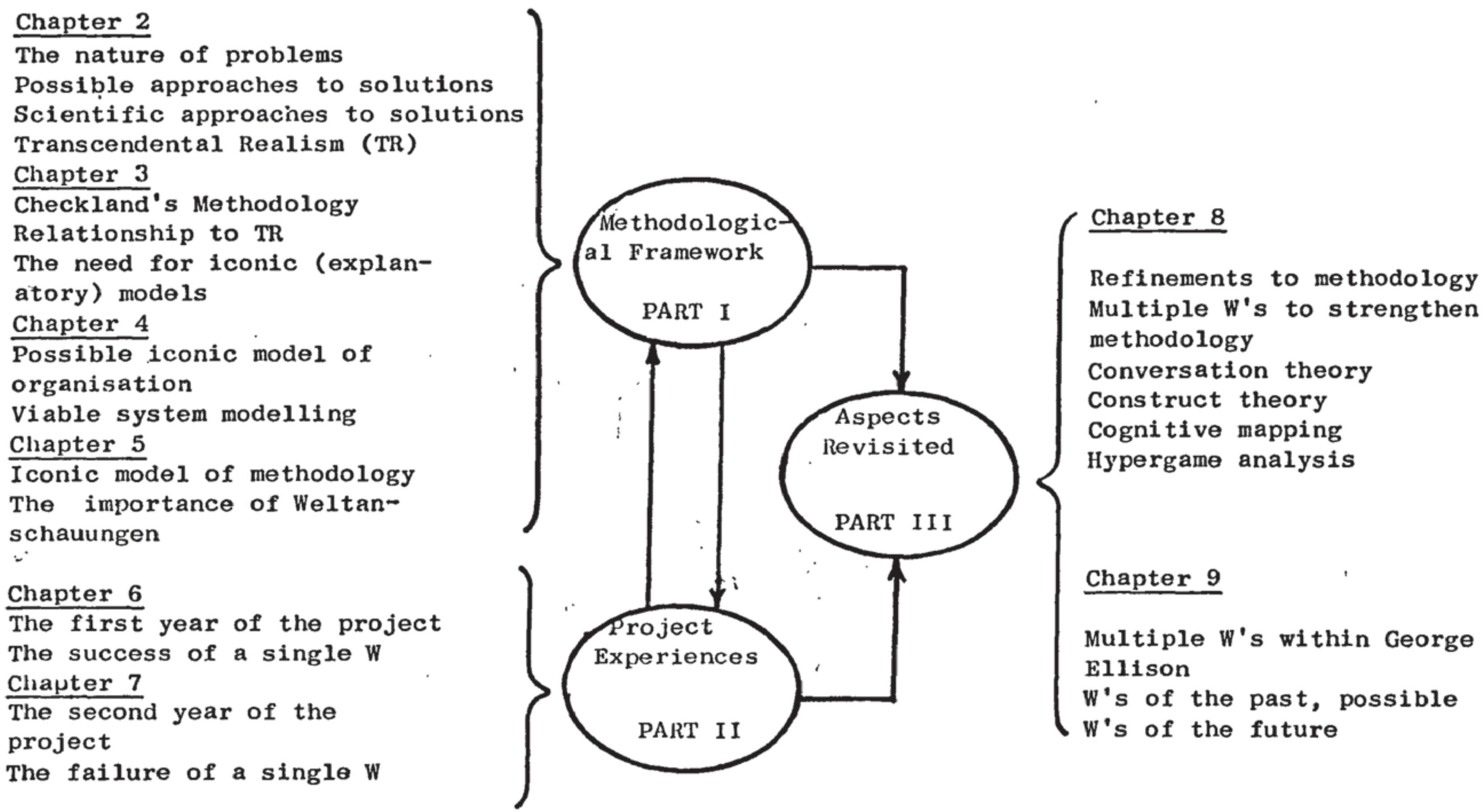

Figure P.3.

Structure and Content of the Thesis Combined

Having described the general structure, and the broad content of the thesis, the author hopes that the reader will now be sufficiently acquainted with the work to allow a free choice of path through the thesis. However, it may be useful if some specific recommendations are made, and these are given below.

At the broadest level, one can say that readers who are primarily interested in the practical and organisational aspects of this work should focus attention upon Chapters 6, 7 and 9, and allow their own questions to guide them from there. Readers who have a specific interest in the methodological framework should begin with Chapters 2, 3, 4, 5 and 8. Some further comments are necessary in relation to the methodological work.

Chapters 2 - 5 and 8 record the path of exploration that the author felt was necessary, but it is not essential that readers who wish to understand the author's methodological framework follow the same path. Anyone who already has an appreciation of the subjective and relative nature of organisational problems will become acquainted with the core of the author's views by examining the section on Transcendental Realism in Chapter 2, followed by the treatment of Checkland's methodology in Chapter 3, and the author's model of the methodological process in Chapter 5.

Chapter 4 may be missed on a first pass, because it provides an illustration of one of several approaches that may be employed to improve OPS, but it not essential to the development of the author's methodological framework. Chapter 8 may also be missed initially, since the ideas, important though they are, represent a refinement of the framework.

The author hopes that every reader will wish to read the whole of this thesis, but as to the other routes through the work, the author must leave readers to decide for themselves.

Chapter 1

Background and Overview

1.1. Introduction

The material of this chapter is purely introductory and is intended to provide a background appreciation of the work recorded in this thesis. The contentents are not substantially different to that of the preface and Readers' Guide above. Readers who have found the preface and guide to have provided an adequate introduction may wish to omit this first chapter. However, some readers may be interested to know more about the IHD Scheme as well as other aspects of the background framework of the author's work.

1.2. The Interdisciplinary Higher Degrees Scheme (IHD)

The IHD Scheme at the University of Aston in Birmingham began as an unusual experiment in higher edication in 1969, following the Swann Report (1968), and with a pump priming grant from the Joint Committee of the SRC/SSRC. The Scheme acts primarily as a facilitating mechanism to foster collaboration both between University departments and between the University and a wide range of external organisations.

The focus for this collaboration is usually a real world problem, or problem situation, provided by a sponsor in the form of an external collaborating organisation. An important feature of the problem situation is that it should not be a "contrived"problem, but represent an area in which the sponsor has a genuine need and critical interest in the outcome of the research. Also, the chosen areas should offer opportunities to apply the knowledge resources of the University, and this requires that sponsors take a broad view of what is a successful outcome.

A large part of the work of the Scheme involves finding and matching suitable students and projects. Once placed, students usually work for a three-year period as employees of the sponsor whilst being registered as a higher degree student with a suitable faculty of the University. The Scheme itself is not, nor is it as part of, a faculty, and this is important to enable the facilitating role within the University. Many IHD projects represent an unusual blend of interests as well as academic disciplines. Sponsors get help in tackling difficult problems, using high qaulity students whom they may keep, should the project be reasonably successful. Academic departments in the University get real world test beds to try out new and existing ideas, plus a regular contact with industry or commerce which may be sadly lacking in traditional research supervision. The student should get a knowledge of at least one new discipline, plus a wealth of employment experience that is unlikely to be matched by any other training option. This may involve working with levels of the organisation that would take many years to achieve in a normal graduate career. Not least of the rewards will be a higher degree, awarded after some of the aspects of the work have been written up.

In order to balance these potentially conflicting interests, the student is required to work with a number of supervisors. These include a representative from the sponsoring organisation, a main academic supervisor from a different faculty of the University, as well as an

IHD tutor. The supervisory team and the student meet regularly to review progress and to endorse any proposed changes of emphasis in the work. The role of the tutor is to facilitate introductions to potential supervisors and to help balance any conflicts of interest that may arise from time to time.

In order to ensure that the students are encouraged to explore new disciplines, a programme of coursework is prescribed, mostly during the first year. This may involve attendance of selected MSc units within a chosen faculty, as well as a basic programme organised and run by IHD (a development since the first year of this project). Balance is maintained by a requirement that attendance at either the University or the sponsoring organisation should not exceed 70%.

Should further details of the IHD Scheme be required, the reader should consult Cochran (1979, 1981), Robertson (1981), Robertson and Cochran (1980), Saunders (1980) and van Rest (1980, 1981).

1.3. The Sponsoring Organisation as a Project Environment

The sponsoring organisation in this project was George Ellison Ltd. (GE), a medium-sized electrical switchgear manufacturer operating from a single site in the West Midlands. At the outset of the project, the company envisaged a number of alternatives for enquiry ranging from a technically-based project associated with a patented, but undeveloped electrical distribution system manufactured by the company to investigations with more wide-ranging, corporate implications. The project began with little more agreed than that the focus would be in the latter area, and that the author would spend the first year working to crystalise and sharpen the project focus.

During the period of the project, GE has experienced extreme financial difficulties to the extent that the very existence of the organisation has been in question. The pressures generated by such conditions inevitably result in circumstances which do not favour the smooth development of any project, especially one that had the overriding characteristic at the outset of being little defined. Attempting to find a problem situation that could be shared with the management of the organisation is extremely difficult when the focus of management's attention, and indeed, management itself, is changing very rapidly.

During the project, the author worked with three industrial supervisors, three chief executives, two Commercial Directors, two sales managers, two commercial managers, two sales office managers, two management services managers, a marketing manager, three cost and management accountants and two financial accountants. Only management positions where changes have taken place are mentioned, but it should be noted that the author worked with many other individuals, and that several of the changes noted have involved the same individuals moving from one position to another.

The intense pressure generated by insolvency tended to limit the sphere in which managers were prepared to co-operate with any researcher. This effectively limited activities "on the ground" to issues which were "alive" at the time, or for which the researcher could take direct responsibility. The fact that the author unwillingly gathered day-to-day responsibilities during the project reflects not only the pressures on management but also upon the author, and illustrates the kinds of imbalances that can arise, as referred to in 1.2. above.

The project has not been a classical application of academic knowledge to the practical problem of an operating organisation in which the objectives were crystal clear, so that problems, solutions and effectiveness could be precisely identified and quantified. The objectives of the sponsoring organisation seemed to require a contribution to its problems without a clear definition of the problems to be tackled. In the event, the project work was concerned with issues ranging from strategic to operational, and these do not form a particularly "neat" package.

All the practical work of the project was unquestionably of value to the sponsoring organisation at the time it was carried out, but the author was singularly unsuccessful in persuading the sponsor to adopt any major recommendations during the research period. However, the author did join "the debate" and was recognised as a legitimate actor, and at the end of the contract research period, the sponsor expressed a strong desire to retain the author with a view to pursuing many of the issues highlighted by the research. Of greater importance, perhaps, is that the experience of this project has stimulated the author to develop a line of enquiry that has led to a coherent and distinctive research framework. For further details of the sponsoring organisation, see Appendix A, Exhibit 2.

1.4. The Theme of the Project

For a large part of the IHD project, the aims and objectives of the author and the supervisory team were directed towards finding operational areas of the sponsoring organisation to act as "targets" for a type of problem solving. This involved an image or model of the researcher as a kind of Mr. Fixit, who either put things "right" or informed the company as to how they could be. However, the difficulties were such that this model could not apply, and the achievements (the most notable of which was the survival of the project) fell well short of the author's aspirations.

This situation began a process of enquiry into problem solving in complex organisational situations in an attempt to understand the extremely difficult situations experienced in the sponsoring organisation. This thesis is, more than anything else, a statement of some important things that have been learned in this process. It could have been about any or all of the functional areas in which the author worked. and made contributions to the organisation. Indeed, this was the intention at one time so that the work would have been about marketing, information systems, corporate planning, etc. etc. It is still about some of these things but only in a secondary way, with the experiences of the project activity providing illustrative material to support the main theme which is <u>Organisational Problem Solving</u>.

The thesis might ideally be written as a statement which reflects the author's knowledge at some point in the process of learning which began, in this case, when the period of high involvement in organisational life was over. However, the process does not stop while the "snap-shot" is being recorded and this dynamism inevitably leaves its mark on the work. This work could have been structured in two sections, but it has been felt necessary to include a third on theoretical refinements in an attempt to reflect the developing views of the author in a useful way.

The first major block is a section containing four chapters (2 to 5), concentrating on the theoretical content of the work in which an attempt is made to map out logically consistent framework directed towards the main problem that the Ellison experience generated for the author, namely : how does one do organisational problem solving ?

The second major block, Chapters 6 and 7, attempts to relate some of the story of the involvement of the author in organisational issues in a way that illustrates the difficulties and principles developed in the first section. This will be a story both of involvement with GE and of how one came to ask the questions that Section 1 attempts to answer.

The third major block contains Chapters 8 and 9 which focus on refinements to the material of the two previous blocks. The first of these chapters deals with alternative techniques that may be employed within the problem solving framework described in Chapter 5. Chapter 9 revisits the Ellison situation with a view to exploring the major W's involved. Chapter 8 is concerned with identifying problem handling W's that may be blended with a general framework, while Chapter 9 seeks to understand some W's that have not blended particularly well. In 1.5 below, the contents of the three major sections of the thesis will be described in more detail.

1.5. The Contents of the Thesis.

In this section, the main themes and sub-themes of the thesis will be outlined so that the reader will have a reasonably clear picture of the contents and objectives of the individual chapters as they are unfolded. This should also help the reader who wishes to dip into a chapter of particular interest to appreciate its position in the whole work. It will be evident to the reader that the work does not contain any section marked as a literature review. This reflects the interdisciplinary (Apostel et al., 1972) character of the work, and the eclectic approach of the author. To survey the literature in every area consulted would have been impossible within the constraints of the project. However, the argumants presented are supported by appropriate references and these will be found throughout the work.

1.5.1. Theoretical Considerations

The first section begins by asking some fundamental questions about problems in general, and works through to an outline of what seems to be a coherent methodology of handling problems in general and organisational problems in particular.

Chapter 2, therefore, discusses fundamental issues and so takes questions at a philosophical level. The nature of problems is dicussed, and the general conclusion is drawn that problems are substantially what they "appear" to be. This is developed in terms of Construct Theory (Kelly, 1955), Pask (1975) and the notion of Weltanschauung (Churchman, 1968). Problem structuring is discussed and the notion of "softness" is introduced, as is the need to "harden up" problems in order to tackle them effectively. Existing approaches to problems are discussed and the contrasting views of Holism and Reductionism are explored at a philosophical level. An attempt is made to develop a pragmatic view which represents a theoretically consistent andworkable account. Finally, this chapter seeks to establish an understanding of what is to be scientific and <u>ipso facto</u>, what constitutes a scientific approach to to problems. This latter question is important since many researchers attempt to be scientific whilst taking the answer to this question and any methods implied for granted. It is particularly important for the author since the Transcendental Realist view of science (Harré, 1972) has been of immense value in helping the author to understand how methodologies for problem solving may be improved.

In Chapter 3, the focus is on ways of handling problem situations in complex organisations. The methodology of Peter Checkland (1972) is introduced as a developed method which, in most of its features, is consistent with the conception of problems and problem situations developed in Chapter 2. This methodology is centred upon the notion of Weltanschauung and the opportunity is taken to develop a view of this concept which goes beyond that developed elsewhere. Finally, the philosophy developed in Chapter 2 is used to identify areas where the methodology may be strengthened. This draws upon a realist distinction between sentential and iconic models and identifies Checklands methodology as embodying sentential models in Root Definitions. Conceptual models are identified as having the potential to embody the iconic (explanatory) models, but as being in danger of failing to do so as developed in much of Checkland's work.

Chapter 4 is principally concerned with viable system modelling and this is important for two distinct reasons. Firstly, it represents an avenue that was explored within the sponsoring organisation. In one phase of the learning process, this avenue was pursued vigorously using the type of viable system model first developed by Stafford Beer (1972) as the principal tool. However, some difficulties were experienced with the model and this prompted a phase of research that involved a rederivation of the viable system model from its neurophysiological origins. This produced a model that was different from Beer's in many important respects. Important though this work is, it is not the main focus of this thesis and is introduced mostly on the basis of its potential to make a useful comparison with the problem handling process as understood, within the philosophical framework of Chapter 2. This brings us to the second reason for including it, which is its potential to act as an iconic model of the control mechanisms of social organisations. This creates the possibility to strengthen Checkland's methodology by using the developed model at the conceptual modelling stage.

Chapter 5 is concerned to consolidate the groundwork of the previous three chapters with the aim of building up a picture of the problem handling process in a way which both acknowledges the aspects of existing approaches which the author feels are of particular value but also emphasises those aspects which are new and original to the author's work. An explanation is offered as to the origin of the most significant complexity in organisational problem situations, and these ideas are developed to give an iconic model of the whole problem solving/interaction process. This work draws heavily upon the previous chapters and generates an elaborate framework that can both accommodate a range of strategies and techniques relevant to the operational and political difficulties reported in subsequent chapters.

These four chapters, then, complete the conceptual framework that was developed in repsonse to the immense difficulties at Ellisons, and this comes closest to a "snap-shot" of what was learned from the experience, although the contents of Chapter 5 are a little contaminated by later conceptual ideas.

1.5.2. The Project Experience

This is the theme of the second substantial block of the thesis and performs a dual role. Firstly, it allows one to tell something of the story of the project in a way that should identify the magnitude of some of the difficulties experienced. Although the first theoretical section is important to help others attempting this kind of "dirty" research, it is equally important that potential researchers appreciate the kinds of difficulties, both technical and political, that can so easily arise. Secondly, it is important because it provides illustrative circumstances, case material, for the kind of approach developed in the first section. The material is presented in two chapters which roughly follow the chronology of the project.

The first of these two chapters (6) deals briefly with the events of the first year, which are commented upon in the light of the framework developed in the first section.

The second chapter (7) of this block deals with the rest of the project, and although all the events of the project are not recorded, most of the significant developments, including technical, financial and political are. The discussion begins with an account of a mini-project that seemed to be reasonably successful. This is folowed by some comments about the company's insolvency in 1977 which radically altered the environment of the research. The circumstances in which the author inherited activities from the company's marketing manager, and the content of these activities are discussed, as are the effects upon the development of the project. The ways in which these events lead to involvement in problems of information systems, and the distribution of available resources are outlined along with details of the associated "which computer" debate. The remainder of the chapter is concerned with attempts to push the company towards a recognition of the need to move away from the philosophy of DP implicit in the "which computer" debate. Every attempt is made to relate these events in a way that preserves as much of the rich picture surrounding them as is possible, and developments are commented upon as much as possible within the context of the theoretical framework of the first section.

1.5.3. Theoretical Refinements

It happens in this case that the author's knowledge has developed during the writing of this work, and this has brought an awareness of the possibilities which provide refinements to the framework of the first major section. The argument in this final block, Chapters 8 and 9, is that essentially, one must recognise that there may be many ways to handle successfully the soft problems of social organisations, and so a range of "techniques" is always useful since the style of particular techniques may be more suited to a given set of actors/ problem owners than others. There seems little doubt that conceptual modelling using viable system modelling techniques within a Checkland-type framework offers a useful approach that a knowledgeable analyst/ consultant could use in an organisational problem situation. This would enable him to map his picture of the organisation and the debate within it. However, it will inevitably arise in some situations, that one or more of the actors cannot, and/or will not see the situation in terms of the nominal modelling techniques preferred by the analyst, but prefers to see it in terms of models peculiar to them. In such a case, one needs techniques which allow an actor to express his own model in his own terms, and if this is done through a theoretically supported technique, the theory of the technique must often remain unknown to the problem owners who may resent lectures on the cybernetics of viable systems or construct theory, etc. when attempting to cope with their organisational problem situations. The techniques employed should help, not hinder the problem handling process.

Of equal importance are the political constraints surrounding any debate, and this was certainly demonstrated in the experiences related in the second section. Changes to systems which look technically desirable may be politically unworkable, and for this reason, the author has needed to examine modelling techniques which look directly at differences of opinion between actors/problem owners.

Generally speaking we may say that techniques such as viable system modelling offer useful but limited explanations of the behaviour of systems because they construe the world only in terms of control mechanisms functionally represented. However, there are potentially as many ways of construing the world as there are individuals to construe it, so that we can often posit explanations of an individual's behaviour in terms of the cybernetic constraints upon him, but we cannot have a complete explanation of his behaviour until we see how he sees his situation. Of course, it is often the case that the limited construction of his behaviour is sufficient for the task we have set ourselves, as in the trivial example of attempting to constrain employees to attend work on time, but many of the more complex organisational situations will require explanations at deeper levels, at the level of Weltanschauungen of the individuals involved, for progress to be made.

The material of this section is developed through two chapters (8 and 9) ; the first of these identifies approaches that are compatible with the main framework in the way outlined above, dealing with conversation theory, construct theory (Bannister and Fransella, 1971), cognitive mapping (Eden et al., 1980) and game theoretic approaches (Howard, 1971, Bennett, 1980). The final chapter (9) attempts to model some organisational situations using elements of the main framework. It is hoped that this will provide deeper insights into Ellisons and illuminate fundamental differences between conceptions of the Ellison organisation as held by key actors. It is, perhaps, an inevitable product of the process that these models represent the author's view of the past, and the author's view of other peopl'e view of the future.

Part I :

An Examination of Some Theoretical and Methodological Aspects of Organisational Problem Solving

Chapter 2

The nature of problems
Possible approaches to solutions
Scientific approaches to solutions
Transcendental Realism (TR)

Chapter 3

Checkland's Methodology
Relationship to TR
The need for iconic (explanatory) models

Chapter 4

Possible iconic models of organisations
Viable system modelling

Chapter 5

Iconic model of methodology
The importance of Weltanschauung
The W in methodology

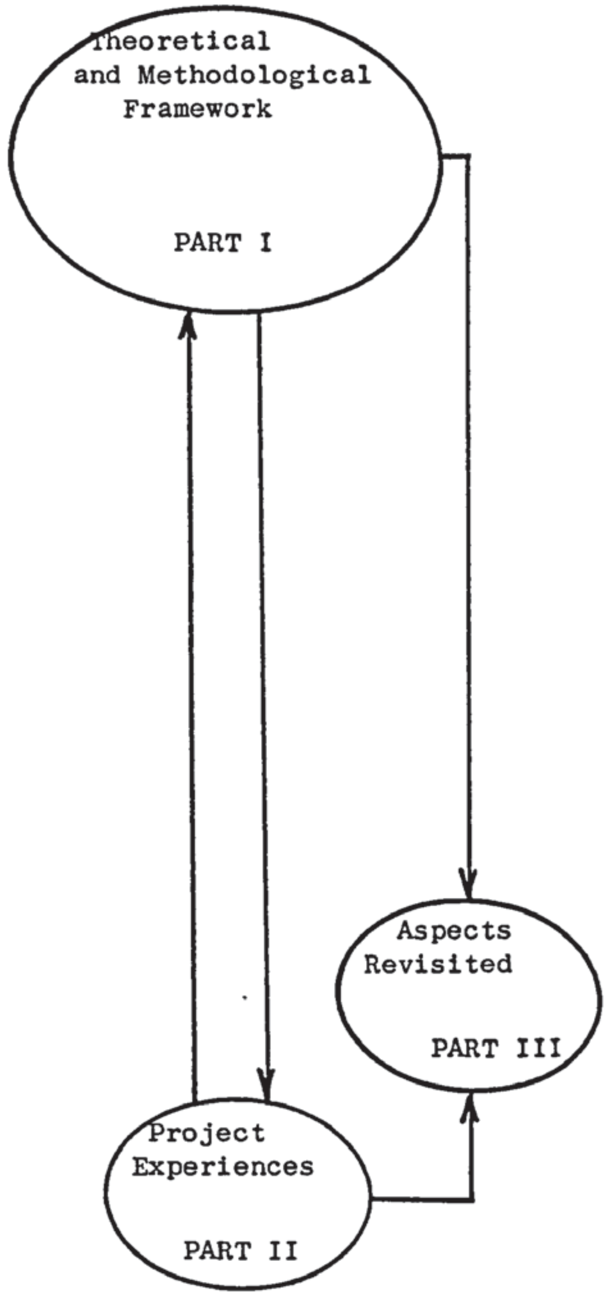

Figure I

The Content of Part I and its Structural Relationship with the Other Parts

Introduction to Part I

The four chapters of Part I record something of the process of exploration that seemed necessary to gain an understanding of organisational problem solving (OPS). The author does not claim that the path followed is the only valid one, or that the aspects that have come to seem important are necessarily the only important ones.

Towards the end of the author's involvement with George Ellison Ltd., the author concluded that his own approach to OPS was inadequate. This generated the need to understand OPS better and to find suitable approaches. However, there must always be a limit to what can be achieved, so the author has adapted aspects of promising approaches as has seemed appropriate. This work, therefore, does not attempt to cover every aspect of OPS. It does attempt to say something useful. The author has learned a great deal, and it is hoped that this can be shared with the reader.

This section deals with a mass of ideas, ranging from the philosophical through to the level of implementation. The long and complex threads that are woven through this section reflect the process which has been necessary for the author. The section begins by examining the subjective and highly variable nature of problems, and identifies the character of suitable approaches to their solution at the broadest level.

Chapters 3 to 5 work towards a more specific identification of a suitable approach. This process is reasonably complete in Chapter 5 where an iconic (explanatory) model of the methodological process is given.

It is worth noting again that readers who wish to understand the author's views quickly, and who already have an appreciation of the subjective and relative nature of organisational problems can usefully take a short route through this section on a first pass. This can be achieved by examining the section on Transcendental Realism in Chapter 2, followed by the treatment of Checkland's methodology in Chapter 3. Chpater 4 may be missed and this leads quickly to the author's model of the methodological process in Chapter 5. Readers who have elected to read Part II first are specifically recommended to take the short route since they should, by now, have an appreciation of some of the important subtleties in OPS.

CHAPTER 2

THE NATURE AND STATUS OF PROBLEMS

2.1. Introduction

The essential focus of an IHD problem is the problem situation to which the study relates. Some projects address a problem that is well structured, carrying clear and widely agreed criteria of success, and successfully solve the problem within those criteria. Such projects are mainly those with strong technological associations. Many others are, however, "soft" either by nature (a logical fact), or by lack of definition (a contingent fact). In the latter case, criteria of success will always be less clear than with the ideal "hard" problem mentioned above. In the former case, clear criteria may emerge after a period of problem structuring. However, if the essential nature of the problem is "soft", objectives may still be very general. The research reported here is unmistakably in the area of "soft" problems, and begins at a point of least structure, i.e. a soft problem, little defined.

In this chapter, the problem of problem definition will be discussed, and this raises the often neglected, or taken for granted, methodological and philosophical questions about problems. Questions such as "What is a problem ?" and "What constitutes a proper approach to the solution ?" are relevant here.

The discussion on the nature of problems aims primarily at stressing the relativity and variability of human observation and conception of problems. An understanding of this is needed in order to appreciate the value of the kind of problem structuring advocated in the following sub-section. This is a process in which the owners attempt to make clear to themselves what constitutes the problem for them. Consideration of these issues is helpful in underlining the interpretation of "problem" followed by the author. This is an essential prerequisite to the discussion of problem-solving developed in this and subsequent chapters, because it will help the reader to understand why the author follows particular methodological preferences. The view of "problem" followed is a central part of the author's conceptual scheme through which the problem solving process is understood.

Having given an interpretation of "problem", the discussion moves on to consider possible approaches to problems which might be expected to help in dealing with them. It is appropriate that in this chapter these issues are dealt with at the broadest level so that such things as Reductionism and Holism are considered first. An attempt is made to take a pragmatic view of the issues involved, so that the rough character of suitable approaches is identified. This is, in fact, the beginning of a process that will develop through this chapter and Chapters 3 and 4, so that a complete model and explanation of the problem handling process can be given in Chapter 5.

The latter part of this chapter is concerned with various philosopical interpretations of science, since this seems to the author to be an appropriate place to look for guidance when attempting to isolate suitable approaches to problem solving at the broadest level. Having examined this area, the author concludes that Transcendental Realism (TR) (Harré, 1972) offers the best framework to carry forward to the rest of this work. It is essential that the reader grasp the character of this realist interpretation because it plays a central role in the development of the author's ideas in later chapters. To aid the understanding of TR a reasonably full description is given. The areas that are particularly important are realist epistemology, and the interpretation of explanation.

2.2. Contrasting Views on Problems

The traditional scientific (positivist) view of problems and problem situation is gradually being recognised as completely inadequate (Checkland, 1976). The failure of this paradigm is manifest in social or "soft" systems, and stands in striking contrast to its apparent success in the physical or "hard" sciences. The success of this "scientific" method amounts to getting the "right" answers for the "wrong" reasons, while its failure shows that it provides wrong answers as well as wrong reasoning, and this may be viewed as a failure of a test in the Popperian sense (Popper, 1963).

Members of the scientific community, the Kuhnian practitioners of "normal" science, have often expressed the hope that science (hard and soft) will, in time, be unified, and this is underpinned by the belief that this classical (positivist) paradigm can, in principle, deal with the special (contingent) difficulties of soft systems. Pask (1979) dubbs the application of this general paradigm to soft systems "SOP (Social and Psychological) Science":

> "Mainstream Sop-Science consists of two closely related research programs : one is naive behaviourism, the other is an ego-oriented discipline compatible with behaviourism, in which some neurones are added to provide motive and a surrogate for mind. Sop-Science is built in the image of physical science, and is revered as though it really had the content of physical science." Pask, 1979.

It is quite clear that the unificatory aspirations of reductionist thinkers cannot be satisfied through any reductionist methodology, and none of the standard rationalisations of the failure of Sop-Science given by its protagonists will stand serious examination. For example, it is often argued that soft system science is "young" in comparison with hard science, but this is manifestly untrue. Serious thinkers have pondered the nature of man and society as well as the universe since the dawn of civilisation. Leibniz (Hollis, 1973), Descartes (1968) and Locke (1959) provide 17th century examples, while Plato (1974) or Aristotle (Bambrough, 1965) are examples of the ancients.

In the positivist paradigm, problems are conceived as having some kind of objective status, as do the phenomena which constutute the problem area. This conception is never more evident than in the prescribed role of the experimenter or problem solver who is seen as controlling an environment with known characteristics, to produce specific stimuli to which an organism responds. The stimuli are held to be known, and the responses are monitored and quantified. Deductions (which are usually inductions) are thus made about the mechanism(s) (causal) within the organism. This is the approach that lies behind what Pidd and Woolley (1980a) call "the check list" and "science research" streams in problem structuring. However, the reality of Sop systems is that they are generally more complicated than can be comprehended, and thus the fundamental tool of Sop Science, the controlled experiment, is of little value.

When viewed realistically, problems begin to lose the facade of objectivity, as do the individuals associated with them, and begin to emerge as highly variable and volatile entities which shift according to the individuals' points of view. It is this variability that the following discussion sets out to explore and perhaps explain.

2.2.1. Problems

What then, is a problem ? Mitroff (1977) defines problems as follows :

"In the most general sense, a problem can be said to exist whenever there exists a discrepancy, however slight, between a purposeful individual's (or a group's, a society's, a civilisation's, etc.) desired states or goals and the current level of accomplishments in the way of attaining these goals."

This view is supported by Pidd and Woolley (1978) :

"...problems begin with perceived dissonances between current and desired states."

Mitroff formally defines a problem as follows :

$$P_i(t) = G_i(t) - A_i(t) \qquad (1)$$

where $P_i(t)$ is a problem at time t, $G_i(t)$ is a goal at t and $A_i(t)$ is "an accomplishment or performance function at t".

In general, a problem is "solved" if $G_i(t) = A_i(t)$ but may be considered "resolved" is any remaining difference falls within an acceptability limit $l_i(t)$, i.e.

$$G_i(t) - A_i(t) \leq l_i(t) \qquad (2)$$

This condition accepts that a "perfect solution" may not, and often should not, be expected. Mitroff defines a further category of solution as "dissolving" problems, where the weighting one gives to a particular problem falls to a low priority in relation to some other problem(s). This is expressed by :

$$W_i(t) \left[G_i(t) - A_i(t) \right] \leq l_i(t) \qquad (3)$$

where $W_i(t)$ is the "weighting function". Thus Mitroff's more technical definition of a problem becomes :

$$P_i(t) = W_i(t) \left[G_i(t) - A_i(t) \right] > l_i(t) \qquad (4)$$

It seems that changes in the relative importance of problems might sometimes be reflected in amendments to goals, in which case, the simpler formula in (2) is sufficient to express the relationships. It is, however, clear that goals are subject to revision according to complex psychological processes. Woolley and Pidd (1981) recognise the importance of goals :

"Needless to say, different individuals or groups may have quite distinct desired states, and this may define problems differently".

Thus goals may vary through time with the same individuals, and through individuals at the same time. The same is true of organised groups, with a corresponding increase in complexity.

Changes in goals and weighting functions are often evident in the kinds of processes described by de Bono (1971) where the key to problem solutions is often the ability to see the same things/situations "differently".

We now have a basis for the hypothesis that problems are socially and psychologically determined. Goals are variable, according to psychological, sociological and cultural influences, and this makes problems vary according to the change in each variable, any one of which may be highly complex.

Up to now, it has been suggested that problems are subjectively determined because of the factors surrounding either the goals involved, or the relative importance attached to the problem. This leaves the attainment side of the equation free from subjective inputs. However, it will now be argued that the accomplishment function A_i varies, albeit less so, in a similar way to W_i and G_i.

A_i will change according to movements in the state of affairs that relate to G_i. Not all possible changes in the "real world" can be supposed to be detected or detectable by the group or individuals for whom the problem exists, and thus we require the notion of "perceived reality". "Owners" of the problems have problems by virtue of a difference between desired end states and accomplishments, and we shall see observations are variable in a way which goes beyond physical and trivial psychological (goal-based) factors.

In order to substantiate this claim, it is necessary to move into the realms of epistemology, and consider what is involved in knowledge of states of affairs. We shall not complicate matters unnecessarily by addressing the philosopher's puzzling question as to the existence of a "real" "objective" world, but shall take its existence for granted, thus rejecting the positivist claim (Ayer, 1930) that sense data are the ultimate referents of experience. Also, causal connections between a "real world" and the perceptions experienced by any observer will not be doubted, but it will be argued that there is a significant difference between the sense data received or generated by an observer's sensory system and the information construed from it. This distinction forms the basis for some important insights into problem situations in Chapter 5 below.

In its most general form, the argument is that observation is "theory-laden" ; theories are logically subject to possible revision, and therefore $A_i(t)$ and $A_i(t_1)$ and $A_i(t_2)$ may differ because of a revision in a belief system as well as from the straightforward change in "real world" states of affairs.

To show the validity of this claim, use is made of a distinction between two kinds of seeing (Putman, 1969), namely "seeing" and "seeing that" ; what Harré (1970) describes as the distinction between "perceiving" and "observing". Perceiving is the result of neutral interaction between an observer's sensory apparatus and the real world ; thus, the observer "sees" what his neuro-optical system perceives, "feels" what his neuro-tactile system perceives, etc. In this way, observers recognise or "see" features of the real world. What the observer makes of what he sees is, however, observing. Literal seeing will involve perceiving certain light patterns of particular colours, etc. "Seeing", the act of perception, becomes observing when we "see that" the pattern of light, etc., is, in fact, a recognised member of a particular category of things in the field of vision ; a kind of second-order perception. As in both Putman and Harré (op.cit.), the point may be illustrated with a simple example. Suppose two trains to be standing on adjacent tracks at a railway station. Within a carriage of one train is a person viewing the other train (seeing) through a carriage window, but with the platform-side window blind drawn closed. The passenger's expectation is that the train is about to leave, so that the relative movement, when it occurs, of the window pillars of the train is interpreted as his train leaving the station. This impression may be further reinforced by suitable jolts of the train. Logically, this is not the only explanation of the data perceived. Both trains, for instance, may be moving, or the observer's train may be stationary with the "observed" train moving. It would not be an uncommon experience for an observer in the situation described to raise his platform-side blind to find his train stationary, and be forced thereby to revise his belief that the 'observed' train was moving. What the observer sees, or perceives is the relative movements of what he "takes" to be railway carriages. What he observes, however, is dependent upon his prior beliefs and the evidence, other observations which logically, if not contingently, are open to the same qualifications. Initially, the observer observes ("sees that") his train is moving, but in the light of further observations (interpreted perceptions), observes ("sees that") the other train is moving. In all observational situations, the evidence available will be finite, and this will always leave the logical possibility that some <u>other observation</u> is consistent with the perceptions present in the observer. The observer observes what he does because of his prior beliefs about : the way the world works; its mechanisms and structures and the situation he is in; the temporal and physical location of the observer within these mechanisms and structures; in short, his point of view, or in Checkland's terminology (following Churchman), "Weltenschauung".

These ideas play a fundamental role in the development of a refined and original explanatory model of the methodological process discussed in Chapter 5. The ways in which differing views or perspectives on the "same" situation can generate complex conflicts in a manufacturing company is illustrated by much of the case material in Chapter 7.

The relativist view is consistent with the concept of person developed by the construct theorist, Kelly, who holds that "A person's processes are psychologically channellised by the ways in which he anticipates events", and "a person anticipates events by construing their replications" (Kelly, 1955). Kelly (1970) characterises his view as follows :

"Like other theories, the psychology of personal constructs is the implication of a philosophical assumption. In this case, the assumption is that whatever nature may be, or howsoever the quest for truth will turn out in the end, the events we face today are subject to as great a variety of constructions as our wits will enable us to contrive. This is not to say that one construction is as good as any other, nor is it to deny that at some infinite point in time, human vision will behold reality out to the utmost reaches of existence. But it does remind us that all our present perceptions are open to question and reconsideration, and it does broadly suggest that even the most obvious occurrences of everyday life might appear utterly transformed if we were inventive enough to construe them differently."

The view of man as a stimulus-response being is rejected.

"He (man) responds to what he interprets the stimulus to be and this in turn is a function of the kind of replications (constructs) he has detected in or imposed upon his Universe."

Constructions involve "organising " "perceptions" in different ways, namely organising into different categories or sets of constructs. A construct is, strictly speaking, a discrimination along a continuum. For a good account of Kelly's work see Bannister and Fransella(1971).

What emerges clearly from the discussion so far is that the categories into which the objects and events of experience are "seen" to fall are not wholly dependent upon the "ultimate nature" of the world, but are primarily dependent upon preconceptions of the observer. Perceptions, when allocated to a category, become observations. Thus, if we are to observe particular things, we must know what counts as a particular thing. The observation that "I am writing a thesis" must be preceded in some sense by a knowledge of what counts as thesis writing. A system of categories or structure of belief is in existence prior to the recognition of a member or members of these categories in experience. Observing in general will require an ability to differentiate perception into established categories.

The process of differentiation will involve establishing or recognising identicals at one end of a scale as we, for instance,"see that" the behaviour of System X is identical to the behaviour of System Y, and total dissimilarity at the other end of the scale at which we "see that" there is absolutely no similarity between System X and System Y's behaviour, with degrees of recognisable similarity in between.

If identicals, similars and total dissimilars are to be recognised, there must be criteria for recognition. The basis for a particularly "neat" set of criteria is provided by Leibniz's principle of the identity of indiscernibles (Ishiguro, 1972) which asserts that if the there is no property that X has that Y does not have, then X is identical to Y :

$$\forall x.\forall y.\left[\sim\exists\phi\,(\phi x \cdot \sim\phi y) \supset (x = y)\right]$$

This simply means that if there is no discernible difference between things, they are the same thing. Conversely, we might turn the statement about and say if two things are identical, there will be no discernible difference between them :

$$\forall x.\forall y.\left[(x = y) \supset \sim\exists\phi\,(\phi x \cdot \sim\phi y)\right]$$

In this form, the principle is known as "Leibniz's Law".

As a criterion of identity, this may seem too strict since one often says objects are identical when they are not at all. Identical necklaces, for instance, would not qualify under this criterion since they do not share the same spatial positions, etc. However, I wish here to only use this as a starting point to define two categories of recognition.

Having defined identity in the strictest sense, we can derive a definition of total dissimilarity. If total identicals have all properties in common, it follows that total dissimilarities have no properties in common.:

$$Vx.Vy. \left[(x \neq y) \supset \sim \exists \phi (\phi x \, . \, \phi y) \right]$$

These criteria may have no practical use, since the former only serves to make observations identical to themselves, while the latter identifies an empty class - everything at least shares existence. Their value is to define two extremes between which lies a third category of recognition, the category of "similars", which we may specify by saying that "similars" have shared properties. They do not either share no properties or all properties. Thus, if X and Y are similar, they share at least one property :

$$Vx.Vy. \left[(x \Sigma y) \supset \exists \phi (\phi x \, . \, \phi y) \right]$$

This, then, is the category that we are interested in, since all perception will be organised into categories or observations which fall between two extremes of strict identity and total dissimilarity. However, to be similar, observations (categories) may have one or all but one properties in common, and thus it follows that if statements to the effect that "X and Y are similar" are to be "useful", one must be able to specify explicitly or implicitly, in what respects X and Y are held similar. A device for this purpose is employed in Chapter 5 taking the form of a technical notion of Analogy (Pask, 1975). This is explored in Chapter 8.

For the purpose of identification, then, not all properties are relevant. "Identical" necklaces are not identical in the strict sense, but similar. For the purposes of differentiating necklaces, not all properties that any particular necklace can have are relevant, necklaces are defined by the set of properties that separate necklaces from other categories of objects. When we say these necklaces are "identical" we are implicitly recognising that these objects share, on the one hand, the set of properties that defines this class of object, and on the other, any additional properties that would normally differentiate any one necklace from all others. Thus, the truly "identical" necklaces of everyday speech would differ only in their spatial/temporal position.

The point that this somewhat technical argument aims to underline remains essentially the same ; the categories of experience are not forged objectively in any complete sense by real world mechanisms, but subjectively by psychological mechanisms of experiential beings. The categories of experience are variable according to the properties taken to define them, so that at one extreme, experience is undifferentiated, and at the other, there are as many observations as there are defining properties. Individuals adopt the categories they do according to their purposes or inclinations and while, as a contingent fact, they may generally adopt the same categories, they need not, logically, do so. All the great breakthroughs in thought may be "seen" to be a function of revised categories. Within this work, this powerful idea remains central and provides a linchpin which enables the author to combine aspects of Realist philosophy, personal construct theory, conversation theory and viable system modelling in a way that illuminates the processes of organisational problem solving.

2.2.2. Conclusion on Problems

It is hoped that the above arguments have served to illustrate that any problem is open to subjective "inputs" on the attainment side of the equation (Mitroff, 1977). The overall result is that problems are as variable as the people that own them. They may be solved or resolved by changes in the states of affairs that prevail in the problem situation, changes in the way the problem situation is viewed (changes in observation due to subjective factors), or changes in goals related to the problem situation, and they may be dissolved by changes in the relative importance attached to the problem. Ordinarily speaking, there are no problems in nature, their ontological status depends (is contingent) upon the existence of a problem owner who may construe the problem situation and the observations relating to it in a unique way.

If one is to solve a problem, one had better be clear about what problems are in general, and what this problem is about in particular. Once it is appreciated that problems are highly variable according to complex psychological processes, the need to define and structure the problem becomes apparent, so that the actors in the problem situation can be clear about <u>what</u> (whose) problem, what construction of reality they are thinking about.

2.3. Problem Structuring

In the last section, the softness of problems was emphasised as the probable existence of different points of view in relation to any agreed state of affairs. Even the prevailing states of affairs are seen to be subject to disagreement in a way which may be perfectly consistent with objective states. It is very easy to find books and learned articles on problem solving, but these often take, as a starting point, a given category of problem, i.e. a transport problem, a scheduling problem, a personnel problem, etc. etc. Insufficient attention is paid to problem structuring which we may regard as the process of formalising or externalising a construction of a problem within one or a number of Weltenschauungen. This is vitally important in the light of the conception of "problem" developed in the previous section in order that the owner of a problem may be clear about the problem he "owns".

Two kinds of benefit follow from problem structuring activity, which make the activity valuable if not indispensable. The first kind occurs in situations where "perceived dissonances" are open to alleviation by some technique or other, as in the transport type problem. Problem structuring will be the process through which the parties concerned arrive at a conclusion about the "problem" and this conclusion must arise with greater facility if there is structured activity, a methodology aimed towards this goal. However, it often arises within organisational problem situations that the principal "actors" disagree fundamentally about the problem situation ; either it is not agreed that there is a problem, or there may be radically different views as to what the problem is.

In terms of the problem situation of George Ellison Ltd., this kind of predicament is illustrated by the "Which computer ?" and associated debates outlined in Chapter 7, and the difference in general outlook on the business modelled in Chapter 9.

In these cases, problem structuring is the only activity that can take place and the process of formalising or externalising constructions serves to provide a methodology that enables a civilised debate to take place. Insofar as the debate fosters a common view, it serves the purpose of conflict resolution, although it may often arise that "parties" agree to differ rather than straightforwardly agree. The process of externalisation of viewpoints through a structured debate ensures that there is some common understanding of the issues at the focus of the disagreement. Disagreements will change as a function of the views of the problem owners, thus, in a healthy debate there will be a constant restructuring of the problem(s) so that the nature of the "observed" problem evolves.

The work of Eden and Sims (1977, 1978) supports the general conception of "problem" and the need for structuring/definition developed in this work. Against a background of organisational complexity, "the reality of an objectively defined problem" is not attainable.

"In this environment, problems are not self-evident at all ; under the guise of the same problem title, each actor sees a reality which is unique to him, that which comes to be known as the "real" problem for the consultants depends, then, upon his "own" reality, and that belonging to those actors to whom he chooses to listen."
Eden and Sims, 1978.

Particular attention is directed to the "problems" that this conception poses for the practitioners of O.R., the consultant, in attempting to understand the definition of a problem adopted by the client.

"Our starting point will be the process of understanding, defining, or negotiation which takes place between a consultant and his client. It is crucial because it involves the construction of a model, by the client, which is intended to represent a problem he owns (Reynolds, 1973*). That is, the client can only represent his problem through the process of structuring words, gestures, intonations and pictures (the elements of the model) into a model which can be interpreted by the consultant." Eden and Sims, 1977

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* The concept of ownership is taken from M.Reynolds (1973) "Ownership in Work", Management Education and Development, 4, 86-94.

The various approaches to problem structuring to be found within operational research are surveyed and characterised by Pidd and Woolley (1978, 1980a,b, Woolley and Pidd, 1981). Four streams or approaches are identified as follows :

1. The Checklist Approach - this seeks to structure problems, i.e. solicit constructions by seeking answers to a predetermined list of questions which represent an algorithm for carrying on the structuring process.
2. The Definition Approach - this is similar to the Checklist Approach in that a set of entities are prescribed for an analyst to define. The distinguishing characteristic is that "problem" means "decision problem" and everything is seen as decisions. By contrast, the Checklist Approach sees problems as "something gone wrong".
3. The Understanding Approach - this view is based upon a view of O.R. as "science", whose role is to investigate reality. One might even call it the "Science Research Approach".
4. The People Approach - this is characterised by the subtlety of the approach which lays stress on mapping out the perceptions of the various actors involved in the problem situation.

In the work reported here the first three approaches to problem structuring are rejected on the grounds that they are in contradiction to the concept of "problem" developed in the previous section, holding, as they do, to the objective existence of problems. Within the People Approach, one finds the work of Eden and Sims (1977, 1978, Eden 1978) and Checkland (1978). Checkland's work is seen as particularly relevant to the work of this study, not only because it is in sympathy with the concept of problem developed here, but also because it does offer a coherent and operationally-tested methodology which is considered to be helpful in the context of this research.

In the next section of this chapter, approaches to problems are considered at the broadest level of categorisation. This will involve some consideration of Holistic and Reductionist approaches and the general conclusion is reached that these apparently contrasting and contradictory approaches can reasonably be seen as complimentary.

2.4. Approaches to Problems

In this section it is intended to consider the broadest aspects of problem "solving" by discussing approaches at their most general level of categorisation. The broadest categorisation to be dealt with here is into HOLISTIC and REDUCTIONIST. These types of approaches to problems (their solution, resolution, etc.) are not discussed exhaustively, but it is hoped that the treatment will be adequate to give an understanding of the consideration involved. In relation to these categories, it will be argued that realistic, workable methodologies involved a rejection of these categories as absolute lines of demarcation ; both holistic and reductionist techniques are required at appropriate stages.

Problems exist not only in organisational situations such as those discussed in this thesis, but also in the humanly defined knowledge areas which provide our understanding of "how" these situations work. Science, both natural and social has its methodologies which one might classify as above (Holist and Reductionist). Further, advances in organisational problem solving are often argued to stem from the application of science, both the product (knowledge) and the process (methodology), to organisational problem situations. Thus, Stafford Beer (1966), in describing operational research, quotes a statement of the Operational Research Society of Great Britain as follows :

> "Operational research is the attack of modern science on complex problems arising in the direction and management of large systems of men, machines, materials and money in industry, business, government and defence. Its distinctive approach is to develop a scientific model of the system, incorporating measurements of factors such as chance and risk, with which to predict and compare the outcomes of alternative decisions, strategies or controls. The purpose is to help management determine its policy and actions scientifically."
>
> Beer, 1966, p.92.

Frederick Taylor (1911) was one of the first workers in management to see the relevance of scientific knowledge and method to the problems of management, and believed that he could show (among other things) that "...the best management is a true science, resting upon clearly defined laws, rules and principles as a foundation." (Taylor, 1911, p.7).

Undoubtedly, there is a basic desire amongst many writers on organisations and organisational problem situations, to act scientifically, and even when this need is not explicitly stated, as is often the case with practitioners in management, a claim to have produced the answer or recommendation scientifically usually commands attention. These attitudes have become part of the ethos of modern management, but although "scientific" considerations underpin much management thought, insufficient attention is paid to what being scientific amounts to.

This question is the focus of a debate which has developed in line with developments of epistemology, and there are a number of different accounts of what it is to be scientific which could be outlined here. The preferred view of the author is a REALIST account and a version of this will be used to evaluate and classify the Checkland methodology in Chapter 3. However, before proceeding with a description of scientific approaches, the general categories of Holism and Reductionism are explored. Reductionism is considered first.

2.4.1. Reductionism

This is the general term for approaches to problems which embody the belief that all phenomena can be explained and understood in terms of simple laws or generalisations which are held to govern the phenomena. The apparent complexity of the world of experience is an illusion which is underpinned by a simpler reality ; thus, different kinds of matter are "nothing but different collections of "similar" atoms" (Boorse and Motzi, 1966), minds are "nothing but a by-product of brains" (Hardie, 1960, Huxley, 1874), morals are "nothing but attitudes" (Williams, 1972), purposeful behaviour is "nothing but conditioned reflexes/responses", etc. (Skinner, 1955)., all of which can be uncovered by the analytical technique.

Jung (1971) describes reductionist thinking as "negative".

> "Its habitual mode is best expressed by the two words 'nothing but'... Above all, it shows a distinct tendency to trace the object of its judgement back to some banality or other, thus stripping it of any significance in its own right. The trick is to make it dependant on some commonplace or other." Jung, 1971, p.353 .

Clearly, this is not a favourable view of reductionist thinking, and to give some balance to the argument, it is necessary to introduce a distinction between the pragmatic value of any methodological instrument and its theoretical justification.

It is undeniable that most of the ideas that have supported the undisputed advances of modern science and technology have been reductionist in character, and as such, this type of approach must be acknowledged as having pragmatic value in shaping the physical environment. However, it is partly a product of reductionist thinking that science and philosophy are seen to fall into discrete areas or disciplines ; thus the social impact of technology has tended to be the concern of the social historian and not the scientist or technocrat. The growing complexity of the modern world is making it impossible to ignore the impact of "hard" (analytical) science upon society, with the result that many of the more important questions conceived by "society" are seen to lie, not outside the domain of traditional science, but squarely <u>across</u> the accepted, and in some cases, institutionalised disciplines (Apostel et al., 1970).

To employ a "hard" scientific technique is to be reductionist because it involves treating a situation within a famework of a set of simplifying assumptions, the greatest of which will be "<u>ceteris paribus</u>". In order for this to be possible, one must assume that the subject under consideration is a closed system, i.e. a determinist machine where every facet of the system, including inputs and outputs, is known or knowable. Failures in such techniques are symptomatic of two fundamental things. Firstly, the world of human experience (observation) is not a closed system but an open system, i.e. it is not wholly predictable. Secondly, it is not, in these cases, possible to treat the experiential world as if it were closed, and still achieve high levels of performance in problem solving.

The long history of success for traditional science has been possible because there have been, and, of course, are situations where the world can be successfully treated as closed, and the instrument to achieve this closure is the controlled experiment in which one excludes sources of random variation. Thus, for hard science to be possible, the world of man's experience must be conceived as an open system (to account for the failures of determinism). These ideas will be explored in the section below on "What is it to be scientific?", but before considering these issues further, the apparent contrasting views of Holism will be examined.

2.4.2. Holism

This is the general term for approaches to problems which avoid any innecessary simplification based upon the belief that the systems in the "real world" are at least as complex as they seem and probably more so. It does not, contrary to the belief of many, stand in diametrical opposition to reductionism, since perceptions as raw data and unrefined does not produce any patterns or likenesses (cf. Chapter 1). Reduction is necessary (through a Weltenschauung) in order that something be recognised as a problem, a system, a component, etc. Any view which did not admit a reduction would have to be characterised as Naive Holism, and is rejected here. Having recognised problems, systems etc. the difference begins to emerge. Firstly, the context of the problem is recognised as significant and important ; thus, holistic thinking recognises the importance of environment, meta system, etc. Secondly, the dynamic nature of problems/systems is recognised so that any analysis will be focussed as much upon the relationships between the elements of a system as the elements themselves. In general terms, this amounts to treating any relevant systems as "open" and probabilistic.

Why, then, is the relationship between elements in a system at least as important as the elements themselves ? Consider, by way of illustration, the traditional mechanical clocks ; wherein lies the "clockness" and how would a member of a "clockless society" investigate it ? Within the framework of this discussion, one might imagine how the reductionist and holistic thinker might approach these questions.

The reductionist thinker, and the general characterisation given above, would be interested in the component parts, being motivated by a desire to know "what" is in a clock. However, it seems clear that "clockness" does not reside in the component parts of a clock but in the relationships between the parts, and an understanding of this would seem to require some consideration of function. (The role of function in systems thinking will be considered in more detail in the next chapter). To qualify as a clock, any mechanism must perform the function of a clock as defined by the "user" of the mechanism. To be precise, a mechanism will be adjudged a clock according to the purpose of a user, and to this extent, clockness lies completely outside the physical mechanism. It is the ability of the components to "mesh" together to perform the prescibed function that licences (together with an understanding of the concept "clock") the description "clock". In short, something of the wholeness of the clock, the clock as a system, a set of interrelated parts, working to a purpose, is required.

This line of argument might be seen to be supporting the idea that reductionist thinking could discover little or nothing about such problems, but this would be unjustified except in the most extreme cases. Provided the reductionist thinker at least knew that a collection of components did constitute some unity or other with a function, it seems possible that a study of the parts might yield some understanding since such work would answer questions about what relations are possible, (the cogs of a clock cannot go together in <u>any</u> way, but usually in <u>one</u> particular way) which might be followed by questions about what functions the possible mechanisms could perform. This style of thinking is not reductionist but might be characterised as "bottom-up holism", and is often the only mode open, as in the case of the fragmented evidence often confronting the archaeologist or paleontologist. However reductionist a methodology sets out to be, its user will be contextually bound and cannot be (entirely) reductionist ; at best he will be a holist in the bottom-up mode.

An argument for the importance of the overtly holist approach to epistemology centres on the concept of "emergent properties", the idea that whole systems display <u>some</u> properties that are not apparent in the parts, and therefore cannot be explained as accumulations of component properties. Implicit in the reductionist ideology is the belief that the key to understanding lies in an analysis of the system, an examination of the parts. By contrast, the holist tends to the belief that the emergent properties are the most important.

Emergent properties seem to fall into two categories, as follows :
Firstly, there are those properties which are the products of amplification, where, strictly speaking, these properties do exist in the components, but accumulations do not account for the <u>quantity</u> present in the whole system.
Secondly, there are those properties that are more genuinely emergent in that they are not present in any quantity in the component parts of the system.

The first category constitutes synergistic components or products and is well described by Ansoff (1965) as the "effort which can produce a combined return on the firm's resources greater than the sum of its parts", and this "is frequently referred to as '2 + 2 = 5'". (Ansoff, 1965, p.75). It is important to realise that systems can show negative synergy in which the combined resources of a firm produce a return which is less than the sum of its parts, a sort of 2 + 2 = 3 effect.

The second category, that of genuinely emergent properties, is often the most important to the Holistic thinker while :

> " The reductionist is the most enthusiastic wielder of Ockham's razor. But even in physics and physical chemistry there are phenomena such as those connected with heat flow which have no meaning at all in terms of individual atoms and molecules, but which are repeatably measurable, and which lead to theory able to explain the observations. Such emergent properties are characteristic of a given level of complexity."
>
> Checkland, 1976.

Having briefly examined Reductionism and Holism, the next section will look at a compromise view which offers a more workable framework.

2.4.3. Holism-Reductionism : A Pragmatic View

The view supported by the author is pragmatic in that it recognises not only that Holistic thinking is vital to ensure that emergent properties and their relationships are not overlooked, but also that Reductionist thinking has an established, pragmatic value, particularly when it is not naively applied. Checkland (1976) quotes Popper (1972) as follows :

"Now I want to make it clear that as a rationalist, I wish and hope to understand the world and that I wish and hope for a reduction. At the same time, I think it quite likely that there may be no reduction possible : it is conceivable that life is an emergent property of physical bodies."

The view that life is an emergent property seems to be supported by Varela et al. (1974) and Zeleny (1977), whilst Pierre Tailhard de Chardin (1955) held life and, in its turn, consciousness to be emergent through the processes of complexification and integration. Given that many problems conceived by modern man are associated with physical and organisational situations which are increasing in complexity, opportunities to "reduce" may provide opportunities to increase problem solving abilities. It is interesting to note that recent work at the University of Aston (Robertson and Molloy, 1981; Robertson et al.,1981) seems to underline the idea that problem solvers do not simply adopt holistic or reductionist approaches as a matter of policy, but show positive predispositions according to their psychological type.

Successful reduction does not require that the "real world" be as simple as we might assume it to be, only that the answers, decisions or actions that flow from such assumptions be commensurate with answers, decisions or actions that would flow from a "correct" understanding. Whilst one prefers to get the "right answers" for the right reasons, to get the right answers for the wrong reasons is not a bad second prize.

Goguen and Varela (1979) have argued that concepts such as Holism and Reductionism, whilst being distinct, are complementary because they focus on different levels.

"Most discussions place Holism/Reductionism in polar opposition. This seems to stem from the historical split between empirical sciences, viewed as mainly reductionist or analytic and (European) schools of philosophy and social science that grope towards the dynamics of totalities.

In the light of previous discussions, both attitudes are possible for a given descriptive level, and in fact they are complementary. On the one hand, one can move down a level and study the properties of the components, disregarding their mutual interconnection as a system. On the other hand, one can disregard the detailed structure of the components, treating their behaviour only as contributing to that of a larger unit. It seems that both these directions of analysis always co-exist, either imlicitly or explicitly, because these descriptive levels are mutually interdependent for the observer."

Goguen and Varela, 1979.

If the ability to deal with problems is to be maximised, over-simplification must be avoided where possible, but a refusal to reduce in any circumstances can only result in ineffective problem solvers. Where the right/perfect answer is not immediately available, action to improve a situation supports learning by trial and error. This is clearly recognised by methodologies such as Checkland's, who talks solely in terms of "action to improve situations" and iteration.

It is tempting to approach a discussion of the relative merits of Reductionism and Holism with a view to determining which is correct, but the discussion has made it clear that this conception is inappropriate since both approaches have their merits and need not be taken as contradictory but complementary. One cannot, therefore, say that one or the other sets the framework to which any more detailed approach to problem solving must conform. The discussion has served to underline this fact, so that it is necessary to look to the discussion of scientific approaches below for a framework. However, one can say that any such framework should allow Holistic and Reductionist strategies to work in a complementary way.

This whole section has been essential both to develop an appreciation of the points made above, and to launch the development of a number of ideas that will lead to an explanation of the problem solving process.

The discussion now moves on to consider the question of being scientific, as outlined above.

2.5. "Scientific" : What is it ?

Despite the importance of this question, insufficient attention has been given to it by many practitioners and thinkers who take both the content and methodology of science to be axiomatic to their approach. The discussion below will attempt to outline five interpretations of this question in a way that will highlight the preferred view of the author. These views, Positivism, Crude Falsificationism, Kuhnianism, Sophisticated Falsificationism and Realism, cannot be dealt with in the detail that would do any of them justice ; however, such understanding as is possessed by the author has been instrumental in shaping the development of those ideas which this work seeks to bring to bear in understanding the practical problem situations within the sponsoring organisation. The five views are not strictly alternatives in the sense of being mutually exclusive, since some share interpretations in some areas if not in others. Neither could these views be said to be the only interpretations that have been posited by members of the scientific/philosophical community ; they are simply views of which the author has become aware, which have been influential in the intellectual development of the author, and which seem to enjoy, implicitly or explicitly, following amongst the academic community.

All schools of thought would agree upon certain basic generalisations about science, namely that the "job" of science is to generate, record and transmit man's understanding of his world so that men may be more effective in achieving their objectives. This embodies the necessity to develop methodologies to explain the past and predict the future through the establishment of suitable theories about the operation of the world. The discussion below will necessarily be concerned with the meaning of explanation, prediction and theory.

It may not be necessary for everyone who wishes to develop a methodology for complex problem situations to examine the nature of science as espoused by philosophers of science, but this has been the route taken by the author. The influence of the Transcendental Realist view of science will be apparent in the chapters that follow,

Another reason is that this discussion will provide a description of the realist approach which is the most general framework that has been sought throughout most of this chapter. The bulk of the discussion will be focussed on the realist account because this is what the reader must carry across to the chapters below in order to appreciate the ideas developed. For this reason, the discussion will be set out in two sections : one covering positivism and several other approaches, and one devoted exclusively to Transcendental Realism. The two sections will be bridged by a short section of explanation which will serve as a contrast to the interpretation embodied in realism.

2.5.1. Significant Interpretations of "Scientific"

In this section several theories of science will be briefly examined. None of these views has been able to provide satisfactorily the kind of broad framework for problem handling that has been sought in this chapter. However, they do merit some discussion because these ideas have been, and to some extent still are very influential within many scientific communities. Also, a brief discussion will serve to underline the fact that a considerable amount of debate has taken place within the philosophy of science, so that questions about science and what constitutes a scientific approach to problems are not trivial. The theories covered here are only outlined, and the reader will find fuller treatments in Appendix B.

The first interpretation of scientific activity to be dealt with here is the Positivist approach. Many of the remarks made above show the author's disapproval of positivism. This stems mainly from its predominantly reductionist character. However, positivism has been an extremely influential interpretation of science and its effects still linger in the world views of many scientists, philosophers and practitioners of scientific management.

Positivistic science blongs squarely to the empiricist tradition and may be characterised as containing four central principles :

1. Accumulation
2. Induction
3. Instance Confirmation
4. Simplicity.

The principle of accumulation embraces the notion that scientific knowledge consists of discovered "facts" of the past and grows by the accumulation of well-attested "facts". Scientific activity, then, becomes the pursuit of "invariances" in the patterns of phenomena in nature so that the scientist can bring new phenomena (facts) of an old kind (invariant in type) under existing laws.

The laws concerned will be expressed in the hypothetical conditional form : if.... then.... and will generalise constant conjunctions of invariant facts in the system under consideration. This amounts to treating systems as "closed" since only systems with no unspecified inputs from an environment could display widespread invariances.

The principle of induction supports a process through which laws are generated through generalising from particular instances or facts. This process can have no logical basis, but it does seem to be a natural product of "common sense" thinking. For scientists not of the positivist persuasion, it is most difficult since one may not accept facts as unchanging or unchangeable elements, and it will always be possible, in principle, to support an infinite number of generalisations or hypotheses with any finite set of facts.

The principle of Instance confirmation is closely linked with the two principles above. It is sometimes referred to as the verification principle and embodies the idea that theories grow in stature as more positive instances of verifying facts accumulate. It is interesting that this leads to a focus on correspondence truth since the issue for the realist empiricist is whether the world is as stated by the theory. The logical objection to the principle is substantially the same as for the principle of induction. No number of positive instances of a phenomenon reduces the likelihood that a law generalising the phenomenon is false.

The three principles above, together are seen by the positivist as responsible for the growth of science. The mechanism of this growth is illustrated in Figure 2.1.

A main aim of positivist science is to bring as much of the world's 'facts' under appropriate theories as possible. Thus, failures of tests will often be met by the generation of exception conditions rather than rejection of hypotheses. However, one can object to this model on the basis that science does not seem to progress by a steady accumulation of facts, but in step functions with the discovery of new facts alternating with theoretical advance.

It has been said that any finite data set can, in principle, support an infinite set of hypotheses and the positivist uses the principle of simplicity to separate out the best of the candidates. This principle embodies one of the greatest difficulties, since it would seem to favour micro- rather than macro explanation. The idea that the world comprises a simple set of samples (say atoms) with no emergent properties is simpler than supposing that there are emergent properties. This strikes against the conclusions reached in Section 2.3 and positivism is therefore rejected.

The discussion above has done no more than present a stereotype of positivism. A slightly more detailed account can be found in Appendix B. The next interpretation of science is that of "crude falsification".

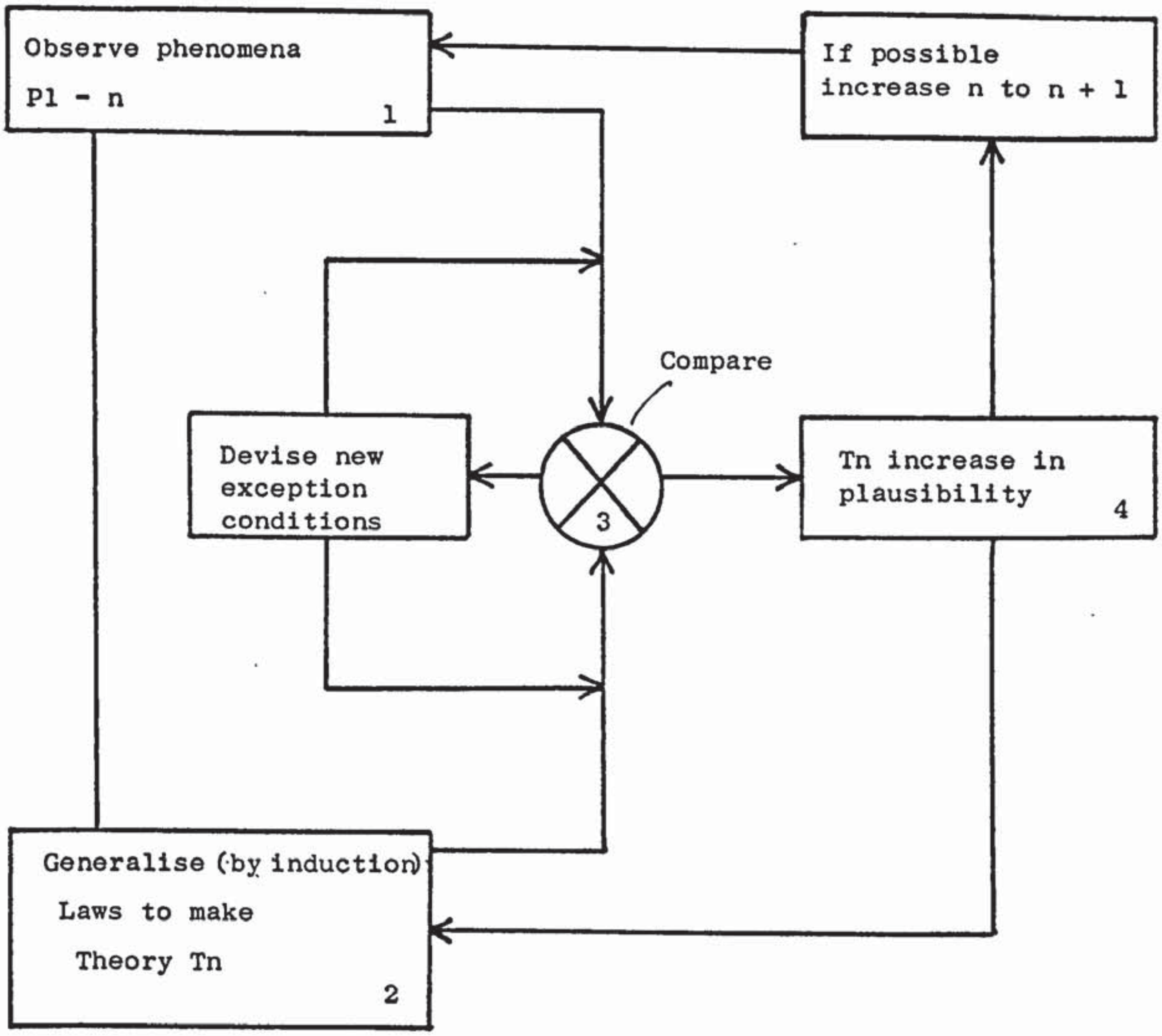


Figure 2.1.

A Positivist View of the Growth of Science

This view has been exemplified in the writing of Karl Popper (1959, 1963) and is closely related to the positivist account given above. It is not possible in the space available here to describe the similarities (see Appendix B for that), therefore the discussion will focus on the major difference.

This interpretation rejects the principle of induction and, importantly, the verification principle as a suitable basis for science. Scientist are required to attempt to falsify hypotheses rather than verify them. This is based upon the Modus Tollens form of reasoning, $\left[(p \supset q).\sim q\right] \supset \sim p$, which can provide a logically sound basis for procedure. This is because a single failure of a test requires, logically, the rejection of the hypothesis tested.

This leads to a classification of theories on the basis of their empirical content. Where high, this content leaves theories open to more tests so that testing becomes the business of science. This leads to a demarcation principle as follows :

Science	-	Metaphysical and Empirical content
Non-Science	-	Metaphysical content only
Pseudo-Science	-	Metaphysical with pretentions to empirical content.

What separates science from pseudo-science is method. The pseudo-scientist does not specify conditions for a failed test in advance and characteristically explains events, post hoc, rather than predicting them. A model of the Falsificationist view of science is given in Figure 2.2.

The falsification principle is certainly an advance of verification.

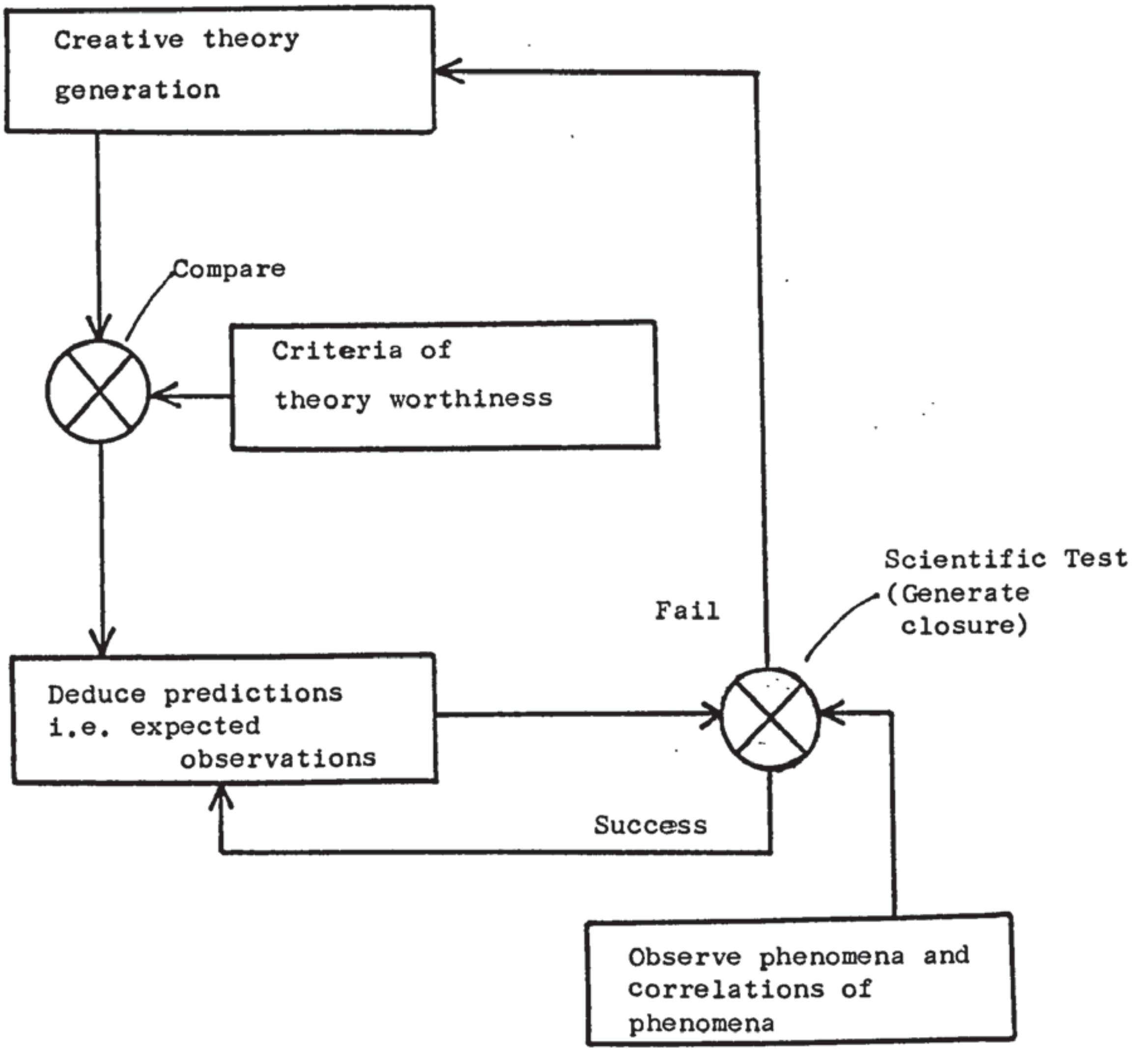


Figure 2.2.

A Falsificationist View of Science

However, the process of theory generation does not seem to have any logical or procedural basis, and even the falsification principle seems doubtful since there is no basis on which to isolate those parts of a theory that may be responsible for failure in an individual case. Should one really reject a whole theory on the basis of one failed test ?

The next interpretation belongs to Kuhn (1962) and is based on the idea that the scientific community is not a homogeneous set of scientists separated only by what they study. Scientists share a basis for working in co-operation with one another and this is a paradigm or example which a scientist follows. Within a particular field of science, there will be one or a number of paradigms which are in competition to become "the establishment" to which the majority of scientists working in that field will give their allegiance. Paradigms begin with some general theory and supplant their competitors by impressing scientists : a sort of "band-wagon" effect.

A paradigm supplies to participating scientists a number of conventions. Firstly, it supplies sets of problems which will be the articulation of the paradigm. Secondly, it supplies methods for tackling the problems of the paradigm so as to allow humbler members to participate in research. Thirdly, a paradigm supplies criteria of success, so that successful solutions are defined or characterised, while failed predictions may not be regarded as significant. Finally, paradigms supply ways of interpreting what is observed, so that as long as scientists see things the way the paradigm does, there can be no disagreement about the "observed facts" within the framework.

Kuhn makes a distinction between normal and revolutionary science. The former refers to activities carried on within, and during the rule of an established paradigm, while the latter refers to scientific activity at a time when the old establishment is weak or dead, and one or a number of new paradigms are attempting to become established.

Kuhn has attacked both the positivists and the falsificationists (see Appendix B) and is attractive here not only because of this, but also because he captures the kind of relativism envisaged in the early part of this chapter. However, one cannot be content with this view since although it stresses the social and psychological aspects of scientific activity, it does not identify any "rational" procedure for paradigm change. As an explanation, one feels that it is valid but incomplete. Once again a more detailed discussion may be found in Appendix B.

The work of Kuhn produced a debate in which the views of Kuhn and the falsificationists were in part reconciled through a kind of sophisticated falsificationism advocated by Lakatos (1970).

The Lakatosian equivalent of the paradigm is the Research Programme. Lakatos accepts the social aspects of scientific activity so ably identified by Kuhn, but argues that Kuhn is mistaken in maintaining that no process yet discovered "resembles the methodological stereotype of falsification by direct comparison with nature". It is accepted that paradigms are "ways of looking at things", but Research Programmes should not be allowed to become a "normal science. Science needs competition.

A Research Programme is conceived as having two fundamentally different components, as illustrated in Figure 2.3. The hard core of the programme is not subjected to Modus Tollens and is thus regarded as irrefutable. The articulation of the programme generates a protective belt of auxiliary hypotheses to which Modus Tollens is applied according to the methodology of crude falsifications. This protective belt is regarded as expendable to the programme and will characteristically change its composition through time.

The hard core will consist of the core constructs of the programme which will be embedded in its central hypotheses. The methodology of the hard core is the "Negative Heuristic" in which counter examples are deflected by generating suitable auxiliary hypotheses which attempt to change the "observations" which constitute the counter examples. The hard core is not invincible, and will fail when the heuristic power (the ability to open up new lines of enquiry) of the programme is exhausted.

The heuristic power of the programme lies in its ability to generate a "problem shift" which arises from the dynamic nature of the protective belt. This will, in effect, generate work for scientists, because the articulation of the programme will only be partial and there will usually be Kuhnian "puzzles" to solve. Since a programme will often have competitors, its continued existence will be solely dependent upon its being able to maintain its heuristic power.

There is no doubt that these latter descriptions do seem to approach a "realistic" account of science, but as guides for complex problem solving, they do not satisfy the author. It is worth noting

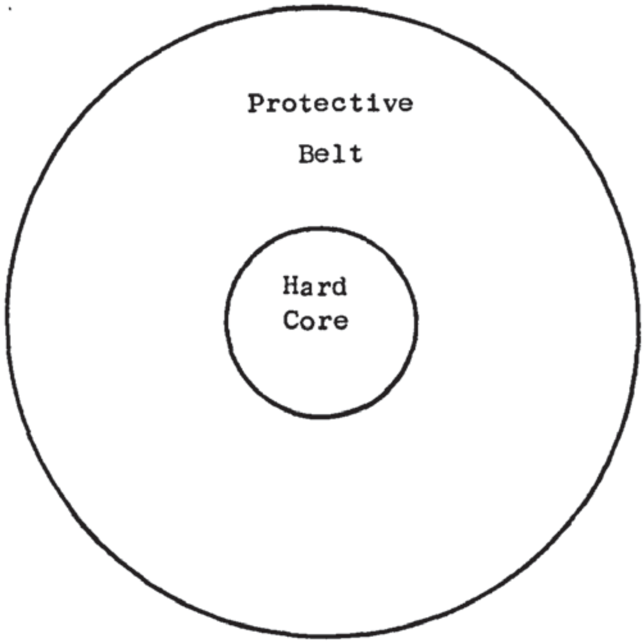


Figure 2.3.

The Research Programme

that all the theories descibed above treat the world as a closed system, and so characterise science and scientists as exploring the regularities (invariances) in the phenomena. Therefore, the theories of science are seen as embodying the laws which generalise the regularities of nature in a descriptive way. Explanation and prediction are seen as symmetrical, arising from a deductive relationship between a law and the phenomena that it generalises.

The features are unacceptable to the author, and sufficient discussion has already been included to justify rejection on the basis of treating the world as a closed system. However, it has not yet been made clear why one rejects symmetry between explanation and prediction. For this reason and because of the importance placed upon explanation in T.R., a short section describing the symmetrical model of explanation is included. As with the material of this section, this will stand in contrast to the line followed by T.R. The T.R. model will prove central to the model of problem solving developed by the author.

2.5.2. The Symmetry Between Explanation and Prediction

A central idea shared by all theories of science is that science explains the world so that man can predict the future and thereby be better equipped to control his environment, for the positivist explanations and predictions are generated in the same way.

To explain any phenomena is to show that a description of the phenomena can be derived from a covering law plus an initial condition by simple deduction as follows :

Whenever A, then B	(Explanans)	past
A		
Therefore B	(Explanandum)	present

This is known as the deductive-nomological (D-N) explanation in which the explanans logically implies the explanandum. The D-N model is principally attributable to Hempel (1965). On this account, explanation and prediction are logically identical operations ; symmetry arises because in explanation the event to be explained will be given, and the law, plus an "initial" condition cited to explain it, whilst for prediction, the law and initial condition are given and the future is predicted from them. The <u>form</u> of the inference is from past to present whilst prediction involves inference from present to future.

Whenever A, then B	Past
A	Present
Therefore B	Future

It will be argued below that there is, in fact, an asymmetry between explanation and prediction, and that the account given above fails because of its inability to account for the extra element in explanation which goes beyond a general description of the phenomena involved.

Karl Popper is amongst those who have followed this interpretation of explanation, although, as we shall see below, he has differed substantially from the positivists.

> "To give a <u>causal explanation</u> of an event means to deduce a statement which describes it, using as premises of the deduction one or more <u>universal laws</u>, together with certain singular statements, the <u>initial conditions</u>. For example, we can say that we have given a causal explanation of the breaking of a certain piece of thread if we have found that the thread has a tensile strength of 1 lb. and that a weight of 2 lbs. was put on it."
>
> Popper, 1959, pp.59-60

Popper uses this model of explanation as a significant ingredient in his characterisation of scientific activity. Arguing specifically against Operationalism and Instrumentationalism, he goes on to advocate that these be replaced

"...by the recognition of the fact that we are always operating within a complex framework of theories, and that we do not aim simply at correlations, but at explanations."

He goes on

"...It has often been said that scientific explanation is reduction of the unknown to the known. If pure science is meant, nothing could be further from the truth. It can be said without paradox that scientific explanation is, on the contrary, the reduction of the known to the unknown. In pure science, as opposed to an applied science which takes pure science as "given" or "known", explanation is always the logical reduction of hypotheses to others which are of a higher level of universality ; of "known" facts and "known" theories to assumptions of which we know very little as yet, and which have still to be tested."

Popper, 1963, p.63.

As a slight aside, it is interesting that Naughton (1979, 1980, 1981) has built a strong criticism of the General Systems movement (GST) upon what he calls the "non-statement view of science". This is based upon the work of Sneed (1971) and others and has a distinction between pure and applied domains not unlike that given by Popper above. Appealing for a more pragmatic approach to GST, Naughton has introduced the notion of "craft theory" which is characterised as "how knowledge" rather than "why knowledge", and does not imply the necessity to explain, at least, not in the terms of our preferred view. The important point here is that the applied sciences do not only apply science, but have a body of experiential knowledge which amounts to knowing how the particular parts of the world operate in terms of actions and outcomes, but not why it should be so. This may not even involve any generalisations, but one can imagine generalisations easily arising so that explanation may be possible in what we regard as the minimal sense of the D-N model. Craft knowledge may well be both real and useful in terms of interdisciplinary problem solving, but it is argued here that as knowledge it must be qualitatively inferior to scientific knowledge since, as will be argued below, knowledge of the mechanisms of production is always better since it is a real basis for knowledge of which generalisations are applicable. Further, the validity of craft knowledge is always contingent upon that part of the world in question remaining stable in terms of its patterns of phenomena which is always a weaker assumption where the mechanisms involved are unknown.

2.5.3. Realism

The discussion in the two previous sections has served to illustrate that the question of scientific procedure is far from being simple. However, one should not forget that the arguments being presented are intended to point the way to an appropriate method for problem solving, and thus far, some tempting views have been examined and rejected. This section wil examine an account of scientific activity which is acceptable to the author and is therefore able to provide a scientific basis for an explanation of the problem solving process. By the end of this chapter, "scientific procedure" will have been characterised and a number of models will have been produced which will form essential elements in the methodological model described in Chapter 5.

Any account of science which begins with the idea that a real world exists independent of an observer is, strictly speaking "realist", so that even some versions of positivist science fit this description, and the fact that the phenomenalist can be positivist shows that realism is not a condition for the positivist version of science.

Both versions of falsificationism described above are realist in this sense, and Kuhn's philosophy does not seem to completely rule it out. The Realism described here, Transcendental Realism (TR), goes beyond these views in a number of important respects. Its account of explanation is different, as are some of its fundamental philosophic assumptions, so that it represents a more plausible, and for the author, a more attractive account.

To begin with, TR does not treat the world as a closed system, but an open one which has the implication that a scientist cannot explain the world simply by investigating the irregularities in phenomena, for to do so can only produce a description of the world, and thereby reduuce epistemology to ontology. TR aims not only to give a plausible account of how science might proceed, but also of how it has proceeded. Thus, in order to make experimental science possible, and the achievements of the natural sciences plausible, the world is treated as an open system in which local closures can, for all practical purposes, occur within a certain domain. It will be argued below in Chapter 3 that <u>all</u> problems are, in a fundamental sense, "soft", but that up to a certain level of complexity we may operate pragmatically on the (false) assumption that the world is a closed system, i.e. controlled experiments are feasible up to a certain level of complexity. TR aims to give a plausible account of science which covers the whole of science. For the Transcendental Realist (TRist)

"Theories are the crown of science, for in them our understanding of the world is expressed. The function of theories is to explain."

Harré, 1972, p.168.

This is, perhaps, a statement which would find agreement amongst the protagonists of the views presented above ; however, the TRist account of "theory" and "explanation" are quite different.

Theories on the accounts described in 2.4.1. are either laws of nature or collections of laws of nature, and the effect of assuming these laws to operate in a closed system is that they become descriptive generalisations amongst constant conjunctions (like "cause" produces "effect"). TR, by contrast, treats explanatory theories as embodying an "extra element" which must account not only for the phenomenon, but give a plausible explanation as to why the phenomenon is the way it is and not otherwise. (This seems to capture the spirit of Leibniz's principle of sufficient reason). This, in turn, produces a completely different notion of explanation so that laws, whilst sometimes being adequate (with some qualification) to predict phenomena, cannot explain them.

The basic thesis is that in order to explain phenomena or sequences of phenomena, one must be able to give a plausible account of the "generative mechanism" producing it. When dealing with open systems, we have to think in terms of multiple mechanisms at work, for it is this fact that forces us to treat some systems as open, and destroys what would otherwise be constant conjunctions among phenomena. The generative mechanism(s) will be described by the theory, and this will explain the phenomena under study, but will not be explained itself, since this will, in turn, require the description of (a) mechanism(s) at a yet different level of reality.

"The virus theory of poliomyelitis is truly a scientific explanation, where the beautifully systemised laws of mechanics are not. Of course, in certain cases the mechanics of particles in motion explains other phenomena, because then the laws of mechanics serve as perfect descriptions of the casual mechanism at work. Such, for example, is the often quoted example of the kinetic theory of gases, where the mechanics of the molecules of the gas sample serves as a casual mechanism which explains how samples of the gas behave under various conditions. The kinetic theory is an explanation, and a scientific explanation at that, of the behaviour of gases, but it follows the paradigm of the virus explanation of poliomyelitis, and not the paradigm of the force formulation of mechanics. The fact that mathematical means of "expression are used in the kinetic theory should not blind us, as philosophers of science, to the essential difference of the former and the essential likeness of the latter."

Harré, 1972, p.171.

Progress in science consists of progressively uncovering more layers of generative mechanisms, because every description of mechanism will, in turn, require an explanation. TR holds that this stratification is a reflection of the "real" structure of the world and that the mechanisms, whilst being the product of imagination (through a rational process) can come to be known to be true.

"A general pattern of scientific activity emerges from this. When a stratum of reality has been adequately described, the next step consists in the discovery of the mechanisms responsible for behaviour at that level. The key move in this involves the postulation of hypothetical entities and mechanisms whose reality can then be ascertained. Such entities need not be smaller in size, though in physics and chemistry, this has normally proved to be the case."

Bhaskar, 1975, p.169.

An implication of this account is that the quest of science is unending ; either the next stratum _is_ being uncovered or science _has_ reached "the ultimate" (if it exists) and having described it, cannot explain it because there is no underlying mechanism. No matter how long attempts to explain fail, the logical possibility remains that there might be an explanation ; one can show conclusively that there is an explanation, but not that there is not.

From the preceding discussion it might be inferred that TR denies the significance of constant conjunctions and inferred laws, but this is a mistake. TR simply stresses that on the one hand, the world (Social, Psychological and Physical) with which science deals, tends to yield an invariance of _result_ rather than prima facie regularities, i.e. the world is an open rather than a closed system. On the other hand, invariances amongst phenomena may or may not be evidence for a law, and the absence of an invariance may be consistent with the existence of a law. On the positivist and falsificationist accounts, constant conjunctions of events were not only necessary but sufficient for the establishment of a law, but for the TRis, this is neither necessary nor sufficient. In the case of constant conjunctions which are felt to be of significance, one needs to give an account of the associated mechanism(s) to wholly justify the attribution of law. Similarly, the known existence of mechanism(s) may lead one to postulate law(s) where there are no constant conjunctions at all.

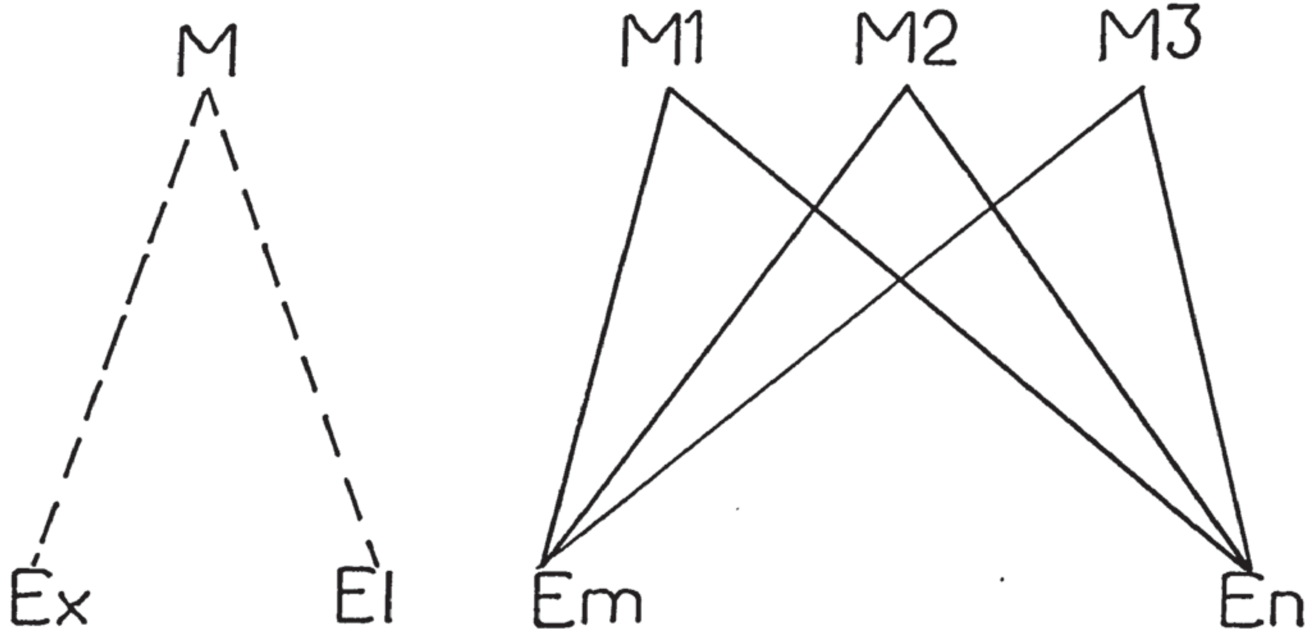
In the former case, one has to have an intermediate category for the candidates for law so that their status is clarified whilst waiting for the discovery of the necessary generative mechanism : such laws are PROTOLAWS.

> "A protolaw strives to become a law by seeking a theory to which to attach itself. In this way, it becomes associated with ideas of a generative mechanism which explains the phenomenon it describes."
>
> Harré, 1970, p.132.

The protolaw case and the associated hypothesis formulation are illustrated in Figure 2.4.

One needs the notion of tendency to allow for open system conditions and the inadequacy of the rigid "if...then..." law statements in such conditions. The concept of tendency thus becomes central to TR when describing or characterising mechanisms so that they may be attributed "powers" which is a tendency to act in a particular way by virtue of their natures. These ideas are discussed in detail in Harré (1970, 1972, 1979) and Bhaskar (1975).

(Adapted from Bhaskar, 1975)



There are grounds for supposing that there is an M such as that Ex, El <u>tends</u> to be produced.

PROTO LAW

Em, En by virtue of M1 or M2 or M3

Hypothesis formulation

<u>Figure 2.4.</u>

<u>The Relationship between Mechanisms and Phenomena</u>

At this point it is appropriate to remind oneself of the relevance of all this to problem solving. In the final analysis, to be scientific is to attempt to explain a phenomenon and not simply describe it, and this must involve citing a generative mechanism which, where the explanation is wholly adequate, comes to be known in reality. In following this line, the author is accepting the need to build this kind of explanation into the modelling process of any methodology, i.e. methodology must attempt to use scientific models.

A consequence of the D-N model of explanation is that the application of the term "scientific model" becomes restricted. This is because one often finds that suitably tested generalisations about the world are not available when dealing with particular phenomena. Thus, Rescher (1970) distinguishes between descriptive, practical and theoretical explanation, while Taylor (1970) talks in terms of scientific explanations, what-explanations and reason-giving explanations.

The account of explanation preferred here differs from what may be described as traditional empirical realism in that it advocates an additional element in adequate explanation, namely the idea of a generative mechanism. In adopting this view, one is scientifically committed, not only to describing how the world is, but also how (where possible) it comes to be that way.

The concept of model as a surrogate for reality is important in this approach, but Harré (op.cit.) makes an important distinction between sentential (descriptive) models and iconic (explanatory) models. The distinction between sentential and iconic models is not always clear, so that a few words on this may be helpful. This distinction specifically depends on an appreciation of the layered nature of reality and man's perception of it, plus the idea of a model as a dynamic entity given life by the exercise of a modeller's imagination :

"Scientific work is as much work of the imagination as it is work at the laboratory bench."

Harré, 1972, p.23.

The layering of physical reality is reasonably clear, and the progress of science reflects this by proceeding to uncover entities at different levels of reality to explain the problematic behaviour of previously known entities, i.e. systems of atoms to explain molecules, etc. Explanations do not, of course, necessarily require systems of entities at lower levels. Observer dependence in physics is a meta effect, and in the behavioural sciences, adequate explanations of human activity and behaviour require consideration of micro (psychological) and macro (sociological) mechanisms.

What is nominally possible in science is to describe, i.e. produce sentential models. One can describe a pattern of phenomena at a given level of reality so that all scientific models are decsriptive, but not all descriptive models are scientific. Only when a description is such that one can appreciate the role played by that phenomenon in the production of other phenomena at a different (perhaps socially or psychologically determined) level of reality, is one dealing with an iconic model, and then only if one can visualise the generative mechanism represented in action. Such a model, therefore, is only iconic to the extent that it explains (gives the method of production of) phenomena at a different level. One thinks here of Harré's contrast between the descriptive laws of mechanics and the truly explanatory virus theory of disease.

It is interesting to note that on this view the D-N model of explanation discussed above is hopelessly inadequate. This simply because it makes no attempt to bridge layers of reality in the way required for adequacy. Furthermore, it does not even count as scientific since TR does not accept the bringing of particular phenomena under general laws as scientific in itself, although it is a legitimate part of a process which aims to move beyond these descriptions to the identification of possible mechanisms, and finally, the real, generative mechanisms responsible for the phenomena and the laws. To emphasise the need for caution when talking of laws without knowledge of mechanisms, Harré has introduced the notion of a Protolaw, described above.

Broadly speaking, one can say that a Protolaw is one that is generated through the process of induction. The validity of such a law rests solely upon the constant association of the events related in the If... Then... statement within the experience of one or a number of people. The kind of reasoning which generates and supports laws by this process is inevitably circular since patterns of individual events justify the laws, and the laws play a central role in explaining and/or predicting events of that type. As an explanation, then, the D-N model states that event B appeared because there was an event A and all A's are followed by B's, but this is no better than saying that this particular part of the world (B) is as it is because the world in general is like that. This becomes even more abused when one realises that generative mechanisms are often such that regularities may occur spuriously on the one hand, and not at all on the other, despite the absence in the former and presence in the latter of a generative mechanism. This may simply be a function of the complex nature of the world, physical, psychological or social, so that regularities are neither sufficient nor sometimes necessary for the statement of a valid law.

The account of TR given thus far has used examples of explanation with a "hard" science flavour, but Harré gives an account of science and explanation which holds true for physical and social science and stresses the complex nature of reality :

"Neo-realist philosophers feel the necessity to speak of a world more complex and differently constituted from that revealed in immediate experience. They have proposed a positive account of a machinery of models and analogies...
By consciously breaking with the logicist as well as the empirical aspect of the old philosophy of science, the question of what does constitute a theory (an explanation), if it is not logical form, can be raised. The neo-realist answer to this question is based upon an analysis of the content of real scientific theories, that are clearly taken to be explanatory by the community of scientists. There seem to be two interlocking demands placed upon them.

a) A discourse is explanatory if it describes a plausible generative mechanism (real or hypothetical) which does (or could) produce the naturally occurring or experimentally contrived phenomenon to be explained. Usually, the generative mechanism cannot be studied independently of the phenomenon it is supposed to produce, at least when it is first proposed, that is in the formative stages of theory. It is to provide surrogates for real, generative mechanisms that neo-realists introduce models and metaphors into the two sides of theory construction - that is into the imagined world the theory describes, and into the vocabulary of the discourse that describes it.

b) A second, more stringent condition can be laid on explanatory theory, within this system as a general framework, by the imposition of a generally aristotelian framework on the scheme outlined in a). We reach this by asking what it is about the observed patterns that needs to be explained, then we are already halfway to an Aristotelian restriction on the components of generative mechanisms and their surrogates, iconic models of such mechanisms.

Thus, generative mechanisms, GM above, can be further specified. They must include agents and templates to account for the being and the properties of the generated product respectively. If social studies are to be scientific, they must conform to this account of explanation".

Harré, 1979, pp.161-163.

The development of science as seen by TR is well illustrated by Bhaskar, in Figure 2.5.

(Adapted from Bhaskar, 1975)

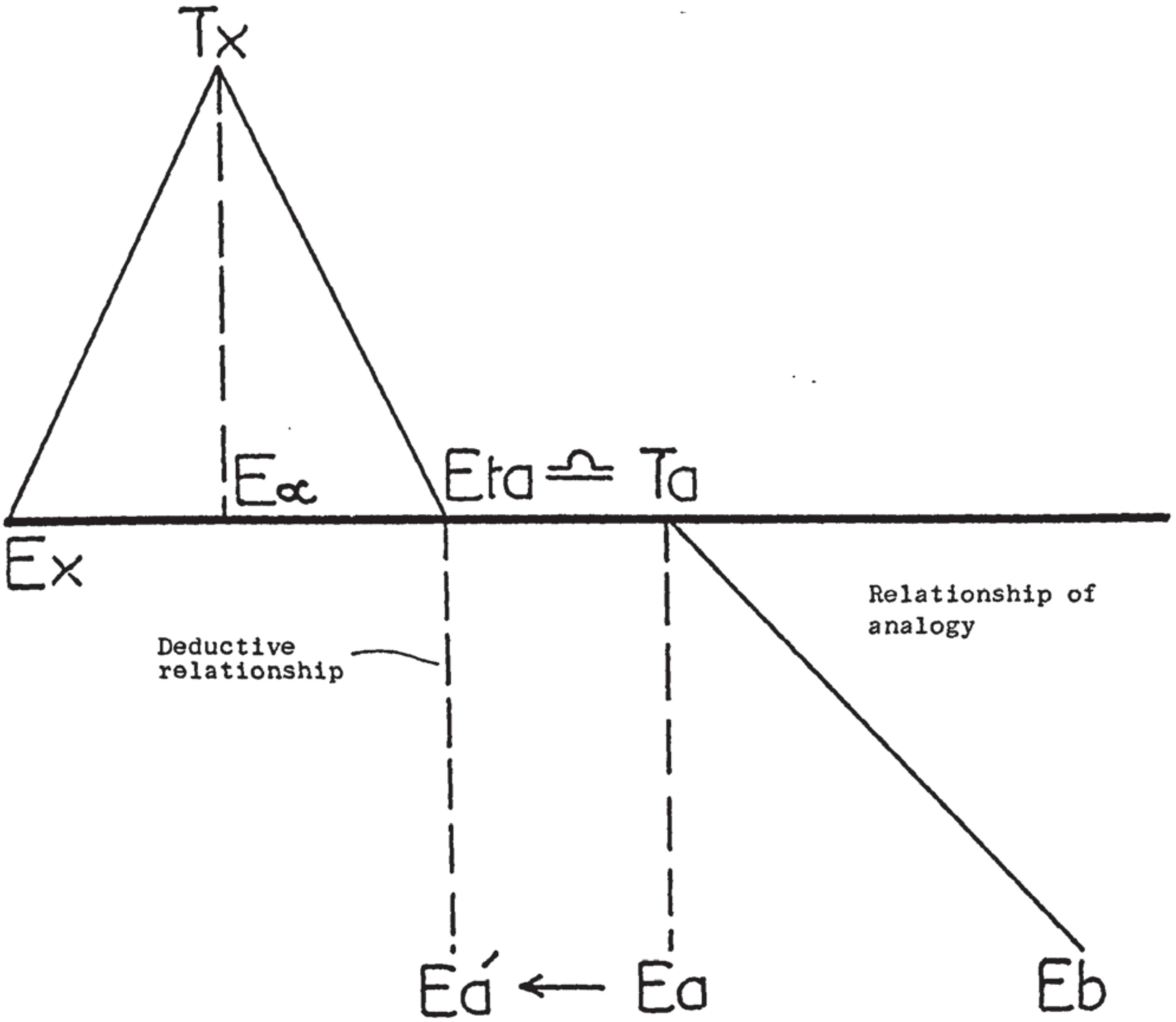


Figure 2.5.

The Development of Science as seen by TR

Ta is the generative mechanism which is held to be responsible for, and thus explains the phenomenon Ea. It has as its source, the phenomenon or mechanism Eb and possibly others, to which it bears a relationship of analogy, and which may involve stressing the differences as well as the similarities. Tests will be done to establish Ta as a real mechanism (if it is) so that the protolaws it licences become established as genuine laws. The process of establishing the reality of Ta will change our understanding of both the phenomena explained and Ta itself, so that Ea becomes Ea and Ta becomes Eta. Eta exists at a level of reality along with other phenomena Ex and may be used sometimes along with mechanisms Ex, by analogy the idea of a mechanism Tx which, if shown to be real, will explain Ex, and in this way, science uncovers layers of reality. This illustrates the simplest case and might be taken to imply that "new" mechanisms have sources at only one level of reality ; this may, but need not be so.

The need to adopt this approach in organisationally-based problem solving methodology has been stressed by Molloy and Best (1980) and has subsequently been taken up by Huxham and Dando (1981).

At this stage, the general character of Transcendental Realism has been outlined so that it is now clear that one can and, for the author, should take a scientific approach to complex organisational problem solving. This is the general framework which the author will use to guide the construction of a scheme for handling problems.

Before examining specific approaches to problem situations, it is necessary to focus more closely on the Realist treatment of models. This is important, not only to clarify general relationships, but also to clarify the relationship between sentential and iconic models.

2.5.3.1. Models in Theories

The discussion has, so far, focussed upon the distinction between descriptive theories or generalisations and truly scientific theories which are explanatory by virtue of describing an extra element, a generative mechanism. Now, TR holds that man's understanding of these mechanisms of the production of phenomena is embodied in models and that there is, despite the implied or explicit denial of this in all the previous accounts of science, a rational process through which man develops his explanatory or ICONIC models. This process involves reducing the unfamiliar to the familiar (opposite to that envisaged by Popper) through analogy so that the resulting model has a bi-polar relationship to two distinct domains :

> "For the transcendental realist, then, a model has a relationship with its subject as well as with its source. And it is within the nexus formed by this double articulation that new knowledge is produced. For new knowledge is doubly articulated, articulated in two dimensions (transitive and intransitive) : it is socially produced knowledge of a natural (man-independent) thing. It is this bi-polarity that a model expresses in standing in two sorts of relationship : a relationship of analogy with its source, and a relationship of adequacy (when it is) with its subject matter. Many philosophical problems arise from a misunderstanding of the second relationship. It is not a relationship of correspondence ; the terms of the relationship are not necessarily like each other, though pictures and iconic models may play an important role in scientific thought. Moreover, there are no general, philosophical criteria for such judgements of adequacy ; they are necessarily intrinsic to the particular science concerned."
>
> Bhaskar, 1975, pp.166-167.

Central to this realist account is the idea that formal logical processes such as those permitted under the Aristotelian or modern quantification principles of reasoning do not exhaust all possible modes of thinking and may exclude some of the most "productive" by ruling out pictorial or inspirational modes ; however, science is little aided if, like Popper, one says that new knowledge is to have no rational basis. The TRist analogy offers a completely workable rationale which harnesses the creative process to a defined end, the production of new knowledge, for the imagined mechanisms, the models produced by analogy, will come to be known to exist as a result of empirical testing.

Harré (1970), like Bhaskar (1975), also develops a distinction about the source of a model and its application, which form the basis of a Taxonomy of (iconic) models to which we shall return later. Allied to this is the distinction between "sentential" and "iconic" which identifies the two central categories we have been exploring above, namely descriptive and explanatory.

Harré (op.cit.) defines a sentential model as follows :

"If T and T^1 are sets of sentences, then T^1 is a model with respect to T, if for each p, such that p is a member of T, there is a q, such that q is a member of T^1, and when q is acceptable, p is true, and when p is false, q is unacceptable." Harré, 1970, p.36.

In a less formal way one can say that if T^1 is a descriptive model of the phenomena described by T, then T^1 is only adequate if elements of T^1 match in a formal or logical way to the elements of T, and the descriptions contained in T are true according to a correspondence theory of truth.

Iconic models by contrast are defined as follows :

"If T is a set of sentences about some subject matter N, then M is a model of N if T^1 is a sentential model with respect to T, and M is a set of objects, etc. such that for all q which are members of T^1, q is known to be true or false by reference to M. Such a model M, I call an iconic model of N". Harré, 1970, p.36.

We now have the completed set of model relationships (although we have yet to explore the source/relationship) which is set out in Figure 2.6. The arrowed relationships in this figure are descriptive although the M⟶N relationship is a "pictured decsription". Scientific theories are "statement picture complexes"; they are sentential by virtue of having a formally expressable component, usually expressed in its "laws" or other stated rules of application ; they are iconic by virtue of describing a generative mechanism which, while being described in sentential terms, is completely captured in a "picture" of that mechanism which, in turn, will capture the dynamic of that mechanism at work in a way that the sentential component can not. Knowledge of the rules of chess cannot transmit even the slightest appreciation of the intricacies and excitement that goes with the dynamic of chess in action, though both are transmittable in sentential terms.

The relationship from T^1 to M and T also follows the criteria for the establishment of a law discussed above : laws (T's) must be consistent with the "real" nature of things, their tendency to behave in a certain way. They must also be consistent with the idea of a generative mechanism, pictured in the iconic model M, which justifies the laws we choose to raise from protolaw status. By a similar process, T^1 may model situations in which no regularities occur since we may have established the existence of a mechanism, perhaps with an associated M, which makes a non-regular patter of phenomena intelligible to us. All the truly scientific theories have an iconic component which explains but, in a particular model, is <u>not</u> explained.

We now return to the bipolar relationship that iconic models have to source and application, the relationships of analogy and adequacy

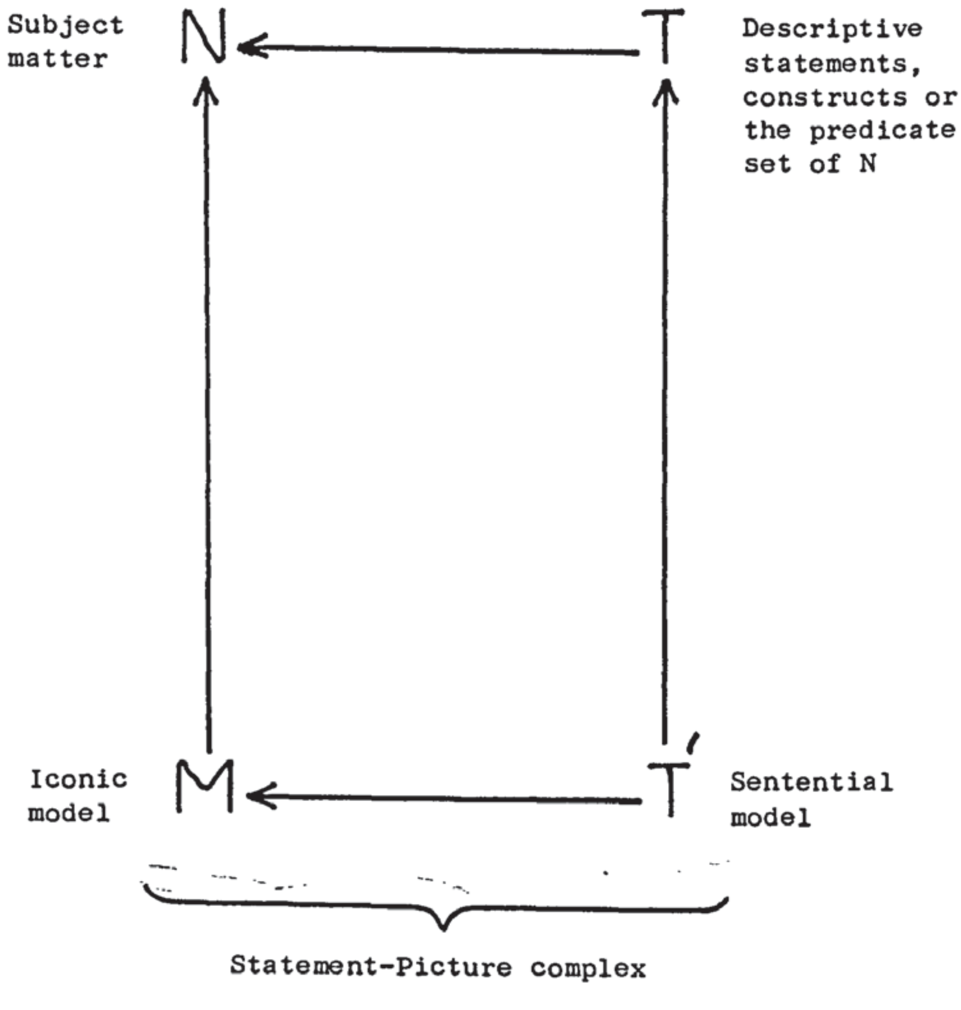


Figure 2.6.

The Relationships between Models and their Subjects mentioned above. Harré (1970) divides iconic models into two classes, and uses this as the basis for a taxonomy of models.

The first of these classes is the Homoeomorphic class in which the source and the subject (application) are the same. This class is divided into three subjects, as follows :

1. Micro and Megamorph which would be used in scaling problems so that the model would be identical in some signficant respect (usually physical) but could be on a different scale to the original.

2. Teleiomorphs which themselves fall into two sub-classes : idealisations and abstractions. Idealisations do not involve any reduction and usually there is considerable amplification so that the ideal woman will have all the qualities/properties of a "normal" woman but in some respects, more so.

   Abstractions, by contrast, always involve some reduction, so that not all the properties of the source/subject will be reproduced in the model. Which properties are actually produced will be a function of the purpose of the modeller. A dummy of a woman in a shop would qualify as an abstraction in this sense. It does not have all the properties of a real woman, only those properties judged to be necessary for the purposes of displaying clothes in a way which stimulates some aspect of the wearing of such clothes by real women.

3. Metriomorphs which always model a class and never an individual.

   "The metriomorph has just as many properties, in the sense of determinables, as a typical member of the class it represents, but the determinate properties...are arrived at by an averaging or similar mathematical operation...so that the famous metriomorphic family of the human male metriomorph, which consists of 2.63 metriomorphic children, has characteristics which no actual human family could have."

The second class of models is Paramorphic, so that the source and the subject of the model are not the same. The properties of this class are divided into two sub-groups according to two sets of relations to source and subject. Relations to subject may be partial analogue, complete analogue or partial homologue, whilst in relation to source, a model may be semi-connected, singly connected, and multiply connected.

In order to understand the distinctions relating to subject, one needs to distinguish between inputs, outputs and processes in a system. Analogues have inputs and outputs which are similar or identical to the subject ; the analogue will be "partial" if processes occurring in model and subject are different, but "complete" if the processes are the same. If the processes, their manner of working, are identical, but inputs and outputs are analogous rather than identical, then the model is a homologue.

Relations to source are classified according to the number of distinct "scientific" areas of knowledge from which analogous relations are drawn. Models drawing upon one science are singly connected, while those drawing upon more than one are multiply connected. Where there are esoteric sources, including the inventor's imagination as well as scientific source, models are semi-connected.

This taxonomy will be useful at a later stage to help to classify the relationship between Checkland's methodology and the organismic models used below to describe some aspects of the sponsoring organisation.

At this point, the examination of TR is complete, having been covered in sufficient detail to identify its differences from some other philosophies of science, and its potential to shape and guide an understanding of how the kinds of difficult problem identifies in the early part of the chapter may be handled. This work has emphasised the need to try to understand problem situations and not simply apply prescriptions without knowing why they are appropriate.

2.6. Concluding Remarks

In trying to understand the problem situation within G.E., the author has found it necessary to examine the nature of "problem" and problem situations at the most general level. This was, in fact, the beginning of a process that was to lead the author to develop some specific and distinctive ideas about the mechanisms involved in problem situations, and the kinds of approaches that are appropriate to them. These ideas are developed in the chapters that follow.

However, the author feels that these ideas may not be fully appreciated without an account of the broad issues involved, and this chapter has attempted to cover these. The result should be that the reader will be able to understand how the author views many of the more specific methodological issues. Many of the views expressed in this chapter are philosophical prejudice, e.g. the realist stance, and there is some value in making these clear.

The author views the material in this chapter as an essential precursor to the more specific work of the later chapters. The author's view of problems has been clarified, and a framework has been established which will help to assess approaches which might be expected to help in dealing with problems. The way in which TR is helpful will be related in the chapters that follow.

Chapter 3

A Specific Methodology

3.1. Introduction

In the previous chapter, the nature of problems has been considered along with general approaches to their solution. This was an essential stage in the development of the author's understanding of the difficulties experienced in the sponsoring organisation. In this chapter it is appropriate to consider a more specific approach which will take the development of a methodological framework a stage further.

The methodology of Peter Checkland was selected by the author in an attempt to further understanding of the problem solving process and the difficulties that may arise. To begin with, the methodology was attractive because it seemed to incorporate a relativist interpretation of problem situations similar to that of the author's (see Chapter 2). However, it was felt that this approach would only be acceptable if it could be accommodated within the realist framework described in Chapter 2. In the event, the realist framework was able to identify some useful features of the methodology, as well as some serious deficiencies. An example of the former is Checkland's view of the role of Weltanschauumgen (w's), while the latter consists mainly in a failure to stress the need to pursue explanatory, as opposed to descriptive models.

The important task that this chapter sets out to perform is to describe Checkland's methodology in a way that will highlight the strong and weak points mentioned above. This is a vital step towards the coherent methodological framework sought by the author in this work. The conclusion that is reached is that in some respects, Checkland's methodology is adequate, and may be taken as the skeleton of an adequate approach. However, the task of these early chapters cannot be complete until the inadequacies of this skeleton have been removed, so that a coherent account of this problem solving process is approached. Chapters 4 and 5 will attempt to complete this task.

In the meantime, this chapter begins by considering some contextual ideas related to the methodology. This is followed by a decsription of the methodology which includes a discussion of "Weltanschauungen" which goes beyond that given in Checkland's work. The final part of the chapter relates aspects of the methodology to the realist view of scientific activity.

3.2. The Checkland Methodology - Background Thoughts

Peter Checkland has developed his methodology since 1969 at the University of Lancaster. The methodology is designed to tackle "soft problems" in the real world. "Soft" is intended to convey an unstructured and subjective flavour. However, it is clear from the concept of problem developed above, that all problems are "soft" in their essential nature ; so that the important differentiation of problems is not done on the basis of "kinds" but of degree. The methodology is generally intended for application in "...systems in which objectives are hard to define, decision taking is uncertain, measures of performance are, at best, qualitative, and human behaviour is irrational."

Checkland, 1972.

Generally speaking the point of differentiation along the continuum of softness is where the controlled experiment technique is judged to be ineffective ; thus the methodology is felt to be particularly relevant to the complex or "unbounded" problems encountered in social organisations. When thinking about degrees of softness, the author has found it useful to construe "softness" as synonynous with complexity. Problem situations have a place on the continuum which signifies the type of methodology which is appropriate. These ideas are represented in Figure 3.1.

In Chapter 2, the idea that the world should be taken as an open system was introduced as part of a discussion of Transcendental Realism. It would seem that the distinction between "open" and "closed" is not a category distinction either, and therefore one can speak of degrees of openness on a continuum in a fashion that parallels the distinction between "hard" and "soft" in conjunction with degrees of complexity. It is now possible to combine these ideas in the enhanced diagram of Figure 3.2.

It has been argued that the distinction between "hard" and "soft", while seeming to distinguish between problems in "natural" and social or human activity systems (Checkland 1976, 1978), actually distinguishes between problems in systems where the scientist can contrive closure artificially, or can generate an acceptable result at the pragmatic level by assuming the system to be closed on the one hand, and where he cannot on the other. For this reason, it is proposed to refer to this distinction, not through the terms "hard" and "soft" but through "closed" and "open" ; thus traditional science will be referred to as a closed science.

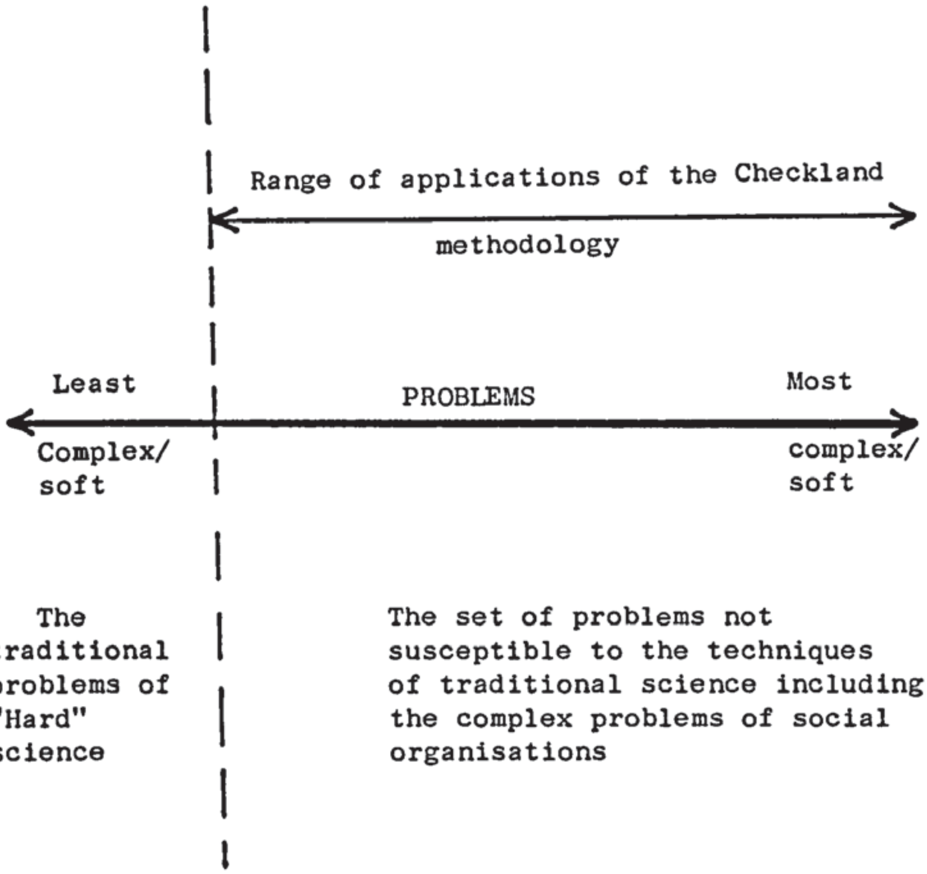


Figure 3.1.

Problems Related to a Complexity Dimension

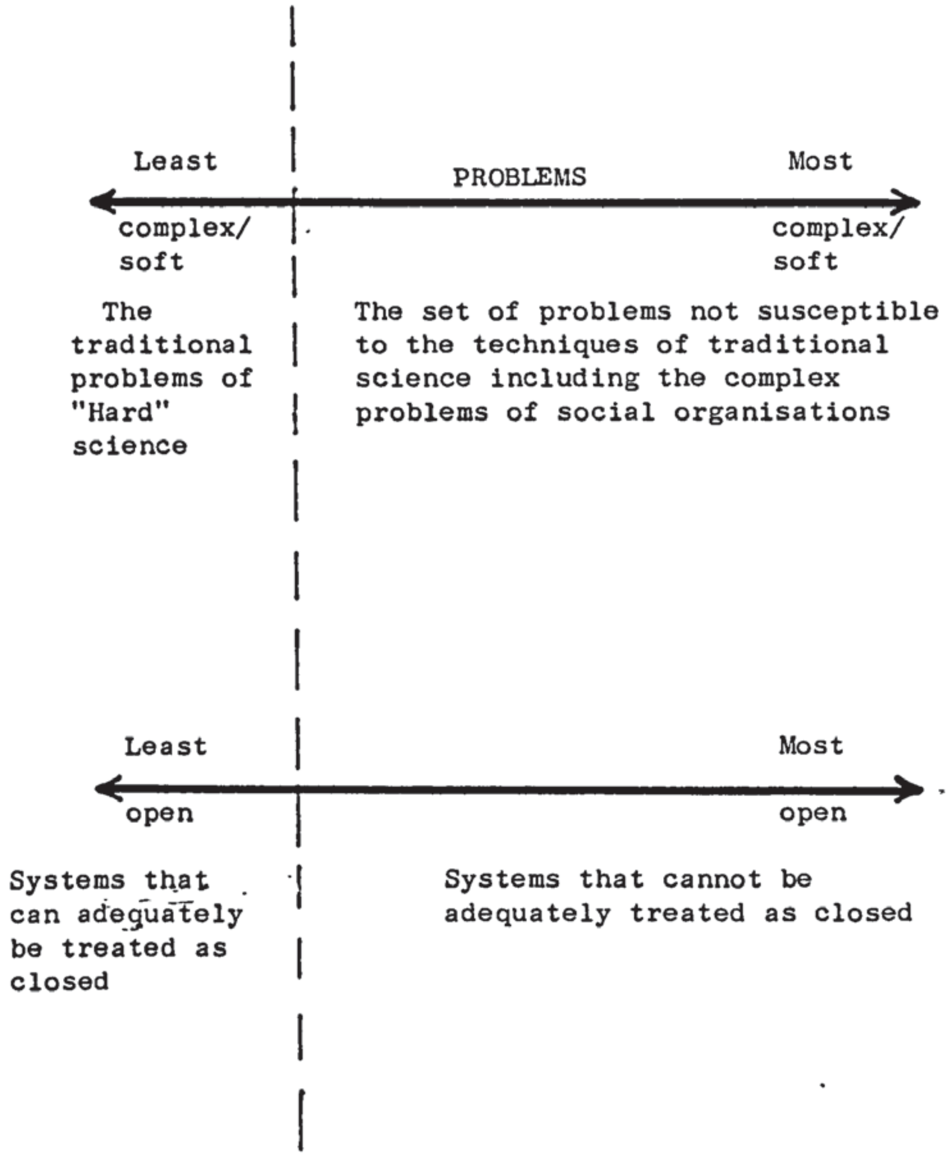


Figure 3.2.

Systems and Problems Related to a Complexity Dimension

3.3. The Checkland Methodology

As we move on to consider the methodology itself, it is worth noting that the general character of the methodology has been described by Checkland (1972, 1975, 1976), Collins (1976) and Naughton (1977) in some detail. Development of some new ideas can be found in Checkland (1979a, 1979b, 1980) and Smyth and Checkland (1976).

This general methodology has been helpful in thinking about the research reported here, and since it is to form the skeleton of a developed methodology, it is described in some detail.

The methodology is organised into seven broad stages which move from the unstructured problem situation through to action to improve the problem situation as in Figure 3.3.

Stage 1 is the problem situation unstructured and equates roughly to Ackoff's "mess" (1974) or system of problems. More concisely, it is a real world situation, an observer's observation or set of observations about which the observer <u>feels</u> unhappy, i.e.

$$W_i(t)\left[G_i(t) - A_i(t)\right] > l_i(t) \quad \text{in Chapter 2.}$$

It is important to realise that the term "unstructured" is used in a relative sense ; the situation may be classified as problematic for the first time, or it may have a history within this classification. Problem situations with a history will have involved problem owners/solvers iterating around a methodology, and if we think in terms of Checkland's methodology, Stage 1 may have been visited many times, thus

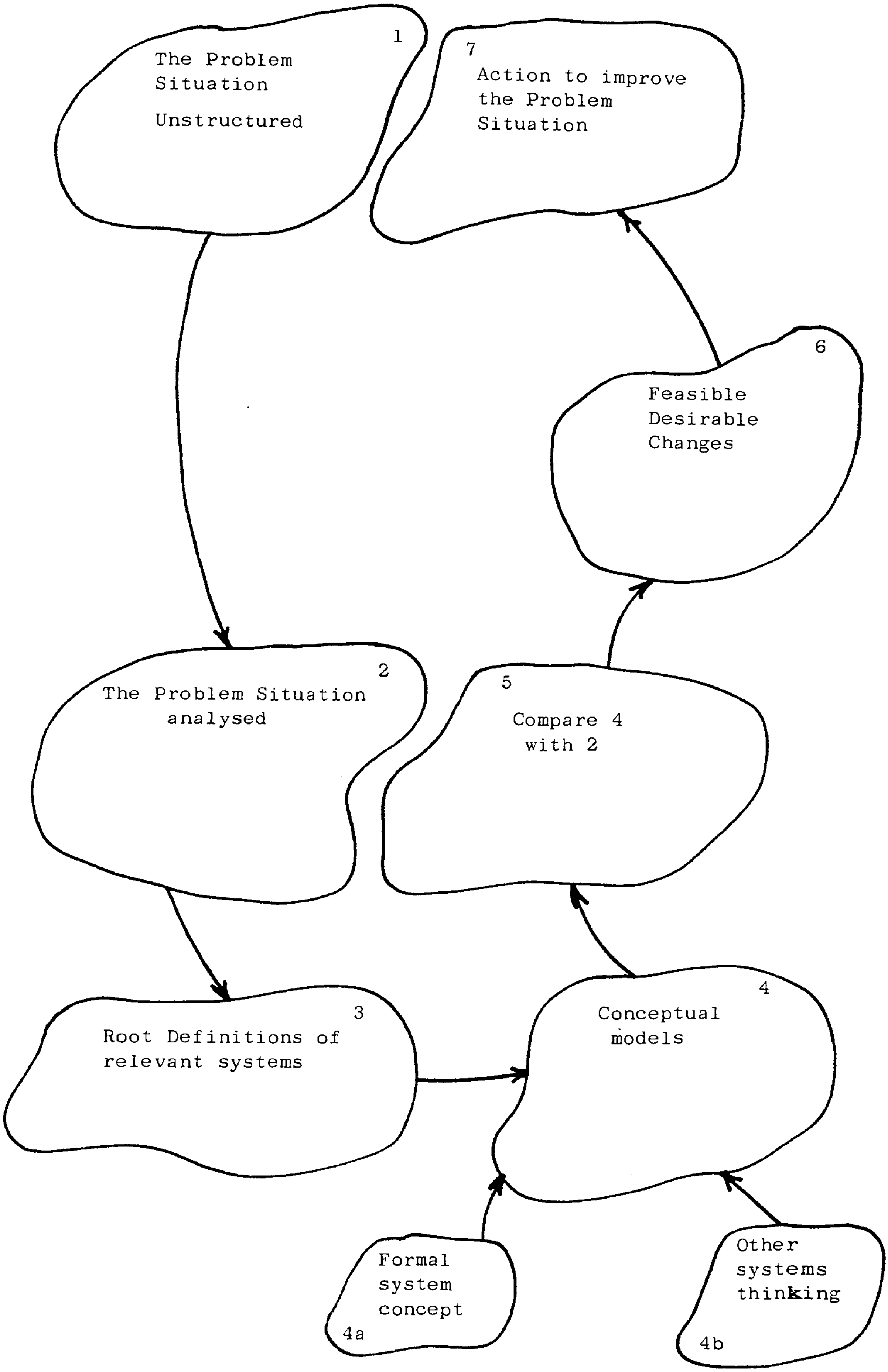


Figure 3.3.

The Checkland Methodology
in Summary (Checkland,1975)

the problem situation is unstructured in <u>relation</u> to what users of the methodology expect it will be. Successive iterations will find the situation more structured in one of two senses.

Firstly, problem owners may <u>feel</u> that the <u>same</u> problem exists but they have more information and understanding of its nature and "conclude" that the situation requires further analysis and application of the methodology. Secondly, the owners may <u>feel</u> that the problem has changed its basic character. This might involve a recognition that the problem situation initially identified has systemic properties or influences, e.g. it is part of a wider picture which must be considered.

<u>Stage 2</u> is the problem situation analysed. This is the process of externalisation of view(s) characterised above as "problem structuring". The process connecting 1 and 2 will often involve a reduction since not all real world features of the problem situation will necessarily be known or considered important by the problem owner(s). The problem(s) which represent the owner(s) dissatisfaction(s) will be formally defined and characterised by this stage.

<u>Stage 3</u> is reached when Root Definitions of relevent systems, which are defined as "the careful formation of concise verbal descriptions of systems believed by the analyst to be relevant to the problem situation within which he is working" (Smyth and Checkland, 1976), have been produced. Adequate root definitions are held to embody, usually explicitly, six considerations codified by the mnemonic CATWOE as follows :

1. CUSTOMER**(C)	-	Client (of the activity) beneficiary or victim, the subsystem affected by the main activity(ies). The indirect object of the main activity verbs.
2. ACTORS**(A)	-	The agents who carry out, or cause to be carried out the transformation process(es) or activities of the system.
3. TRANSFORMATION**(T)	-	The core of the Root Definition (RD). A transformation process carried out by the system. Assumed to include the direct object of the main activity verb(s).
4. WELTANSCHAUUNG**(W)	-	The (often unquestioned) outlook or taken-for-granted framework which makes this particular RD a meaningful one.
5. OWNERSHIP**(O)	-	Ownership of the system, control, concern or sponsorship ; a wider system which may discourse about the system.
6. ENVIRONMENTAL AND THE WIDER SYSTEM CONSTRAINTS**(E)	-	Environmental impositions. Perhaps interactions with wider systems other than that included in 5 above, these wider systems being taken as given.

** Adapted from Smyth and Checkland (1976).

When any of the stated considerations are not present they "should be omitted consciously and with good reason" (Smyth and Checkland,1976). However, it should be noted that the Weltanschauung (W) is almost never explicit in an RD. The Checkland approach derives its general character from a recognition of the importance of Weltanschauung, and it is felt that some detailed discussion of this concept is justified to illustrate the understanding and particular interpretation of the author. This is especially important because this is the most central idea which is carried over into the author's model of methodology. This concept is regarded as the most valuable within the methodology so that a detailed discussion is required. This must, however, be postponed until the next section.

Stage 4 is complete when conceptual models of the Human activity systems identified by RD's (these will later be classified as sentential models) have been generated. Some dissatisfaction is felt with the account of conceptual modelling given by Checkland. However, this does not invalidate the general shape of the methodology and the account presented here will not, at this stage, amplify any differences but simply describe the methodology as the author understands it.

The essential character of the conceptual modelling process is of amplification of RD.

"The task of conceptual model building is simply that of assembling the list of verbs describing the activities required by the Root Definition, connecting them according to the requirements of logic and indicating any flows which appear essential at this first resolution level."

Checkland, 1979b.

This basic activity model serves as the basis for other models or "further expanded versions".

"Some may show activities at more detailed levels, or record all flows in the system, material and abstract ; also, noun-based versions of the model may include organisational entities which might carry out the activities in the basic model...The basic activity model then becomes the origin of an information-flow model which can be used to enquire into present information flows or to design new information systems."

Checkland, 1979b.

These modelling stages are illustrated in Figure 3.4. The basic activity model is at the core of conceptual modelling of human activity systems and provides the general form of conceptual models which Checkland illustrates with the diagram shown in Figure 3.5. This diagram is a topic free model of the form of a conceptual model. The Activities named by the verbs together constitute a transformation process which is named in the RD.

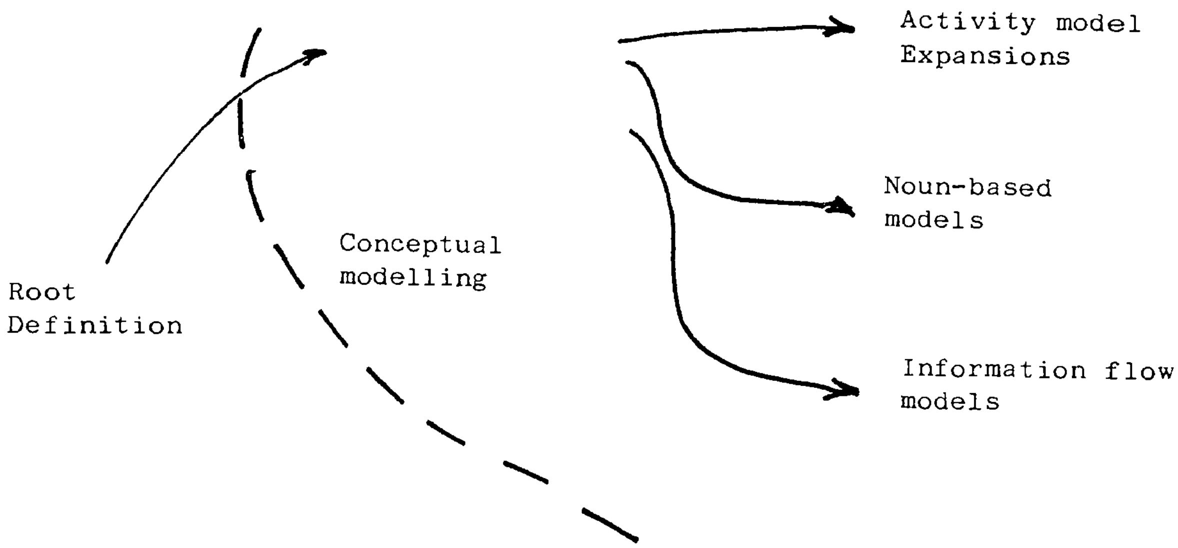


Figure 3.4.

Checkland's Conceptual Modelling (Checkland,1979b)

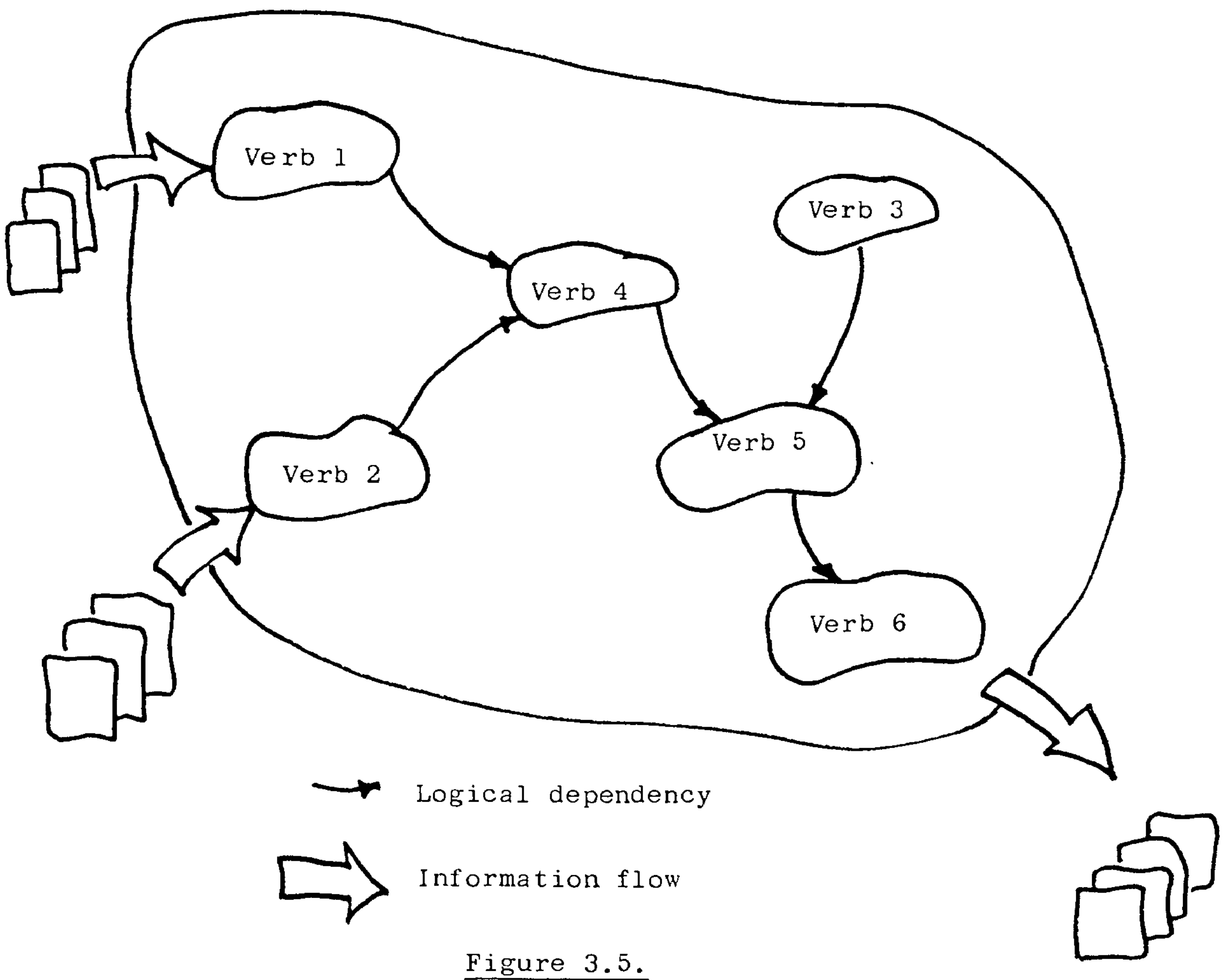


Figure 3.5.

Modelling a Human Activity System (Checkland,1979b)

The modelling described so far centres on what the system "seen" to be relevant to a problem "is" and what it "does", and as such, consitutes sentential models with no explanatory power (this distinction will be made clear below). However, Checkland recognises that each basic conceptual model "which expresses what the system does...can be expanded into a group of models which express possible nouns." However, discussions about further modelling are to be taken on the basis of overall problem contexts and not Root Definitions.

Two important inputs shown in the general methodology diagram are :

1. Formal Systems Concept ; and
2. Other Systems Thinking.

Checkland (1972) gives a definition of a formal system and this is reproduced below, without Checkland's examples.

" S is a"formal system"if, and only if :

(i) S has an objective, a mission, a defintion of a final desirable state, or an ongoing purpose.

(ii) S has a measure of performance

(iii) S has sub-components which are themselves systems (with objectives, measures of performance, subsystems, etc.)

(iv) S has sub-components which interact, which show a degree of connectivity such that effects and actions can be transmitted through the system

(v) S exists in wider systems and/or environments with which it interacts (inputs and outputs). Boundaries are defined by the area within which the decision makers (viii) can cause action to be taken.

(vi) S has resources, both physical and, through the human components, abstract.

(vii) S contains a decision taker and a decision taking process. (Action is caused to be taken - which requires information flows via (iv)).

(viii) S has some guarantee of continuity, is not ephemeral, will recover stability after disturbance ("long-run" stability).

As stated above, the conceptual modelling process is essentially and expansion of one, or several RD's and therefore the defining characteristics of a formal system can be related to RD characteristics. This is illustrated in the following table taken (amended) from Smyth and Checkland (1976).

Formal Sys. Property	Relevant Root Definition Characteristics
1. Objective Purpose Mission	Transformation(T) : The Weltanschauung (W) is implicit in this
2. Measure of Performance	May be implicit in the transformation or defined by environmental constraint (E), will be made meaningful by Weltanschauung (W)
3. Components 4. Connectivity	These are implicit in a RD but the process of developing conceptual models should make them explicit, so that the entity named in the RD is a recognisable system.
5. Wider Systems Environment	The source of (E). Possible location of customers (C). Owners (O) may be a wider system
6. Resources	Transformation (T) and Actors (A)
7. Decision taking Process	Actors (A), Owners (O)
8. Continuity	Owners (O) will usually be the source of the guarantee of continuity

Conceptual models are tied to the form given by the Formal system, the general model of any human activity system, so that the conceptual model may be partially validated by a comparison with the formal system concept as follows :

Formulate Root Definition	→	Assemblé Minimum Necessary Activities	→	Structure Activities into a Conceptual Model	→ ←	Check Conceptual Model against Formal system Model

Taken from Smyth and Checkland, 1976.

Other systems thinking is shown as an input to the conceptual modelling stage because Checkland recognises that it is legitimate to use such systems thinking as the analyst/problem owner may find useful.

" The emphasis has been on usability rather than sophistication, but obviously, anyone may guide and validate a conceptualisation by means of whatever systems concepts he finds helpful - I am thinking of material like Ackoff's compendium of systems concepts (Ackoff, 1971) or Beer's cybernetic model of an organisation based on an analogy with the human nervous system (Beer 1972)"

Checkland, 1972.

The research reported here does make use of "Other systems thinking", namely a new model of the same type as Beer's cybernetic model (Beer 1972). This is necessary because it is felt that the modelling process described by Checkland is too strongly sentential (descriptive), and does not place sufficient stress upon "how" models, i.e. explanatory or iconic models. (See Molloy and Best, 1980). In the discussion in Chapter 2, the theory-laden property of observation was stressed, and this view required that the role of "how" theories (or models which express them) in determining what the system is viewed to be, be recognised.

Stage 5 in the methodology is complete when the conceptual model(s) generated in the previous stage is compared with the analysed real world situation or formalised/externalised problem (Stage 2).

" At whatever level of detail it is carried out, the comparison is done in order to reveal possible changes which could "improve" the problem situation."

Checkland, 1972.

However, Checkland stresses :

"...in the comparison stage of the study the conceptual model is there to help tackle the problem solving in a structured way, not to prescribe what"ought to exist".

This is not to say that conceptual models do not have a prescriptive role, but to recognise that each problem situation will have a unique hostory in which human beings have complicated political and other roles. Thus, some possible prescriptions may not be acceptable to the actors or problem owners and become a matter for debate.

Checkland (1972) stresses that "...only those who live in the problem situation can select a change to be implemented." The systems analyst may state and defend a particular suggestion, but the decision for action can only be made by the actors, not the analyst. Within this research, the author was an actor for almost four years, and was responsible for both influencing debate within the organisation and implementing some changes. However, many of the recommendations of this work are in the suggestive category and will not necessarily find favour with all the actors. It is for this reason that possible changes are characterised and discussed in outline, thus recognising that the organisation will <u>debate</u> any recommendation before deciding what and how to change. The best role that can be expected of the work reported here is that the formal report, the thesis itself, will serve as a catalyst for the debate about problem situations.

<u>Stage 6</u> is complete when "the debate" has progressed to a point where <u>feasible</u> desired changes have been determined. This is reached through a process of filtration in which the actors/owners in the problem situation determine which of the possible changes, and with what amendment they are prepared to act. The outcome is a design for change which has the support of the actors in the problem situation.

> "Design here is not the creation of something which will perform in some specific, people-proof way to achieve some defined objective, it is a creation of some modification to which purposeful individuals are prepared to give their commitment."
>
> Checkland, 1972.

Stage 7 involves taking action according to the agreed design in Stage 6. Checkland recommends that implementation of the design be carried out by what may be usefully regarded as a "temporary implementation system". Thus, in a systems project with a manufacturing company,

"It was found helpful to view "implementation" as an activity system of limited life in which the decision-taking body would at first be those who developed the management tool and later would gradually become the managers who would make day-to-day use of it ; as soon as these managers became the decision taker in a system which makes use of the tool, the temporary "implementation" system would cease to exist and the developers of the tool could leave the stage."

Checkland, 1972.

The discussion of Checkland's methodology has so far been somewhat linear and this, to some extent, masks on of its essential qualities, its flexibility. It does not aim to necessarily solve problems but to improve problem situations (this may include solving with $Wi(t) \left[(Gi(t) - Ai(t)) \right] \leq Li(t)$, but need not). The methodology is a methodology for problem-solving only in the sense that "problem-solving is a way of describing normal human activity (Checkland, 1972). Any improvement should be appraised by a further iteration of the methodology since

"...changing attitudes and new experiences will make new root definitions relevant ; more sophisticated notions of a formal system may require the conceptualisation to be changed ; and so on."

Checkland, 1972.

Iterations are not confined to a whole loop of the methdology but may, and will usually take place after reaching Stage 3, when it would be expected that developments in this stage would be responsible for changes of view, and therefore analysis and conceptualistion. Once past Stage 3, iteration may take place at any point.

This completes the description of Checkland's methodology. Most of the essential elements have been identified and described, but the process is not complete yet. "Weltanschauung" has been identified as an important element, but has not been discussed at length. This task will be taken up in the next section. When this is complete, it will be possible to relate the ways in which the author links this type of open system methodology to the Realist framework identified in Chapter 2.

3.3.1. What is Weltanschauung ?

In the discussion of problems in Chapter 2, the distinction between perception and observation was introduced and the concept of Weltanschauung is closely related. Perception is taken to be the process through which an external reality, the world, impinges upon the consciousness ; observation arises from an interaction between a residual mental components and perception, and Weltanschauung is the residual mental component. These relationships are illustrated in Figure 3.6.

In most general terms, a Weltanschauung is the whole set of beliefs which interact with the perceptual process to produce an observation, a belief about the world. The term "belief" is important here, and is used to refer to present and past observations as well as the set of metaphysical views that an individual may hold. A Weltanschauung is the set of remembered past observations and any remembered inductive or deductively derived beliefs, plus a set of metaphysical beliefs which are not straightforwardly based in any past observations that an individual may hold. The constituents and determinants of a Weltanschauung are shown in Figure 3.7.

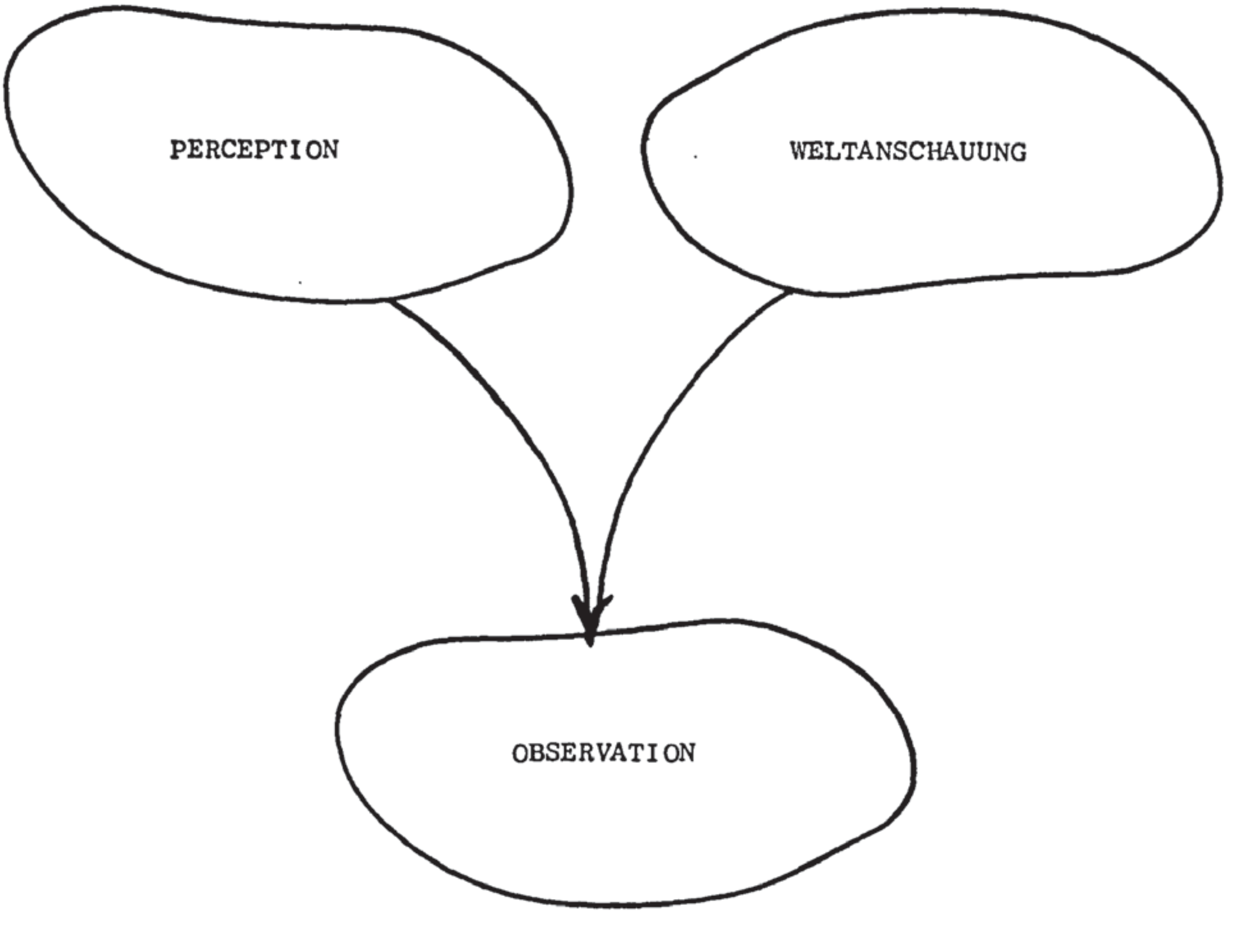


Figure 3.6.

Perception, Weltanschauung, and Observation

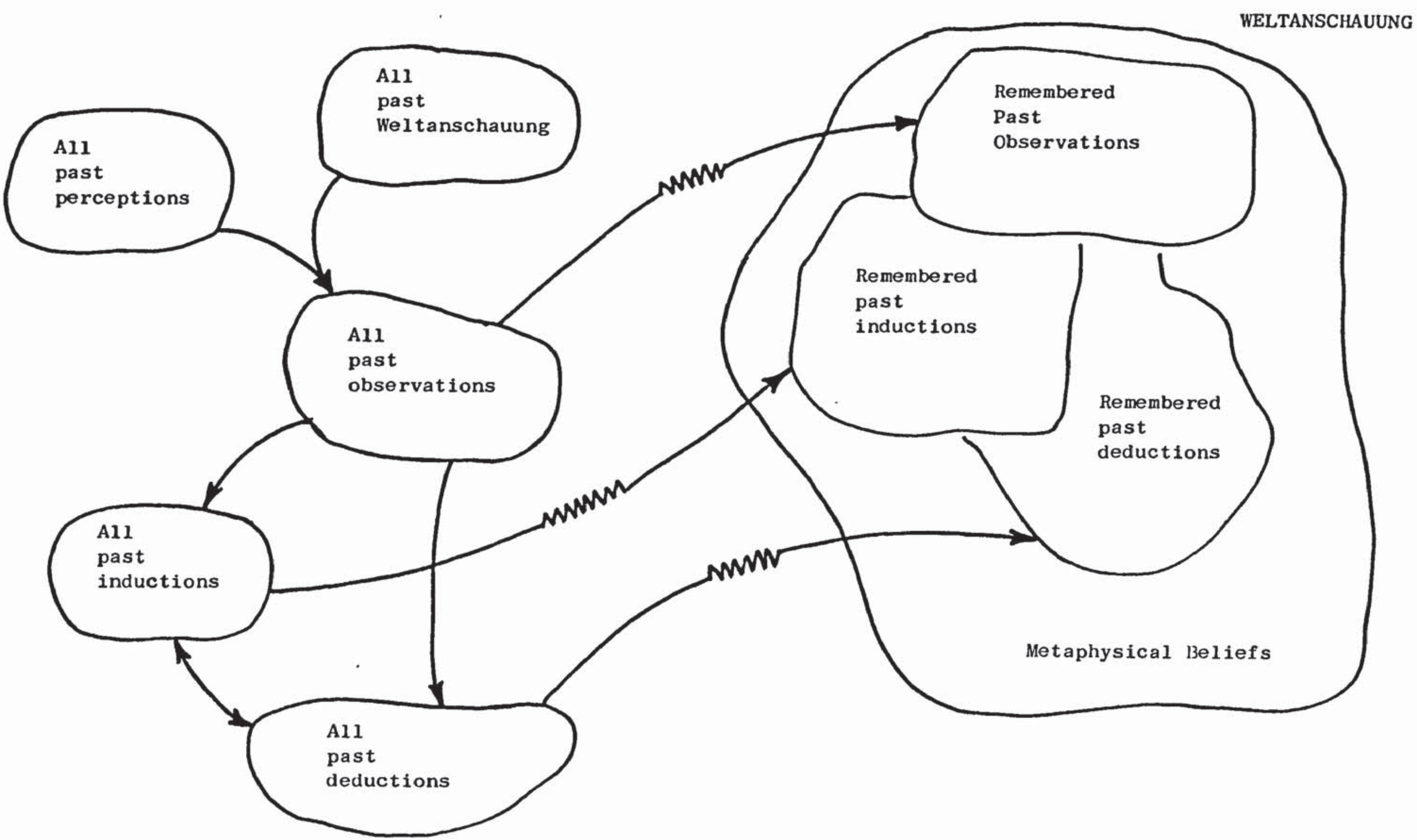


Figure 3.7.

The Constituents of a Weltanschauung

All past observations are the product of past interactions between perceptions and Weltanschauungen. However, an individual will usually have more beliefs about the world than are presented by observations. some of these beliefs will be purely metaphysical with no basis in observations, while others will have an inductive or deductive relationship to observations.

With the possible exception of individuals with total recall, the memory acts as a filter. Thus, if one considers the possible set of beliefs or constructions B_{d-n} that could, in principle, affect a Weltanschauung, then there is a subset B_{i-k} which will be active in a particular case. B_{i-k} will be the result of the tendency of memory to act as an attenuator. However, memory also distorts past beliefs, which has the effect of converting beliefs based in observations to metaphysical beliefs. It is not intended to speculate further upon the origins of metaphysical beliefs except to acknowledge that distortions of memory cannot provide anything more than an account of some metaphysical beliefs.

Eden, Jones and Sims (1980) have identified a subset of beliefs as being particularly important to the process of interaction between perceptions and Weltanschauungen. These are values, and they are held to be important for three reasons :

"First, the information an individual gains as a result of an encounter with one object should apply to other objects in that category. This means that an individual can make an inference about his relationship to an object without directly encountering that object. The inference stems from encountering another object that the individual conceives to be in the same class or category. Second, such categories provide individuals with expectations about those objects that they believe to be members of the same categories. Thus, values can direct perception and behaviour by causing an individual to notice certain charactersitics of an object and to react to the object on the basis of those characteristics. Third, after a person develops a system of values, this individual now opens up channels of choice along which "he is able to move. Without such a system of categories (values) in which to store information, an individual cannot effectively develop a differentiated repertoire of responses...Thus a system of values constitutes a ready-made format for future thinking and behavioural responses. A system of values, accordingly, serves as a frame of reference (Sikula, 1971, pp.282-3, our emphasis)."

Eden et al., 1980, p.41

It is not felt necessary to explore the nature of Weltanschauung much further, and the remaining discussion will serve to emphasise both the importance and complex nature of this idea. There is no doubt that this remains an area where further useful research will be done, and that the basic essentials presented here represent no more than a beginning.

The importance of Weltanschauungen cannot be over-emphasised, since they determine which of the possible observations an observer might construe, i.e. the set of observations or constructions consistent with the observer's perceptions, he actually regards as reality. Weltanschauungen will actually determine what observers regard as"facts" and often account for diametrically opposed interpretations of situations based upon very similar experiences. A Weltanschauung is the network of concepts or categories which are antecedent to, and into which an individual's perceptions of the world are organised. It determines not only what will make sense to an observer, but also what sense he makes.

However, it would be misleading to suggest that an individual's Weltanschauung is singular and continuous ; thus an individual will have a set of Weltanschauungen which will, amongst other things, be be responsible for differing modes of observation and behaviour ranging from the apparently high rational to the purely emotional. These modes of apparently independent thinking are clearly recognised by Pask (1975) who posits the possibility of single brains being organised into "a priori independent processors" in which sets of "stable" concepts are related to one another by analogical relationships to form an "entailment mesh". (See Chapters 5 and 8 for more details of Pask's theory and methodology).A Weltanschauung may usefully be thought of as an entailment mesh within which perceptions form entailment relations with the existing networks, for it is what a concept entails and what it is entailed by it that gives the possibility and actuality to a unique observation from an essentially identical perception for each observer.

"Weltanschauung", having no direct English equivalent, is often described as and observer's "world view" or contextual framework, and these phrases do come near to describing the concept. However, it is hoped that the more detailed discussion of the concept contained above has served to illuminate both the nature and true importance of Weltanschauung.

At this stage, a description of the methodology is complete. This has involved highlighting some aspects which are different for the author, particularly the approach to conceptual modelling. A great deal of attention has been given to Weltanschauung because this is the most important concept. It has been possible to relate the Realist view of the perceptual process to the concept of W in a useful way.

Although aspects of Checkland's methodology have been identified as the basis of the more detailed approach to problems sought in this work, it will be necessary to explore the relationships between this methodology and Transcendental Realism in more detail before the further development of a problem solving framework can be pursued. This is the task of the next section.

3.4. The Relationship Between Checkland's Methodology and the Realist Account of Science

Aspects of soft systems methodology have been identified as useful in tackling a class of complex problems. This has only been possible by viewing the methodology in the context of a realist philosophy of science, aspects of which may not correspond with Checkland's philosophical views. In order to form the basis for further development of these ideas, it is necessary to discuss some relationships between the methodology and TR in more detail. This will attempt to identify possible isomorphisms between the processes envisaged by both approaches. Modelling will also be considered in terms of its place in the process. This mapping serves to underline the modelling deficiencies of soft systems methodology in terms of its failure to incorporate a conception of underlying mechanism in modelling stages.

The author believes that this stems from Checkland's belief that human activity systems are "only mental constructs". However, it has been stressed in this work that all observations are mental constructs arising as a product of a real world and a W. Where no real world exists, the constructs must arise from a W alone. But the question as to whether a real world exists becomes a matter of philosophical prejudice. Even on Checkland's view, mechanism should be important because the W's must play a central role in the production of a view of a human activity system. The mapping process can now begin.

The methodology begins with the problem situation un-analysed, and this is equivalent to the subject matter N shown in Figure 2.13 of the previous chapter. This N will be described by T, which may be a set of sentences ($t_1 - t_n$) which will be equivalent to the methodological Cloud 2, the problem situation analysed. These sentences will contain the constructs and the socially produced "facts" which describe N, so that different actors/problem owners may use a different set of sentences to describe N in a way which is consistent with the independent (real) existence of N. T^1 equates to methodological Cloud 3, root definitions of relevant systems, so that on this scheme, root definitions are sentential models of relevant systems. Each root definition will have several sentences so that T^1 will have a subject $t^i_1 - t^i_n$, but where several systems are identified as relevant to the analysed problem situation, $t^i_1 - t^i_n$ may be a set of sentential models (root definitions). So far, the methodology is as shown in Figure 3.8.

Root definitions will embody a cenceptionalisation of Ai(t) and $G_i(t)$, but will not exhaust sentential modelling. The conceptual modelling identified in Clouds 4, 4a and 4b will also be expressable in sentential terms so that root definitions do not exhaust the subset $t^i_1 - t^i_n$. It is important to stress that when conceptual modelling is <u>complete</u>, $t^i_1 - t^i_n$ will not only model (describe) the relevant systems but also the underlying mechanism(s) which explain why the system(s) behaves in a particular way. The iconic element M must be seen as an emergent property in a qualified sense. M is not produced by the subset of $t^i_1 - t^i_n$ which describes it, for it has its origin in the process of imagination acting through the mechanism of analogy.

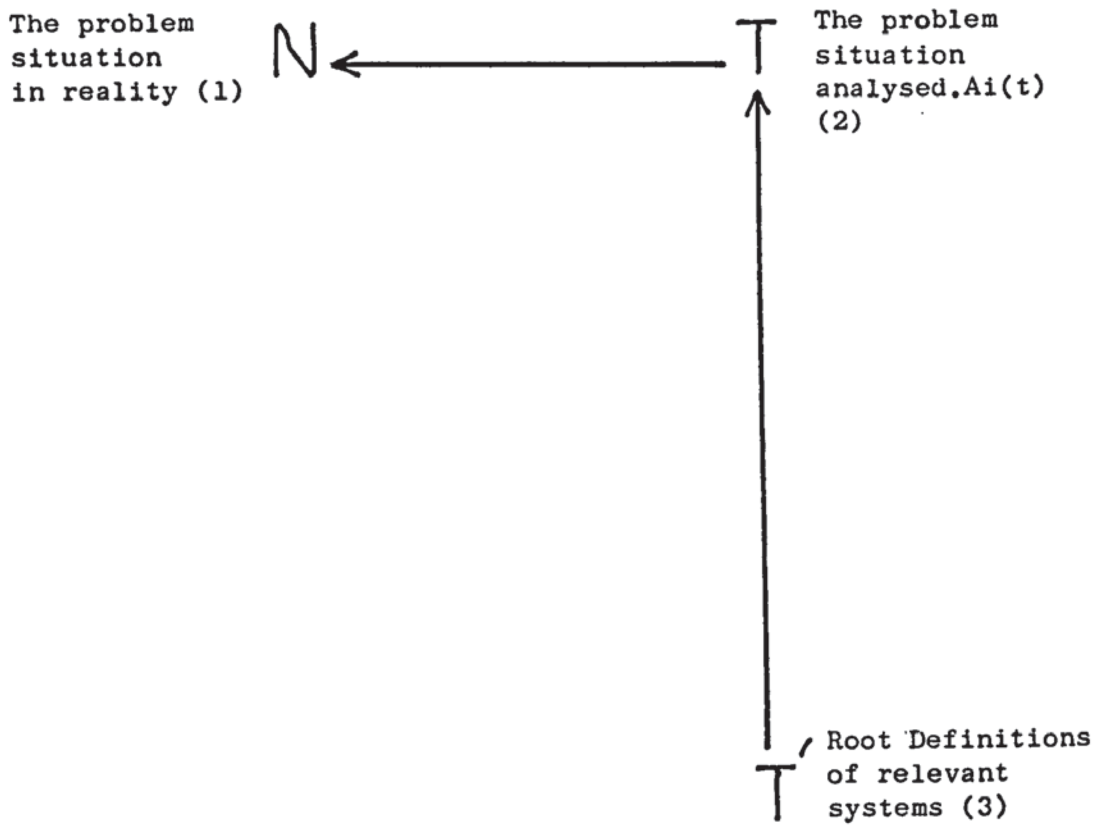


Figure 3.8.

A Partial Mapping of Checkland's Methodology

to TR

However, the idea of M may be transmitted to others using sentences which describe M. When someone has the idea of M, they can <u>picture</u> the mechanism as a dynamic entity, so that a picture of M has emerged from T^1 rather like a TV picture emerging from a series of lines whose luminosity varies throughout their length. The picture of M cannot be wholly described because the elements and processes identified need to be powered by an imagination just as a car must be powered by fuel where M is a real thing. In this case, the iconic element comes from other systems thinking (4b) in the form of organismic modelling, so that 4b equates to M as in Figure 3.9.

If one proceeds with a view to being scientific in the TR-ist sense, then one will have constructed an explanatory model when Stage 4 is complete. Descriptive (sentential) models will not be sufficient, because the methodology goes on to specify feasible, desirable changes and the ability to judge feasibility will rest strongly upon an understanding of how the system works. In this research, explanatory power stems mainly from a form of organismic analysis which draws heavily upon biological as well as general systems thinking. Description and icons of mechanism are thus regarded here as a vital part of the conceptual modelling. Models, when made, must be checked and Stage 5 in the methodology checks the model(s) with the "known facts", while Stage 6 serves to generate further tests of the model's enlightening power. Stage 7 implements tests so that Stages 5-7 may be seen as an attempt to show the mechanisms modelled in 4 are real, and this has increasing validity as the analyst cycles the methodology. This may be summarised as in Figure 3.10.

Clouds 1 and 7, along with events, invariances and the generative mechanisms that produce them, belong in the real world. Clouds 2, 5,

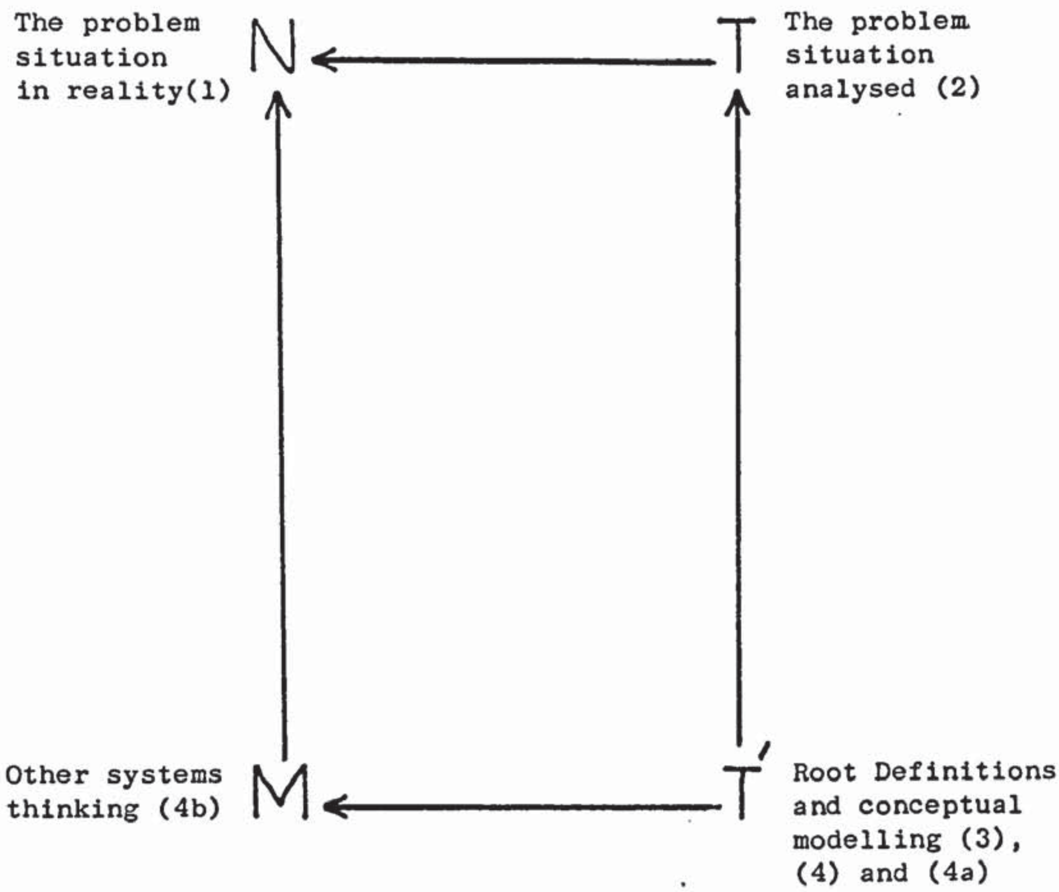


Figure 3.9.

A Further Mapping of Checkland's Methodology to TR

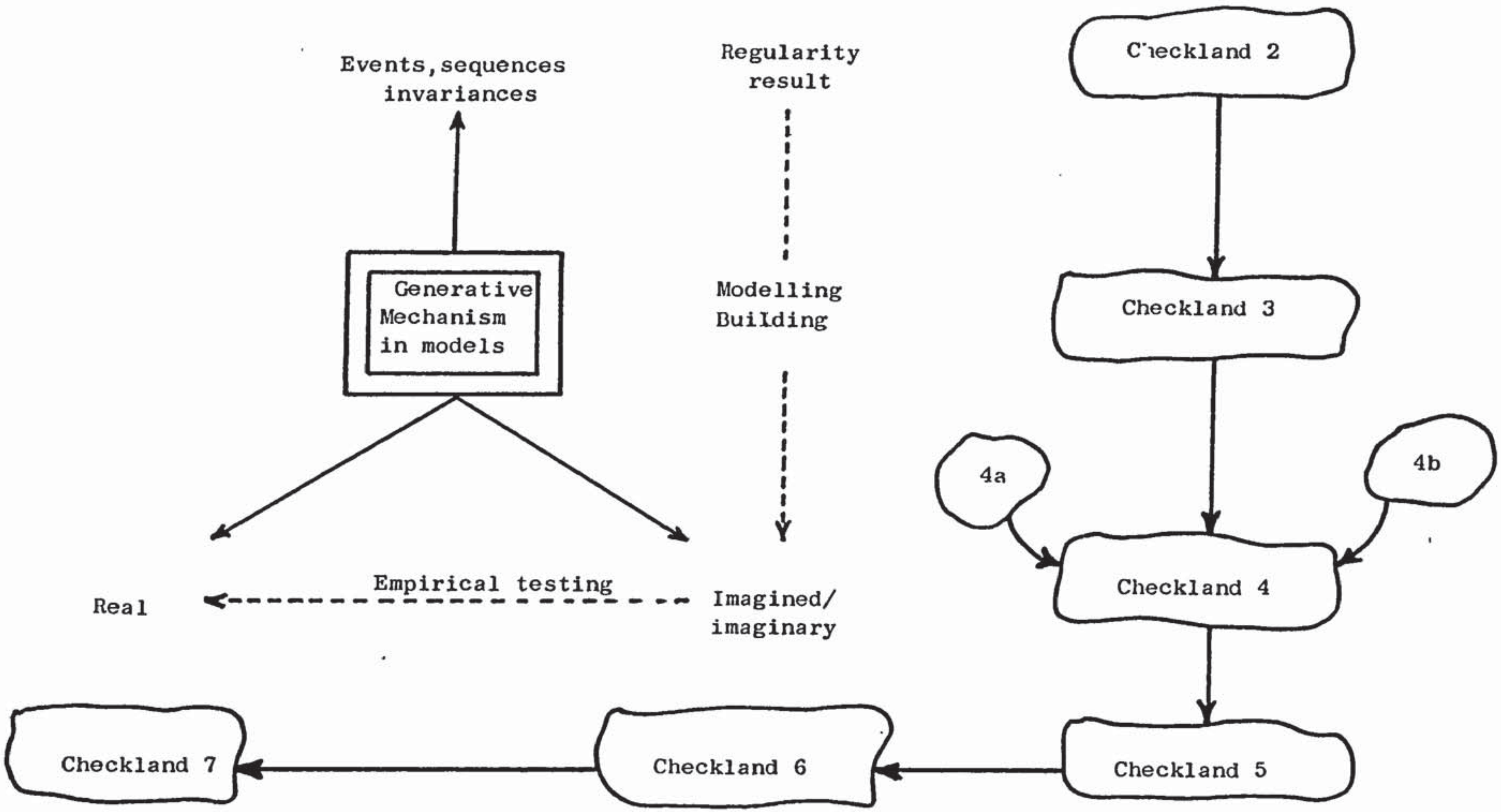


Figure 3.10

A Complete Mapping of Checkland's Methodology to TR and 6 belong to the observed world, while Clouds 3 and 4 belong to the theoretical domain, what Checkland describes as "Systems thinking about the real world."

The attractive features of the Checkland methodology are principally that it can, on the one hand, be made consistent with a scientific approach, although it is not wholly clear that Checkland would support the line developed here ; on the other, it is "realistic" in that it starts with the basic assumption that social organisations (human activity systems) are open systems in which observations vary widely, and regularities may mean very little.

3.5. Conclusion

The transitive element in observations and problems demand that problem structuring and solving in social systems should, (if it to be successful) proceed with an awareness that the system(s) conceived by various actors may be legitimately different and that these systems are essentially "open", and therefore subject to a large degree of perturbation and uncertainty.

Checkland's methodology has been chosen as the central methodological tool, and the discussion has examined the relationship between this methodology and a "scientific" approach to problems, based on the work of Harre (1972) and Bhaskar (1975). The author's understanding of Action Research has been enhanced by this process.

All research which aims to solve specific organisational problems with a sponsor will, by definition, be Action Research because the actions of the researcher will necessarily affect the sponsor. Ideally, analysts and problem owners are conscious of this when following a methodology, and aim to make the maximum use of opportunities for beneficial change. However, the position of an IHD researcher can be a difficult one because of the need to meet academic requirements on the one hand, and the demands of the sponsor on the other. (See Clark, 1972, for a discussion of the aims and constraints of action research in general, and Chapters 7 and 9 of this work for details of the difficulties in this research).

The essential contribution of this chapter has been to show that the methodology of Peter Checkland has important aspects which are capable of advancing the ideas of Chapter 2 towards the coherent methodolgical framework sought in this work. The concept of Weltanschauung has been examined and its importance has been noted. It has also been noted that the methodology is weak in the area of iconic modelling and therefore fails to encourage understanding of relevant systems at the explanatory level.

It will be noted in the following chapters that explanatory power may arise from a number of sources. It seems to the author that the need for explanation is sufficiently important to warrant an examination of one source which the author has investigated as part of the general attempt to understand the difficulties experienced during the IHD project. This source is a form of organismic model developed after Beer (1972) which will be discussed in the next chapter.

Chapter 4

A Source of Iconic Modelling

4.1. Introduction

In the preceding chapters the author has felt it necessary to outline a number of complex ideas as an essential precursor to the presentation of a developed methodological model in the next chapter. This preparatory work is important because it reflects the process that the author has gone through to both understand the difficulties of the applied work and to develop an adequate model of the process involved. However, the process of discovery was not as neat and tidy as the presentation in this thesis might suggest, and the author did, at one time, look towards organismic modelling as a likely path towards an understanding of the project difficulties.

The amount of work invested in the organismic modelling (OM) approach make it tempting to devote a major section of this work to it. However, this seems inappropriate in view of the fact that this approach does not offer insights into the problem solving process in the same way that it provides insights into aspects of organisational functioning.

Checkland (1981) has objected to this type of approach. The main objection would seem to be that such approaches treat human beings as though they were machines, albeit very sophisticated ones. Now, this has some force since supporters of the approach often speak of uncovering the invariances or cybernetic realities <u>underlying</u> system behaviour. Further objections seem to gain force when analysis seems to be reducing human interaction to information exchange systems. In general, the process involves imposing a single Weltanschauung (the scheme of analysis) which itself attributes the possibility of a single W amongst the parts of the system analysed. Talk of cybernetic reality and invariance can sound dangerously like the imposition of a uniform scheme or set of criteria for the interpretation and understanding of any information flows. Checkland's criticisms cannot be fended off by acknowledging observer dependence (Beer, 1979b)if one constantly advocates a single scheme for the interpretation of information.

The strategy employed here might cynically be characterised as wanting the best of both worlds. In particular, the Realist stance of this work wants to retain some substance in notions like "Invariance" and"Underlying reality". However, multiple W's are a central idea in this work so that one would posit viable system modelling as one of a number of possible techniques capable of capturing an important aspect of an underlying reality. Within this W, one would further want to retain as a central idea the notion that viable systems, sub- and meta-systems may have significantly differing W's, so that one requires a relativistic theory of communication in which a message sent may bear no resemblance to the message received, even where there is no distortion in a channel. There may, in fact, be no channel. The cybernetic reality may be, in the limit, that there is a shared reality within a particular organisation, but that this is minimal, so that understanding differences becomes more important than understanding commonalities (see Chapter 5 for a good development of related points). OM is valuable because it can sometimes characterise aspects of organisational functioning in a way that highlights mechanism.

Despite these considerations it is intended to devote most of this chapter to a discussion of organismic modelling and some related ideas. This will be done with a view to relating the role played by the modelling to the broad realist framework developed in Chapter 2. The author believes that the value of the organismic approach lies in its ability to compensate for the lack of iconic (explanatory) modelling within Checkland's approach, identified in the previous chapter. This ability is the overriding justification for including organismic modelling in the development of a suitable framework for organisational problem solving. It remains true that the methodology can be supplemented by other potentially explanatory modelling techniques, and some of these will be identified in Chapter 8.

In order to avoid making the discussion too long, extensive use will be made of Appendices. It is worth remarking that for those who do not already have some familiarity with organismic modelling and related concepts, the appendices are essential reading for an understanding of this chapter. The chapter begins with a discussion of some fundamental ideas associated with organismic modelling. These include homoeostasis, control, meta language, recursion and others. This is followed by a description of Beer's (1972) organismic model and a developed version (Molloy and Best, 1981). The final part of the chapter is devoted to underlining the role of organismic modelling within the realist framework and open systems methodology.

4.2. Some Important Concepts

Organismic modelling is a cybernetic approach which has its origins in the systems movement. Systems thinking is very old and is often characterised as being concerned with holism (see Chapter 2) and emergent properties. The systems movement has come to embody a broad collection of approaches which cross the holistic/reductionist categories discussed in Chapter 2. A form of systems approach is present in this work and is evidenced by the choice of Checkland's methodology as a potentially useful framework. A more detailed discussion of the systems approach is contained in Appendix C.

The other concepts dealt with in this section are of more specific relevance to what may be called "the organismic approach", which is a body of theory relating to a subset of the class of open systems. If open systems are those which have interaction with an environment so that perturbations are present, and the occurrence of constant conjunctions tends to be negated, then organismic systems form the subset of systems which are actively seeking survival. Some would argue that the defining characteristic need not be as strong as this, so that this class consists of those systems which do, as a matter of fact, survive. However, this seems to the author to be fairly weak ground upon which to draw the distinction, and serves only to eject the teleological aspect which must be reintroduced to make the attendant functional analysis possible. System properties such as "openness" and "wholeness" will not be dealt with here since a good deal has already been said about them ; it is sufficient to remark that the former serves to make the phenomena within systems probablistic while the latter stresses the synergistic and emergent properties of systems.

A concept fundamental to organising modelling is homoeostasis. This is concerned with the tendency of interacting systems to accommodate one another at some equilibrium by mechanisms which tend to maintain the equilibrium. Networks of open systems with a wider environment will be subject to a range of perturbations and may be said to be ultrastable (Ashby, 1956) when homoeostasis can be maintained in the face of disturbances which are unforeseen by the system or the system designers. Organisms are ultra-stable in this sense and some social systems may be treated as organisms in that they also display ultrastability. In both cases, homoeostasis (survival) cannot be maintained in the face of any possible purturbation. (See Appendix C for a more detailed discussion).

In discussing methodology a good deal has been said about the complexity of problem situations and complexity is also a key notion in OM. The main units of analysis with OM are the environment, the system and the management of the system. These are held to have descending orders of complexity which generate problems for one in relation to any other.

Beer,(1966, 1972, 1979) following Ashby (1956), maintains that the complexity of a unit is the number of possible states, and calls this "variety". This is discussed in Appendix C, where some subtle aspects of the concept are explored. The main categories of variety identified are listed below :

1. Variety expected (Ve) - the possible number of states that an observer might envisage or expect in a time period.
2. Variety Actual (Va) - The actual number of states of a system in a time period.

3. Variety Manifest (Vm) - This is that actual variety Va plus any difference between expected and actual variety in a time period.

In general, one can say that $Vm = Va + \left| Va - Ve \right|$. This expresses the fact that actors must cope with what the world does and what it does not do that they were expecting it would. The intricacies of these relationships serve to warn against any naive use of the concept of variety. Weltanschauungen must remain important since they will be largely responsible for the expectations of actors/observers.

A basic idea in OM is that a management is in communication with its system, and a system with its environment. A management aims to control its system and a system needs to control its environment. Such control may involve an attempt to change or maintain a given state of affairs, but always implies an ability to determine an outcome at least within a range of possibilities. A higher variety implies an ability to generate more responses so that the ability to control might be taken to imply a higher variety for a given system (environments and managements are also systems). However, control relationships, like variety, have their subtleties which may be thought of in terms of variety.

Most of the important distinctions rest upon the fact that systems (organisms) have a choice about what types, and quantity of variety to actualise in respect of any particular relationship with another system or set of systems. On this basis, the concept of actual variety Va can be refined as follows :
Assume the actual variety that a system can actualise in a given time period to have the notation "Va,m". It will follow that for a partic-

ular relationship between systems it is possible that the system will choose to actualise less variety, or may be forced by the demands of relationships with other systems. This lesser variety can be denoted by "Va,a". An organism cannot always, with its inherent variety, control the environment, although it may, where suitable amplifiers and filters exist to reduce the effective variety of the environment and increase the effective variety of the system ; this is because environmental Va,m $>$ system Va,m. However, social and biological organisms, although restricted in their ability to control the environment, are often successful in controlling their own destiny because they have models of environmental variety, or at least the mechanisms in which it is embodied, and can often select from amongst environmental Va,m which, but not any, subset (Va,a) to interact with i.e. which subset to actualise in relation to that system as opposed to systems in general. This vital point is often overlooked in OM. Organisms need to control their environments or select appropriate environmental variety in order to maintain their essential variables (Ashby, 1956). These define the range of variation available in any homoeostatic relationship. Any selection will define a particular environmental Va,a which one might describe as the "relevant environment". Following this, it is possible to think of environmental Va,m as the "general environment" (see Appendix C for a more detailed discussion).

At this point, some basic ideas associated with OM have been introduced and some of their subtleties have been identified. However, variety and control by no means exhaust the collection of ideas that are important to OM. Were more space available, one would wish to discuss the functionalist character of OM along with the notions of meta language and recursion. These ideas are discussed in Appendix C but it is important to move on quickly to consider more central, if not more important ideas. Organismic modelling is concerned with systems that attempt to survive and maintain their identity. Beer (1972) has called these "viable systems" so it is appropriate that viability, the viable system and the related concept of organised closure be discussed in the next section.

4.3. Viability, the Viable System and Organisational Closure

The central concept in the organismic approach developed from the basic ideas of Bertalanffy and Ashby by Beer is that of viability. In the original work on the viable system model, Beer (1972) speaks in teleological terms about viable systems, as, for example, when he considers the solution to the problem presented by an infinite regress of meta systems :

"It is identification of the viable system, its determination to be itself and to survive."

Beer, 1972, p.

In the new companion work Heart of the Enterprise (1979), Beer also speaks teleologically about the viable system :

"...it will - if it can - survive. It will maintain its separate existence."

Beer, 1979, p.

This way of speaking is, in large part, due to the functional analysis (Appendix C) employed by this kind of systems thinking. For those who can find little affinity for this way of "seeing" things it presents the greatest difficulty because it appears to require the attribution of properties to all social and biological systems which only some biological systems obviously have. In particular, it seems that they are all treated as entities with intentionality and this has become associated with the kind of consciousness that one "sees" in human beings. The powerful concept of organisational closure is both useful in thinking about viable systems and convenient for those who wish to avoid the teleological overtones of functional analysis. Organisational closure is used to justify the idea of the abstract, functional homoeostat and this will be taken up below.

Interest in the concept of organisational closure has been aroused in modern times by Varela et al. (1974), and was developed in the context of biological systems to characterise the feature of biological systems that defines them as living. The organisation of these systems is described as "Autopoietic" and is contrasted with "Allopoietic" systems :

"The autopoietic organisation is defined as a unity by a network of productions of components which (i) participate recursively in the same network of productions of components which produced these components, and (ii) realise the network of productions as a unity in the space in which the components exist." ....

iii.......................... and ....

"In contradistinction, mechanist systems whose organisation is such that they do not produce the components and processes which realise them as unities and, hence, mechanistic systems in which the product of their operation is different from themselves, we call allopoietic. Allopoietic systems are by constitution non-autonomous insofar as their realisation and permanence as unities is not related to their operation."

Varela, Maturana and Uribe,1974.

Autopoiesis is not, however, confined to those systems traditionally recognised as living :

"The product of an autopoietic organisation is not different from the organisation itself. A cell produces cell forming molecules, an organism keeps renewing its defining organs, a social group "produces" group-maintaining individuals, etc. Such autopoietic systems are organisationally closed and structurally state determined, with no apparent inputs or outputs."

Zeleny, 1977.

An important part of the concept of autopoiesis is the distinction between organisation and structure :

"A network of interactions between the components, renewing the system as a distinct unity constitutes the organisation of the system. The actual spatial arrangement of the components and their relations, integrating the system temporarily in a given physical milieu, constitutes its structure. The unity and holism of systemic organisation and structure represents what is commonly referred to as a system.

Zeleny, 1977.

This distinction will be adhered to throughout the remainder of this work. An important consequence of this distinction is that autopoietic systems are <u>not</u> structurally isolated from an environment, but maintain organisational closure in spite of turnover in their structural constituents.

This characterisation of "self producing" systems is important because it identifies whole systems displaying emergent properties.

"There seems to be plenty of evidence to substantiate this view of system-wholes. The traditional source of examples has been living systems. Surely in them the circularity of interconnectedness is more striking than anywhere else, both topologically and functionally. But although outstanding biological systems are not unique in this respect, and the current interest in ecological wholeness and world models are a testimony. One could exhibit examples ad nauseam ; I hope the reader agrees with me that this is not necessary here.(I).

In terms of organisation, what this empirical conclusion reveals is that system-wholes are <u>organisationally closed</u> ; their organisation is a circular network of interactions rather than a tree of hierarchical processes (2). Conversely, then, if we are trying to make more precise our notion of a whole, I propose to make these empirical results a guideline. That is, I propose to take the circularity and interconnectedness of organisation, or organisational closure as the <u>characterisation</u> of system-wholes. In brief, I propose the

Closure Thesis :

Every system-whole is organisationally closed."

Varela, 1976.

The type of circular network of interactions which characterises autopoiesis is more common than one might initially think. Zeleny, as has been shown above, maintains that social systems have this property but other examples can be found. Pask's dynamic production schemes in which description building and procedure building operations are executed by a program in a medium to produce sets of stable concepts which exhibit local cyclicity, would be a good example (Pask, 1975). (See Chapter 8 for more details).

In effect, what this idea provides is a characterisation of a mechanism (itself functionally described) which gives a unifying goal to all systems with such an organisation, so that we have an explanation of a kind, of a living/viable/autopoietic/organisationally closed system's determination to survive and maintain a separate existence. Systems with such a mechanism (organisation) define their own boundaries and maintain them through organisational closure, and may be considered to be in a homoeostatic relationship with an environment ; here, the variable which is maintained within defined limits is the organisation itself.

Viable systems, then, are organisationally closed so that they will survive if they can and this manifests itself in an ability to survive in an environment which is the source of the disturbance or perturbation, as well as sustenance. The term "viable" is often used to infer the probability of a system surviving so that it carries an inference of future existence. However, it should be understood that such inferences are dangerous and that observations of a system cannot be a sound basis in themselves for judgements about the system's future survival. The recognition of organisational closure can form a basis for inferences about the system's past, since it has obviously survived and is surviving. Now, if the system is dealing with a complex environment (so that the system and its observers must treat the system as an open system) it follows that the nature and degree of future disturbances must, in some significant degree, be unknown.

At this stage, enough background has been presented to make it sensible to move on to describe Beer's (1972) version of the viable system model roughly within its own diagrammatic conventions. This task will be taken up in the next section.

4.4. Stafford Beer's Viable System Model

The discussion so far has treated OM in general terms with more attention to some of the more interesting aspects. This section will describe Beer's (1972, 1979) viable system model in outline. This is felt to be a useful illustration of OM, and a necessary precursor to a description of the author's preferred version of viable system modelling.

Accounts of Beer's model can be found in Brain of the Firm (1972, 1979) and Heart of the Enterprise (1979). Further discussions and development with applications appear in Espejo (1975). The discussion below will be the minimum required to establish the model.

For this model it is taken as axiomatic that the complexity of an environment (E) is greater than that of a system (S) as a system is greater than that of a management (M), therefore following the notation used in Sections 4.2 and 4.3 :

$$E.Va,m > S.Va,m > M.Va,m \qquad \text{I}$$

where E.Va,m is the maximum actual variety of the environment, S.Va,m is the maximum actual variety of the system and M.Va,m is the maximum actual variety of the system management. However, if organisational closure is to be maintained, some static control relationships must be maintained so that :

$$E.Va,a \;=\; S.Va,a \;=\; M.Va,a \qquad \text{II}$$

These relationships are illustrated in Figure 4.1, but it should be stressed that the filters may not, although they usually do, exist.

It should be noted that these elements are separated only for convention's sake (after Beer) to facilitate the pictorial arrangement of systems which would, in reality, be embedded in one another. Where filters and amplifiers are present, the Vaa's of the systems will not be equal as in II, but will be equalised by an appropriate function so that :

$$E.Va,a \;=\; S.Va,a \times x \qquad \text{III}$$

$$\frac{E.Va,a}{x} \;=\; S.Vaa \qquad \text{IV}$$

$$S.Va,a \;=\; M.Va,a \times y \qquad \text{V}$$

$$\frac{S.Va,a}{y} \;=\; M.Va,a \qquad \text{VI}$$

This arrangement is the basic building block of the model and is used to represent both a meta (whole) system or any subsystem (element) so that the model has a recursive property which is intended to reflect the functional hierarchy observed in natural and social systems that are organisationally closed. With some further analysis of the management function, this basic configuration is expanded to form a five-tier recursive hierarchy which is intended to represent any viable system as in Figure 4.2.

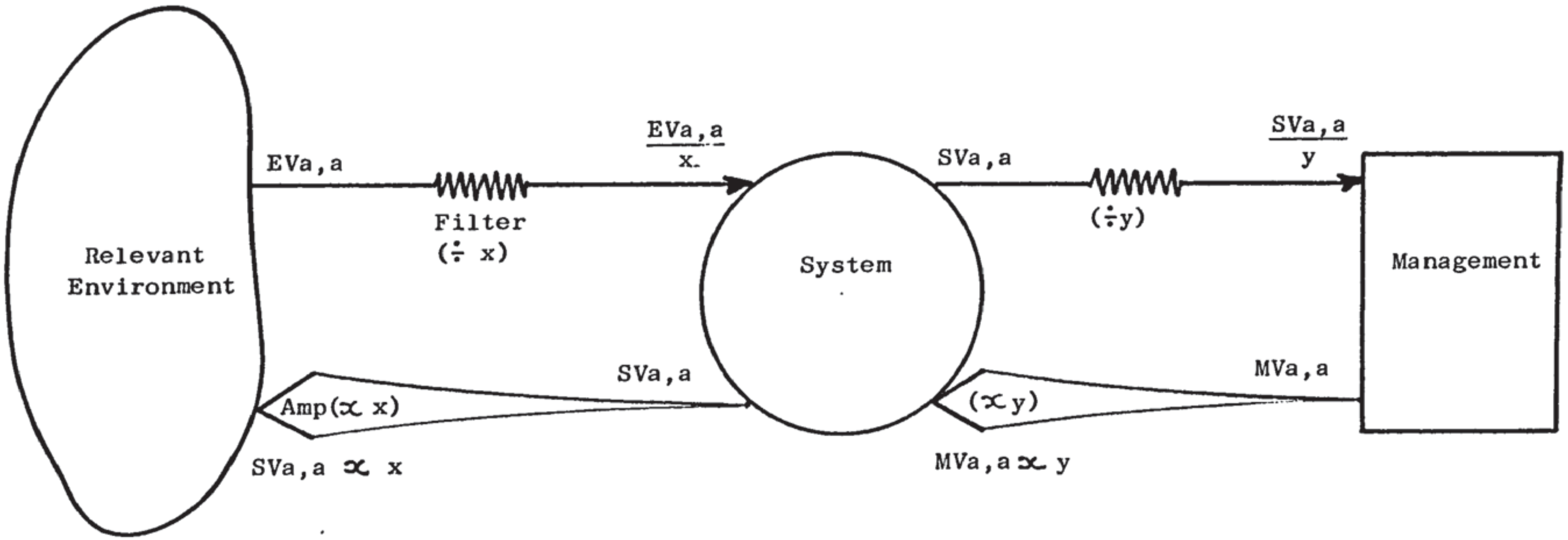


Figure 4.1.

Elements of a Viable System Model

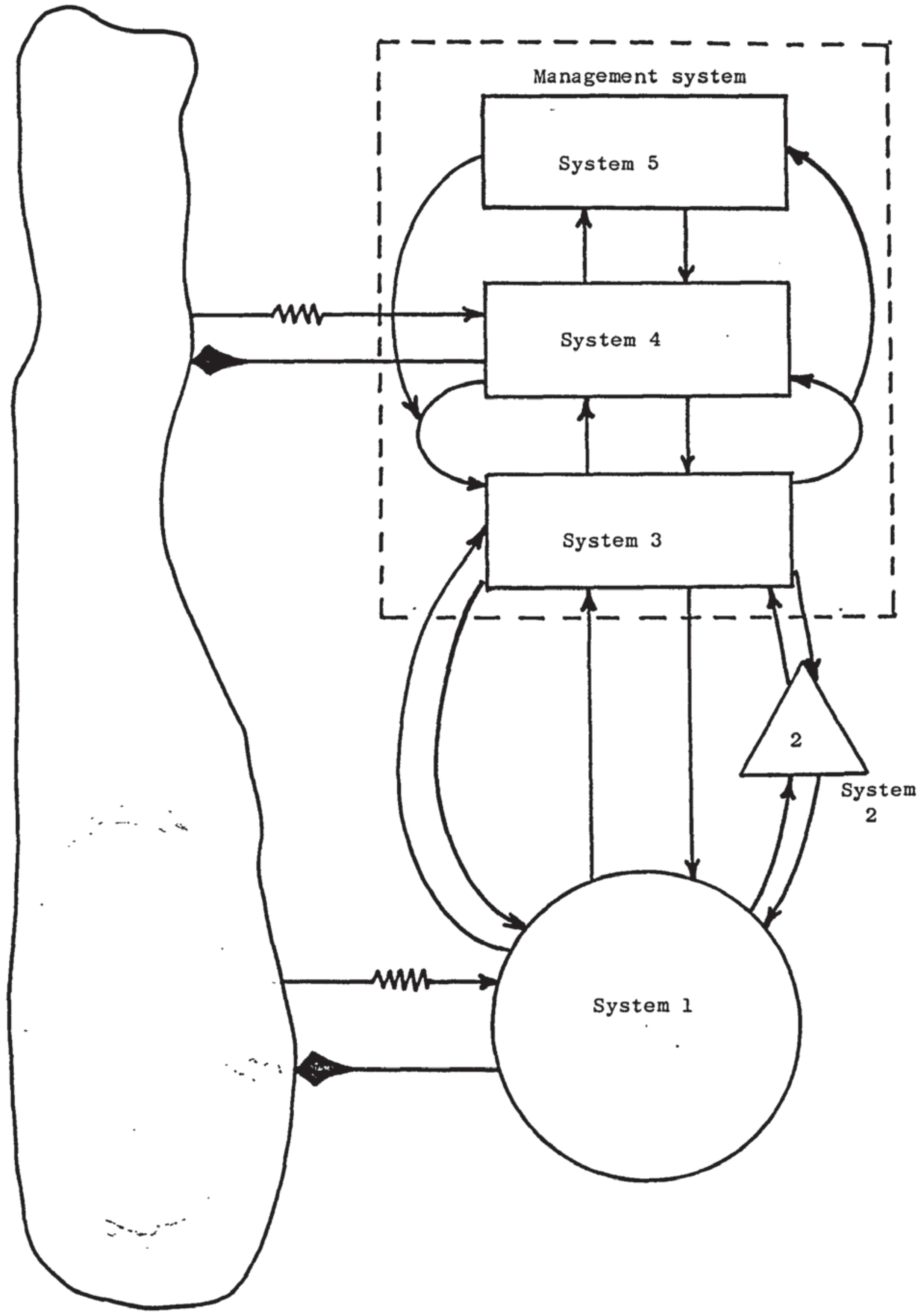


Figure 4.2.

The Five Systems of Beer's Viable System Model

This model is shown for one level of recursion. Systems or functional specialisations are as follows :

System 1 represents the operations performed by the system or, in this case, the enterprise called George Ellison Ltd., and the channel with its filter(s) and amplifier(s) represnts the flows of material, services, money etc., in the form of information. System 1 will contain any divisions or subsystems within the enterprise that exchange identifiable goods or services with the environment. As we have seen, these divisions will be at least two in number, and are represented by the same functional, diagrammatical convention as in Figure 4.1. Thus the system I circle can be expanded as in Figure 4.3.

There will be as many divisions as there are identifiable activities, so that in George Ellison's case, one might immediately construct two divisions : one for manufacturing and one for factoring activity. In principle, this type of analysis could be followed down to, and beyond the level of the human individual, although it should be noted that the human nervous system was the source on which the analogy is built. Beer denies that this is an analogy, but as we have seen, explanatory models always bear a relationship of analogy to their source even when they are adequate in relation to their subject. In this work, successive recursions will uncover divisions, departments, sub-departments, etc. etc.

System 2 is anti-oscillatory and is sometimes described as the co-ordination function. It represents the self-regulating property of the whole System 1 arising from the communication between divisional

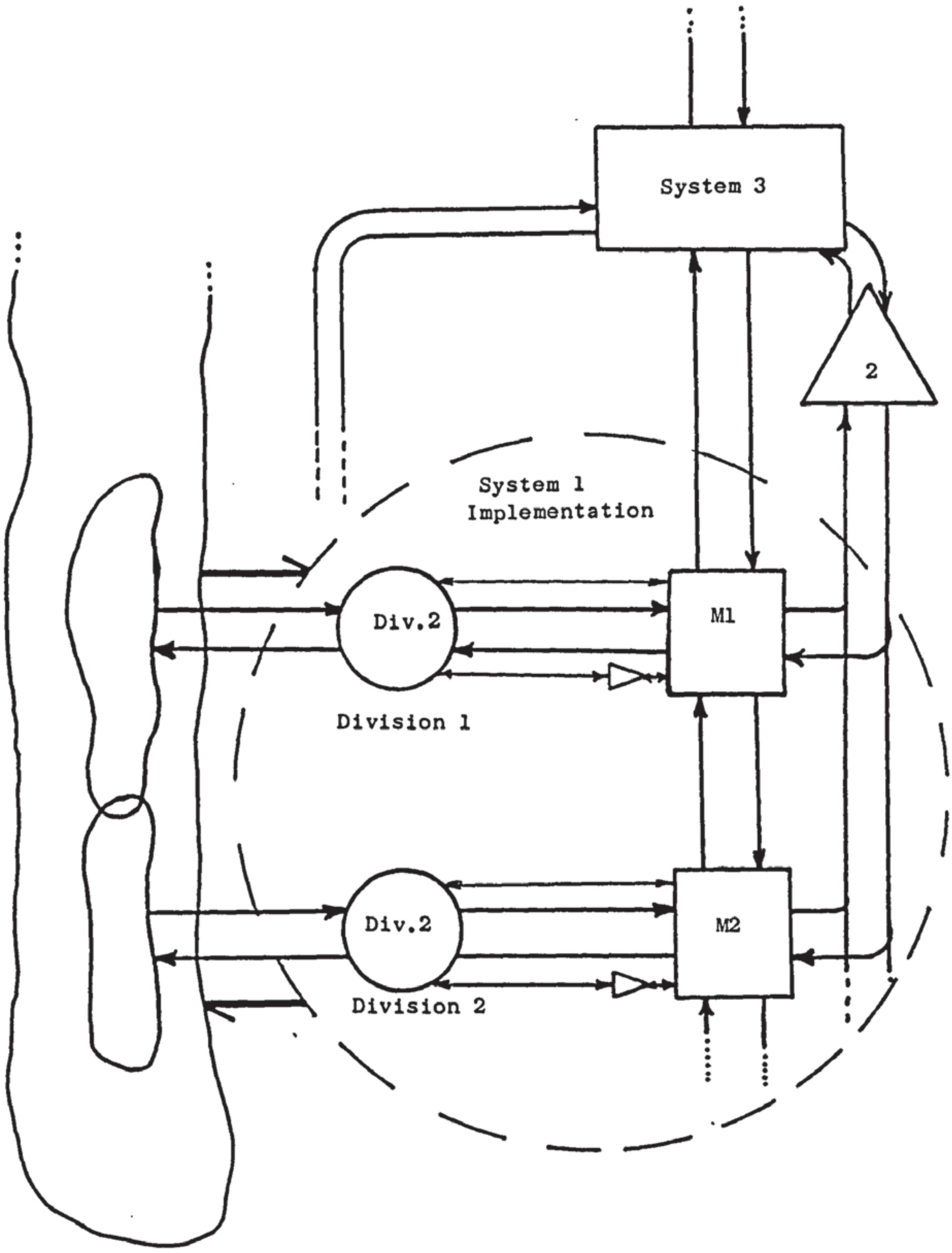


Figure 4.3.

System 1 Expanded

managements plus the external constraining influence from the outside system which has its source in the meta management.

System 3 is the control function which functionally looks after the day-to-day management of the whole organisation. In GE, this will be the managing director plus his various office functions and delegations to transmit his authority in the form of standing orders and commands downwards to the implementation function.

System 4 may be characterised as the intelligence function with responsibility for anticipating future events of relevance to the organisation. It monitors the macro or wider environments of all divisions at the next level of recursion "down". Data which is of specific relevance to the functions of System 3 or System 5 become information for them and are channelled into them. The result is that a dialogue takes place between 4 and 5 about the present and the immdeiate future. Matters of long-term significance are fed "up" to System 5 for consideration in relation to policy and long-term objectives which set the operating limits or goals for System 3.

System 5, then, is the policy function which must decide what is undecidable to System 3. The functional role is often performed by a Board of directors, but might, in practice, involve a range of possibilities including workers' committees, etc.

This description of Beer's model is very brief, and many of the conventions of the model are not made explicit, so that the references cited should be consulted where this provides a difficulty. As such, this account does less than justice to the pioneering work of Beer, but it will suffice for the purpose in hand. The remainder of this chapter will outline the alternative model developed by the author in close collaboration with a colleague as a result of dissatisfactions with aspects of System 2. The model developed adopts the same basic conventions (functionalism, recursion, etc.) but differs principally in the number of functions explicitly recognised (3 not 5). The methodology of this exercise involved reworking the neurophysiological work reported by Beer in Brain of the Firm. Once again, space prohibits a full report of this research here, but the reader is referred to Best and Molloy (1980b, 1981a), Molloy and Best (1981b), and Woolley and Molloy (1981). The next section will give an overview of the new model.

4.5. The Alternative Model

Whilst working with Beer's viable system model, the author found some aspects, particularly System 2, difficult to understand. Consultation with fellow researchers confirmed that others were experiencing similar difficulties, and this led to a phase of collaborative research with D.P. Best. Attempts were made to resolve the problems at a logical level, without success. The only sensible course seemed to be to attempt a rederivation from the model's neurophysiological origins. The results of this work are reported in Best and Molloy (1980,1981) and Molloy and Best (1981). The new model is described in outline below.

The conventions adopted by Beer are followed in this model. Management, system and environment are represented by a box, a circle and a cloud respectively. The interactions that take place between these elements are represented by two-way communication channels which may have amplifiers and filters. To this extent, this model fits exactly the arrangement given in Figure 4.1 above. The differences between this model and that of Beer lie in the absence of System 2 and in the detail of the meta system (management box). As with Beer's model, the full development is not given here, but the main systems are outlined below.

System 1 may be characterised as the operation, and is responsible for the main transformation function performed by the system through structural interaction with an environment. System 1 is self-regulating in the short run, self-organising in the long run and displays synergistic properties in varying degrees. It is under the control of a meta system, together with which it forms and element in a wider viable system, an implementation function to a higher level of recursion. The elements of System one are themselves viable systems, and only the implementation function contains lower levels of recursion. (See Appendix C).

System 2 is a control function responsible for the day-to-day activity of System 1 (what Beer (1979) calls "the here and now"). Within this version of the viable system model, this function has two distinct aspects which might be considered as sub-systems or functions. These components are mutually conditioning so that there is a homoeostatic relationship between them. There is an "automatic" component which sets the general control framework within which the divisions operate. The operating norms of the organisation will be enshrined in this area of control. Within a viable system, automatic control will manifest itself in the form of rules and regulations about the behaviour of the system's components. So far as individuals are concerned, there will be rules surrounding a contract of employment such as statutory starting and finishing times. Some of these rules will themselves be conditioned by the norms set by wider systems. Such norms might, for example, be enshrined in various items of government legislation. Various other operating procedures and standing orders will exist to "govern" the nominal behaviour of the system in relation to customers, government, suppliers, etc. These norms are indispensable in the viable system as a variety reduction device. A managing director, for instance, could not give his individual attention to regulating every aspect of the system for which he bears responsibility. The rules, regulations and procedures that he uses allow him to set the nominal limits of acceptable behaviour, and to check upon the adherence of the subsystems to them. Automatic control is not optional, it is necessary ; without it there could be no organisation at all.

Rules and procedures are not only set, but they are also waived and changed and suspended, and this is carried out by what we shall call the "executive" component of System 2. Thinking of GE, one might surmise that the managing director or his "office" might receive some information, either through contact with the overall environment or from within the organisation, about some prospective large order, or impending strike, etc, etc., which might lead him to change the nominal operation of the company in some way, and this might be on a temporary or permanent basis. The executive function cannot change all the norms at once, since this would plunge the organisation into chaos. The maximum rate of change is dependent upon the nature of the automatic component and its relationship to the divisions.

System 3 in this model is not significantly different to Beer's System 5.It formulates policy which is interpreted by the executive branch of System 2. It does this on the basis of information it "senses" about the overall environment, which is assessed for implications relating to threats and opportunities for the future. Essentially, the same data are available to System 2, but it "concerns" itself with the immediate implications. The diagrammatic representation of the model is given in Figure 4.4.

This model is significantly different from its prototype (Beer's viable system). Principally, the overt co-ordination function is absent (Beer's System 2). It is argued that co-ordination can be understood in terms of feedback control and a separate overt co-ordination function is unnecessary and a positive barrier to diagrammatic consistency.

A second striking difference is the treatment of intelligence (Beer's System 4), which arises from the neurophysiological evidence reported in Best and Molloy (1981). An essential feature of Beer's intelligence function was its filtering/switching property. One cannot deny the filtering and structuring properties of the general senses, but the neurophysical evidence does not support the idea that policy and control have information routed to them as judged appropriate. Undifferentiated data arrive at the policy function and the executive branch of control, and their different purposes defined different information - information for their purposes. The details of this model are reported at greater length in Molloy and Best (1981b).

This chapter provides two examples from the same paradigm of modelling techniques that can be a source of iconic models. They do not

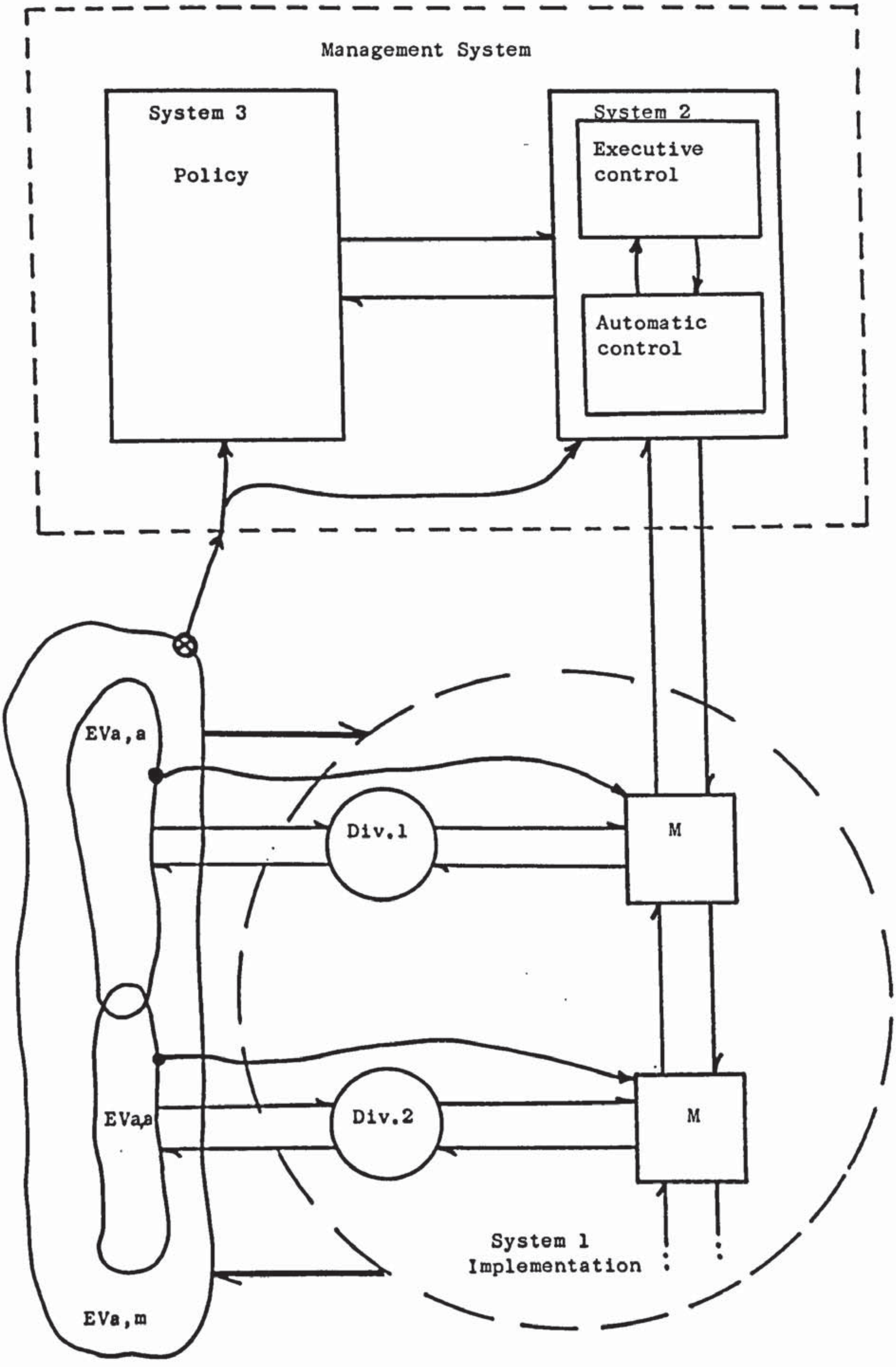


Figure 4.4.

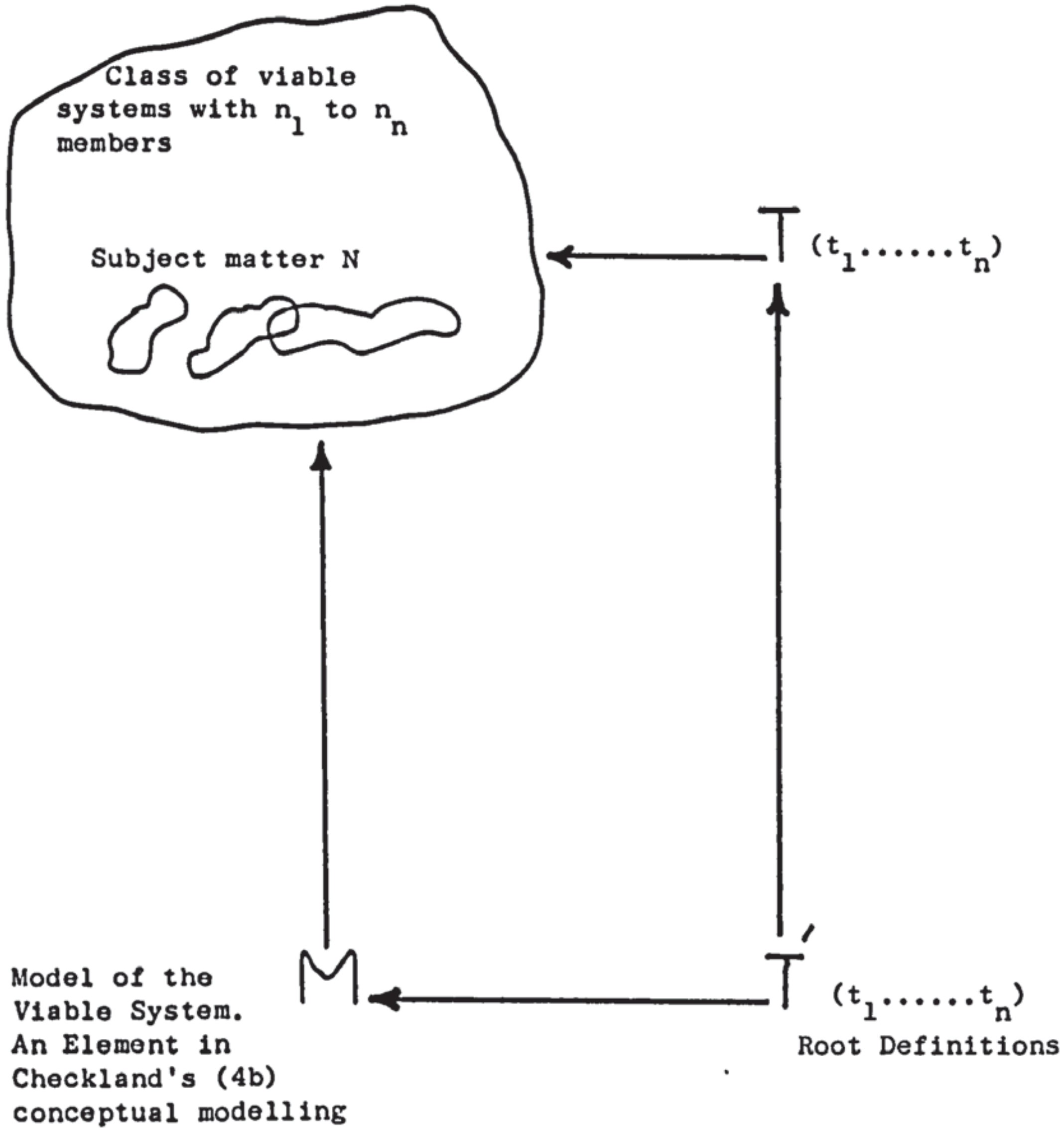
The Alternative Model

exhaust the possibilities and other sources are discussed in Chapter 8. Having given these examples, no purpose is served in describing in more detail, the present treatment being sufficient for the purpose. The remaining discussion in this chapter will underline the place of viable system modelling within the realist framework that has guided this work.

4.6. Viable System Modelling and the Realist Framework

In the previous chapter, the relationship between Checkland's methodology and the network of relations implied by the statement picture complex of Harré and Bhaskar was described, and now the link to the viable system model can be stressed. In terms of the square presented in Figure 3.9., the class, or members of the class of viable systems may be seen as the subject matter N. $T(t_1...tn)$ describes N, but T^1 (the root definitions and some elements of conceptual modelling) model N through T without explaining N. The square is completed by M, the viable system model and T^1 can be judged to be true or false, adequate or inadequate by reference to M. These relationships are set out in Figure 4.5.

Where conceptual modelling has explanatory power, the conceptual model is iconic, but there may be different sets of T^1 stemming from different Weltanschauungen that define different problems and relevant systems. The icons that are seen as most appropriate here are viable system models because viable system modelling deals directly with control, and therefore is of special relevance to G. Ellison Ltd., where survival, and thus, viability have been in the balance. The icons that are appropriate may be expressed in system dynamic models



<u>Figure 4.5.</u>

<u>Viable System Modelling and TR</u>

(Coyle, 1977), block diagrams, etc,, but each will relate in the manner described to T^1, the root definitions.

In terms of the classification of models given in Chapter 2, these viable system models are "iconic" and assuming the adequacy of such models to capture the essential features of the generative mechanisms concerned, they clearly impart more information and understanding than can the sentential models which have here been described as root definitions (T^1). The relation of M to N, then, in Figure 4,5, is one of adequacy where the iconic model is acceptable. Obviously, not all models imagined to be adequate turn out to be so (this is the point of empirical testing), but while they are thought to be so sentential, models T^1 and their sub-models/statements (t^1_{t1} to t^1_{tn}) will be known to be true or false by reference to M (after Harre, 1970).

The viable systems model arises by analogy with the human central nervous system and is therefore a paramorph (the source and the subject are the same), but when considered as modelling a class (all viable systems) it becomes a homoeomorph. The members of this class are complex, adaptive, self-maintaining and evolving (see, for example, Ben-Eli, 1978). They have also been characterised as synergistic, recursive and balancing variety (Espejo, 1975). The validity of allowing social systems in general and human activity systems in particular, into what might ordinarily be considered living, is assumed here. This is not to say that social systems are necessarily living, only that in certain respects they are isomorphic with systems accepted to be living. The main group memebrs of the class of viable systems is given in Figure 4.6.

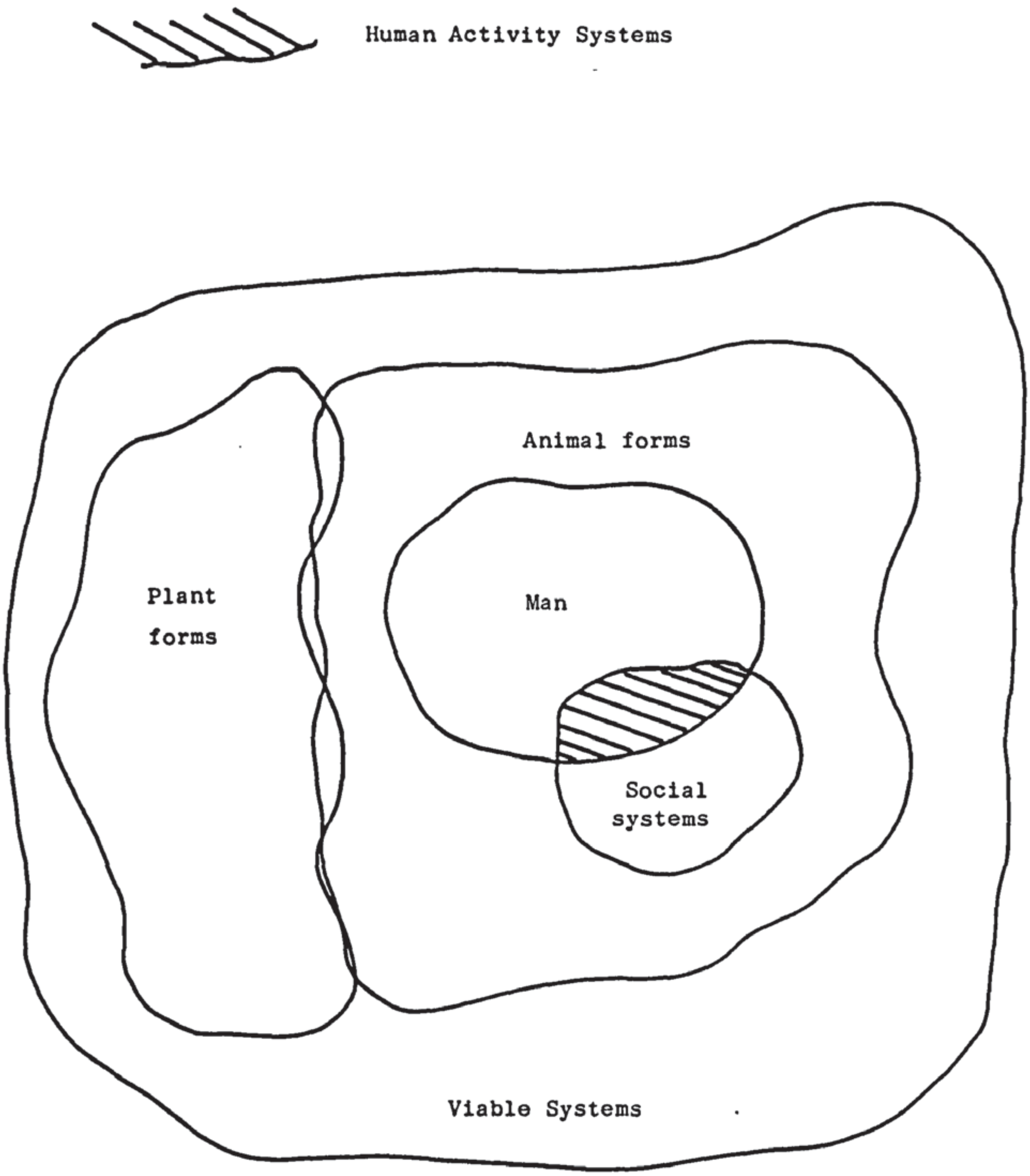


Figure 4.6.

Members of the Classes of Viable Systems

The model, then, belongs to the subject of homoeomorphic models described by Harré (1970) as teleiomorphic abstractions which are defined as follows :

"A teleiomorph...is an improvement on its subject...The other way (than an idealisation) of making a teleiomorph is by abstraction. If the source subject has properties pj...pn, an abstraction has properties pj...pk, i j k n, that is, it has fewer peroperties than its source subject. Hence, the abstraction embodies just the "minimum set" of properties common to the class which it represents."

It is important to understand that the abstraction described will involve a reduction, so that different observers/analysts/problem solvers may define different relevant systems (with different root definitions) as well as different problems. This must be so if the observations made about functional analysis are true (see Appendix C).

4.7. Conclusion

This chapter has been concerned to outline an approach to modelling organisations which the author has found helpful in generating iconic (explanatory) models associated with some problem situations. It is important to understand the need to support prescriptions within problem situations in this way.

The examination of OM has required a superficial treatment of concepts such as homoeostasis variety and control. An attempt has been made to support this analysis with the material of Appendix C. Viability has been discussed and related to the concept of organisational closure. These ideas have forged an essential foundation on which to lay a description of viable system modelling. Two versions of modelling have been examined in outline only. The first of these was Stafford

Beer's viable system model, the second was an alternative embodying a simpler view of organisation leading to a more consistent diagrammatic representation.

The use of this type of modelling technique offers the possibility to strengthen methodologies such as Checkland's. However, they need to be employed with caution. The greatest danger arises from the fact that they may embody a single W which channels perceptions in a problem situation in an unhelpful way. On occasions it may be appropriate to view relevant systems in terms of this kind of single W, but one must avoid becoming "stuck" with one way of looking at relevant systems.

The discussion in this and the two previous chapters has dealt with all the elements that have seemed appropriate in thinking about the complex problems of social organisations. A general structure for dealing with open systems problems has been identified, and some details have been explored, principally Checkland's methodology and OM. It is appropriate that in the next chapter, all the ideas are pulled together into a consistent model of the processes identified. A main aim of this next chapter will be to identify an iconic (explanatory) model of the process concerned.

Chapter 5

A Developed Model of Methodology

5.1. Introduction

The previous three chapters have explored the complex and difficult path leading from an examination of the nature of problems through to the formulation of a suitable framework for tackling them. The discussions have been especially concerned to highlight aspects of the complex problems of organisations. A great deal of the discussion has reflected the process of exploration that seemed necessary for an understanding of the author's experience of the sponsoring organisation.

In Chapter 3, Checkland's approach to problems was examined and substantial parts of the framework were accepted as consistent with the broad framework of Realism identified in Chapter 2. The strategy of this chapter will be to take the Checkland methodology and work through it, introducing the modifications necessary to both incorporate the concepts regarded by the author as vital, and to stress those aspects which are of particular value. This process will draw heavily upon the Realist framework and make use of Pask's (1975) notation for the representation of analogy relations.

The resulting methodological model is iconic as well as sentential, providing a useful statement-picture complex which incorporates the interpretations explored in the chapters above. Checkland's cloud model of procedure (Figure 5.1.) is essentially descriptive and prescriptive of the stages involved in open systems methodology. The model developed below has extra elements which add descriptions/characterisations of the mechanisms underlying the procedure and therefore repre-

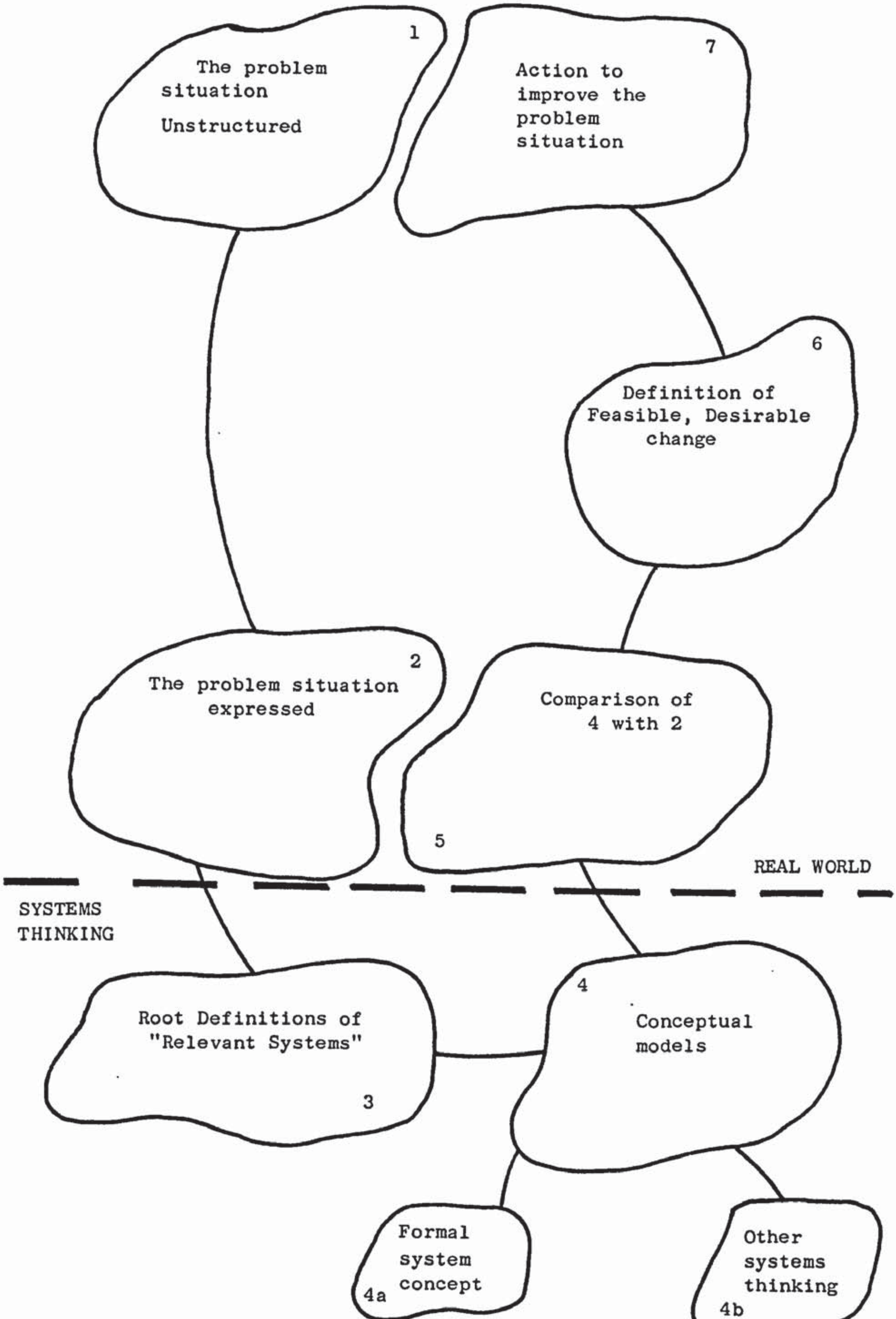


Figure 5.1.

Two Domains of Activity

sents a move towards an explanation as well as a description of procedure. The work of this chapter will begin with a brief examination of the classification of stages in the Checkland methodology.

5.2. The Classification of Stages in the Checkland Methodology

In describing the methodology, Checkland (1979b, 1979c) distinguishes the two domains : the real world and systems thinking, in which the methodological activities are carried out. This is illustrated in Figure 5.1. However, care has been taken in this work, to distinguish in a useful way, between the real "objective" world and the observaions of it, which is the currency in which humans consciously deal (see Chapters 2 and 3). Checkland does not object to such a distinction* even if he is not very happy with it, and this would seem to suggest three, rather than two domains within the methodology, as illustrated in Figure 5.2.

As a rough approximation, this representation seems to capture the distinction reasonably well, but it does not do justice to many of the ideas developed above, nor does it justify a claim to have developed a signficantly improved model of the problem solving/handling process.

When considered in greater detail it is apparent that the distinction between the real world and the world observed does not straightforwardly separate Clouds 1 from 2, but actually splits Cloud 1, as in Figure 5.3. It should be noted that this modification is based on the Realist view of perception/observation introduced in Chapter 3, so

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* Private correspondence 2.10.80.

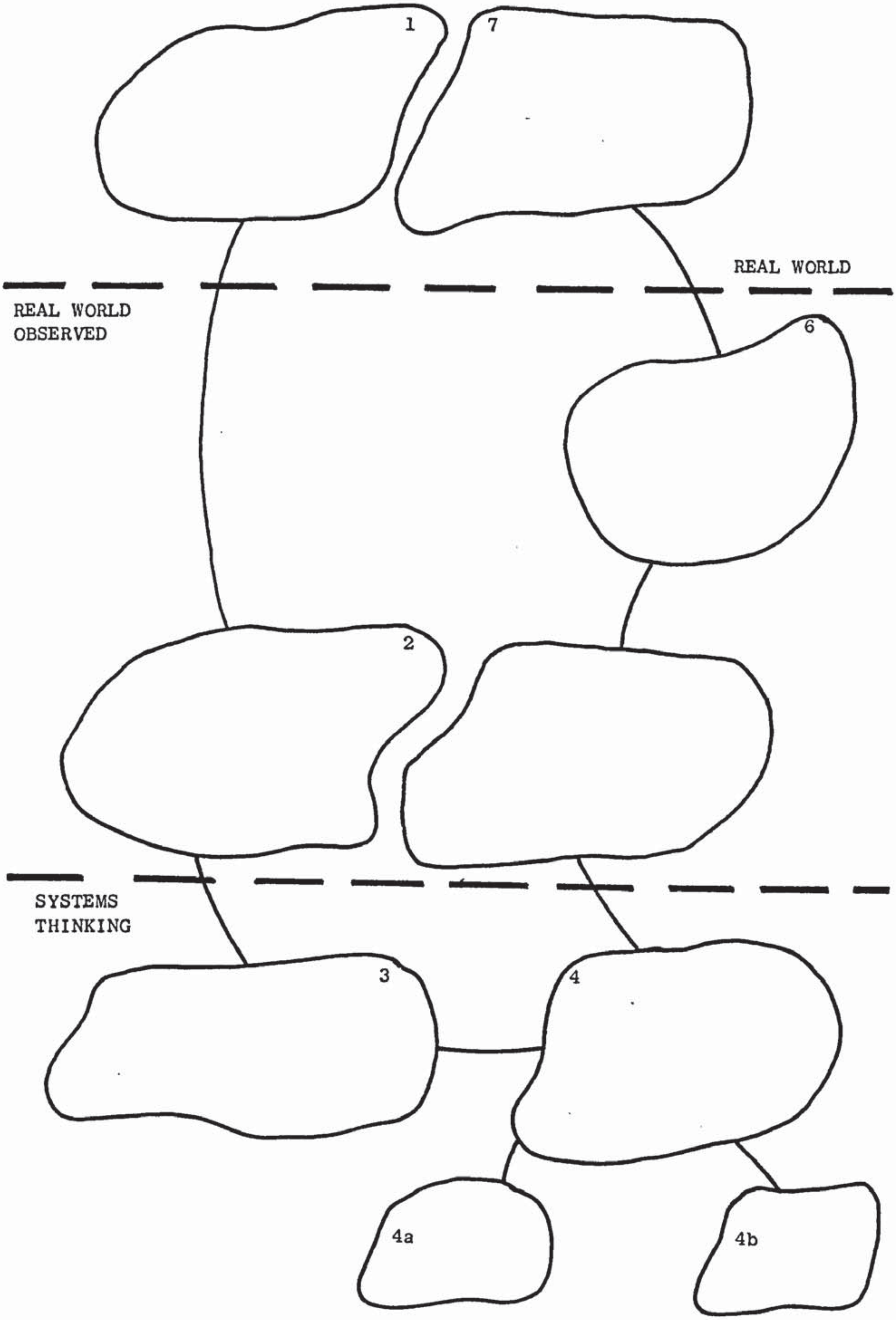


Figure 5.2.

Three Domains of Activity

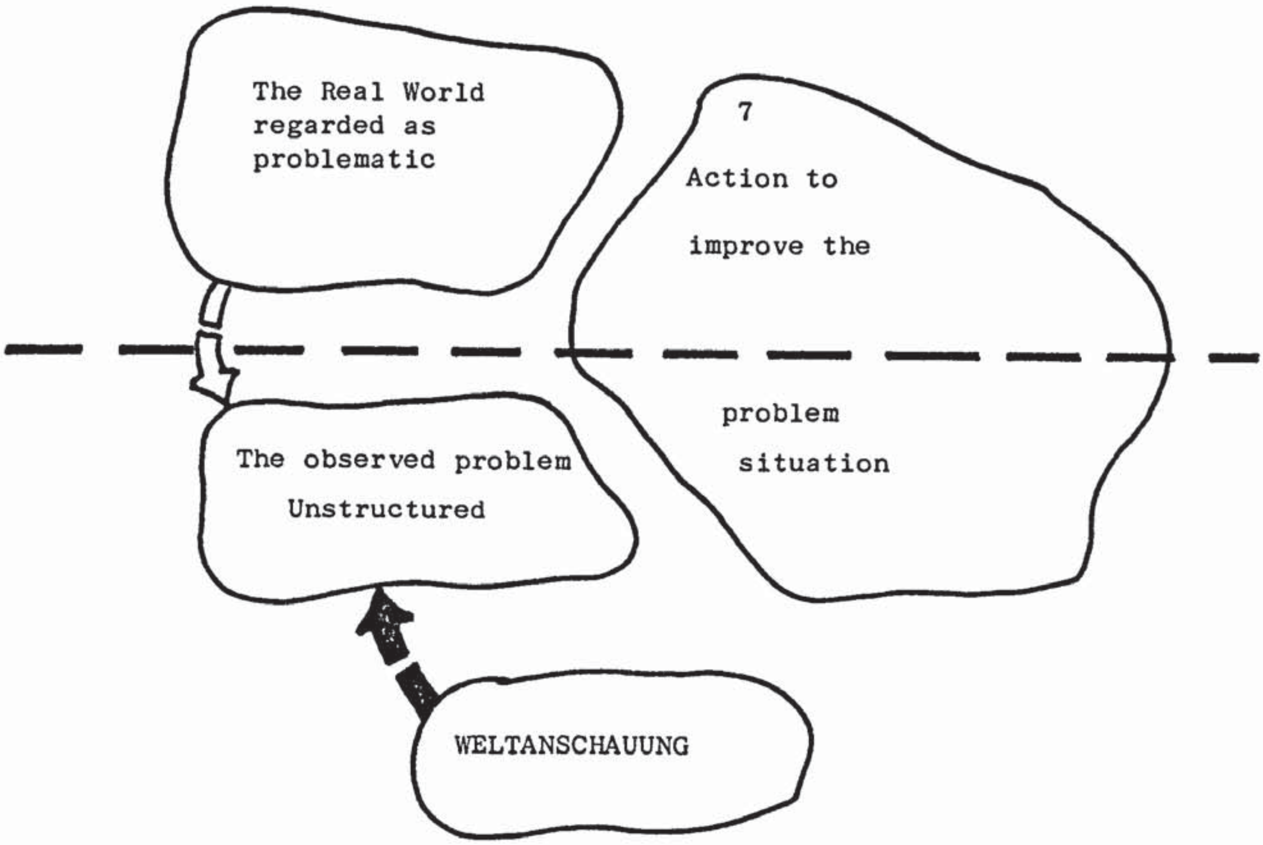


Figure 5.3.

Methodology Modified to Incorporate Realist Epistemology

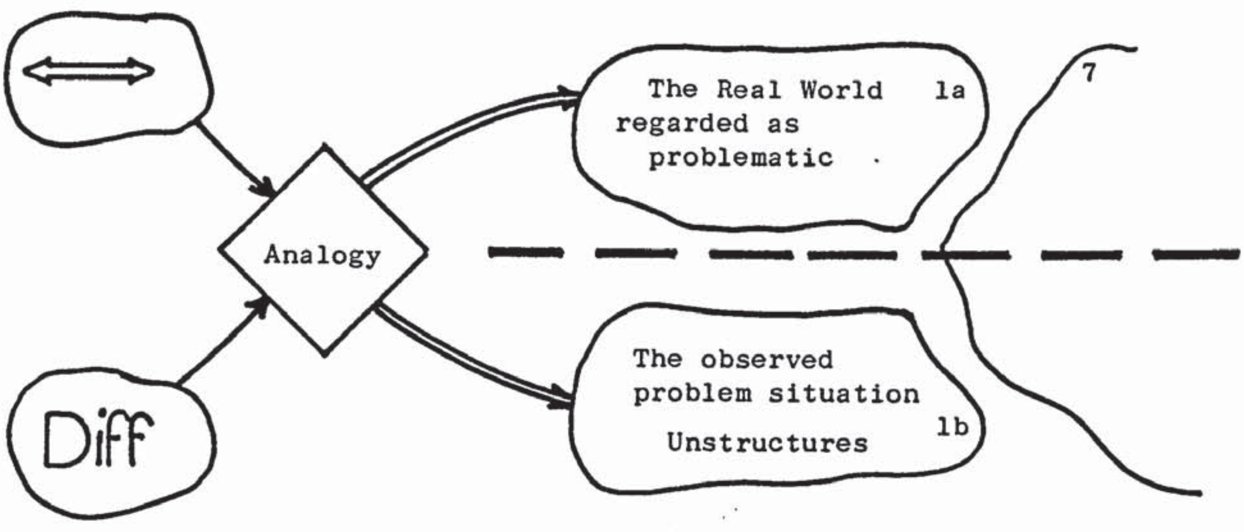


Figure 5.4.

The Analogical Relationships between 1a and 1b that with the exception of Cloud 7, all the elements of Figure 5.3 map to the elements of Figure 5.4 . Cloud 7 straddles the distinction because action to improve problem situations is not always confined to the real world, as, for instance, when the situation improves as a result of "seeing" the same situation differently.

It has already been stressed that the philosophical assumption that a real "objective" world exists is perfectly consistent with the idea of different views of it. However, on some occasions, beliefs are genuinely inconsistent with the objective state of affairs, so that 1a and 1b are often less than isomorphic. This can be illustrated by using Pask's (1979) notion of an analogy (see Chapter 8 for a more detailed account). Figure 5.4 shows this relationship.

Every analogy has two essential features : an isomorphism indicated by "$\Longleftrightarrow$" and a difference indicated by "Diff". This notion exactly parallels the criterion of similarity developed in Chapter 2 ($\forall x . \forall y$ $[(x \lneq y \supset (\exists \phi(\phi x \cdot \phi y) . \exists \psi(\psi x \cdot \sim \psi y))]$), which expresses the notion that similarity represents partial mapping between entities, or, in Pask's terms, "Universes".(It is not difficult to imagine a sense in which Clouds 1a and 1b may be regarded as different universes). At one limit, the analogy represents a complete isomorphism between 1a and 1b so that one can distinguish Universes (Diff) but not their contents. At the other limit, "$\Longleftrightarrow$" represents the existence of universes (i.e. they share the property of existence) but differ completely in their contents. The former limit represents the condition necessary for a true statement about the world in terms of Tarski's correspondence theory of truth (Popper, 1972, pp.319-340).

The sense in which an isomorphism reflects a correspondence between the propositions expressed in 1b and the real world state of affairs needs some qualifications, because one must be careful not to define complete correspondence as truth absolute, so that all other views are "invalid". The proposition that X has properties n_{1-n} may be true if the real X actually has the properties n_{1-n} but the identification of X and n_1 to n_n does not stand in isolation from the theories that explain what it is to be an X and what constitutes the set n_{1-n}. The theory-laden nature of observation makes it impossible to describe the world in objective terms, so that the pure isomorphic form of analogy is still dependent upon a context of meaning which may differ significantly from one person, group or culture to another.

The boundaries of Cloud 1a in a particular situation are not fixed objectively any more than the isomorphic (where it exists) analogy is objective. This cloud is labelled "The real world regarded as problematic", but observers do not regard the real world per se, but their observations of it. Since problems are defined in 1b rather than 1a, it is tempting to pursue the idea that it is the mapping of 1b to 1a that defines 1a, so that it is the isomorphisms that are important. Clearly, it does matter whether or not the views exercised in 1b are important since actors, owners, etc. will often act upon them. This type of analogous relationship conforms to the criterion of similarity derived from Leibniz's identity of indiscernibles in Chapter 3.

This can be developed with some coherence if one considers the relationship of 1a and 1b to 7. Action to improve the problem situation can operate in two distinct domains. It can, for instance, operate upon a person's view of the situation, so that nothing necessarily changes in 1a (strict interpretation would place the problem owners in the problem situation, so that all action would be in the real world problem situation), but the owners see things differently. By contrast, 7 can genuinely operate on 1a, so that it must be shown as having a relationship with 1a and 1b. However, real world actions do not always produce the effects expected, and so it is sensible to broaden the definition of 1a to include not only the real world states of affairs mapped to 1b, but also those which come into play through 7. Also, the situations themselves are dynamic so that the processing of the problem situation will tend to take place in an arena which is wider than the "action" at any particular time.

5.3. Analogous Weltschauungen and Their Effects

Having looked at the analogous relationship between Clouds 1a and 1b, we can explore further analogous relationships associated with the "starting point" of the Checkland methodology. This will necessitate an exploration of the link between the Weltschauung cloud and 1b, shown in Figure 5.3. It may not, in the final analysis, be vital that the users of the methodology be conscious of the fine detail of the analysis described in this chapter, but this knowledge is vital to understanding (explaining) the operation and the effectiveness of it. What is being attempted here is to generate and capture an explanation of the methodology and not just a description of how to proceed, which is all that the Checkland cloud diagram achieves.

In a "real" problem situation, there will be, as discussed above, actors, owners, etc. who will usually be the source of differing views of the situation represented by different Weltschauungen. On this basis,

Figure 5.3 requires modification since it shows a single W. Figure 5.5 represents a multiple W and 5.5b, its repercussion in the other clouds of Figure 5.3.

At first acquaintance it is tempting to infer that the effect of these multiple W's is to widen the range of the unstructured problem situation, 1b, but this must not be done, since great care has been taken to emphasise the private/personal aspect of observations. The necessary conclusion is that multiple W's "generate" multiple observed problem situations (1b's), and it is the "footprint, 1a, that widens as a result. This situation is represented in Figure 5.5b.

At this stage, the model captures a situation and does not, as yet, model procedure in coping with the situation. However, in many ways, this is one of the more important aspects of situations requiring open systems methodology which is only implicit in Checkland's diagramatic representation. The crucial point that the author would wish to emphasise here is that in situations where a closed ("hard") methodology is appropriate, the W's are either the same (isomorphic) or so similar over the range applied to the problem situation that the 1b's tend to be singular rather than multiple.

In general, therefore, one can say that in closed systems science, owners and actors tend to share the same W, and as a group, they tend to take their W's one at a time. By contrast, open systems science is characterised by the existence of multiple W's such that the biggest difficulty is often to get actors/owners to appreciate each others views and tolerate them.

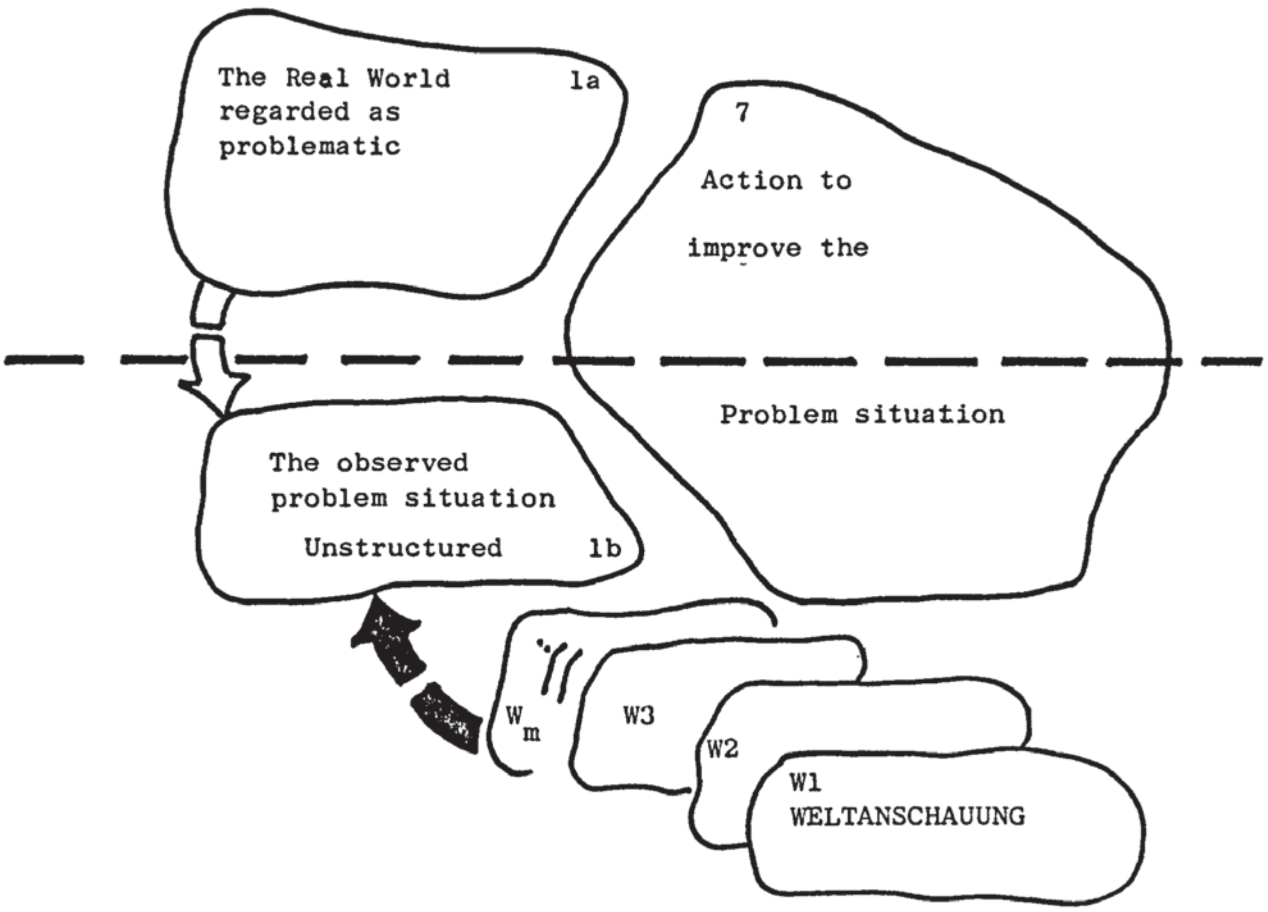


Figure 5.5a.

Multiple Weltanschauungen

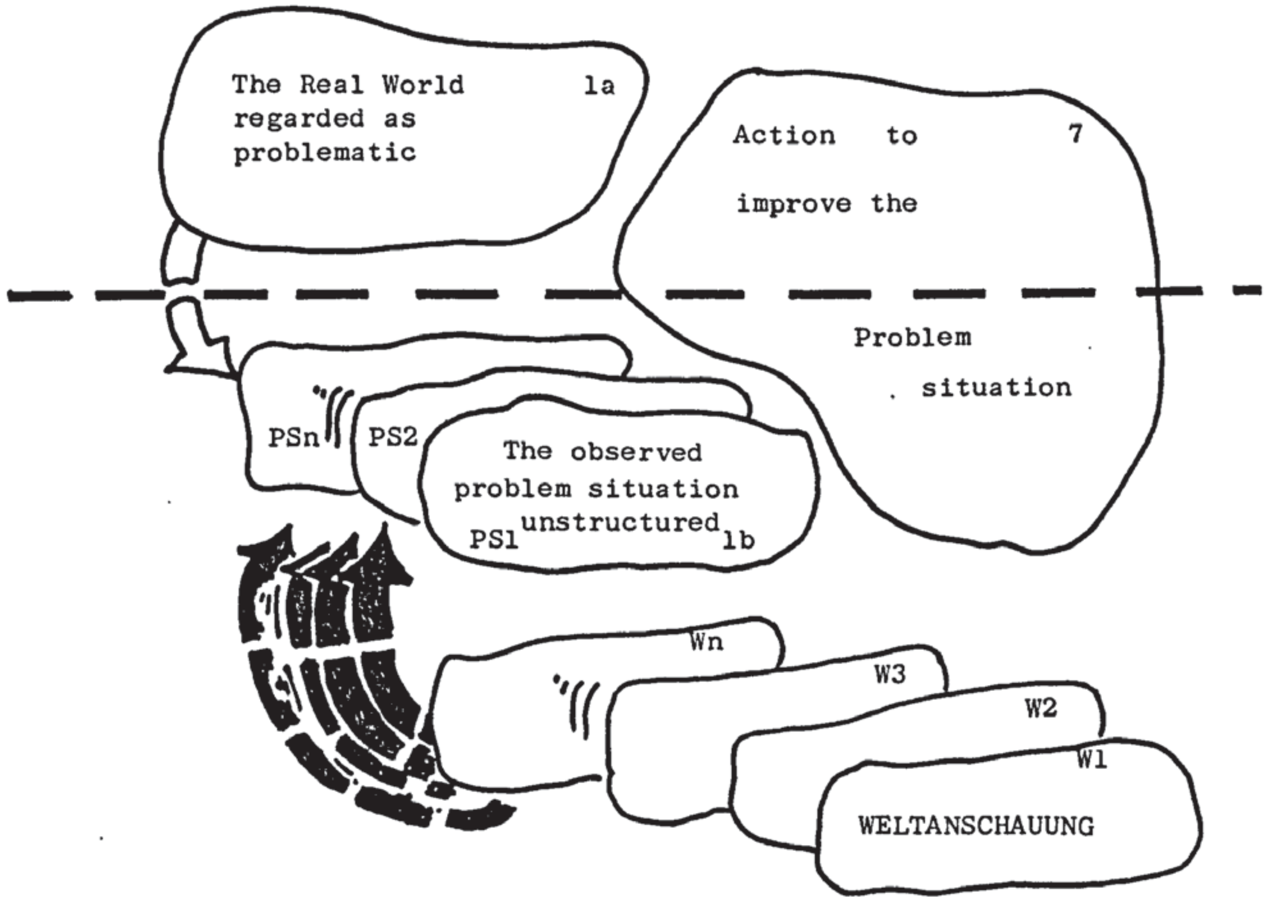


Figure 5.5b.

The Effect of Multiple Weltanschauungen

Returning more directly to the model, one can see that from an analytical viewpoint, there is a particularly complex set of relations involved between 1a, multiple 1b's and mutliple W's. The complex relationship between 1a and a single 1b was represented by the technical notion of an analogy involving a similarity and a difference. Clearly, with multiple 1b's there must also be multiple analogies between 1a and the set of 1b's. However, the multiple W's "produce" the different 1b's, and since one wants to say that the difference between W's and 1b's is important, there is a significant set of analogies which are the reason for the openness of open system problems. One can characterise, for instance, hard science as having clear objectives, and soft science as having no clear objectives, but this is so because of isomorphic ("$\Longleftrightarrow$" but minimum "Diff") W's on the one hand, and multiple W's on the other. This highly complex set of relations is represented in Figure 5.6, assuming only two actor/owners.

As we have seen, A1 and A2 are about the correspondence between the real world and the views of the situation held by individual actor/owners. B1 and B2 are about the difference between the views of people. B1 is the specific differences related to a particular problem situation, and B2 is the general differences between the actor's/owner's views of situations which they each take to be similar to the current problem situation. For instance, it may not simply be that they have a different general approach to data processing problems, but they may not both recognise the situation as a data processing problem.

The example chosen here is a very simple one, with only two actors/owners, and this has involved no less than four analogies, each of which is, itself, highly complex. However, as more W's become involved,

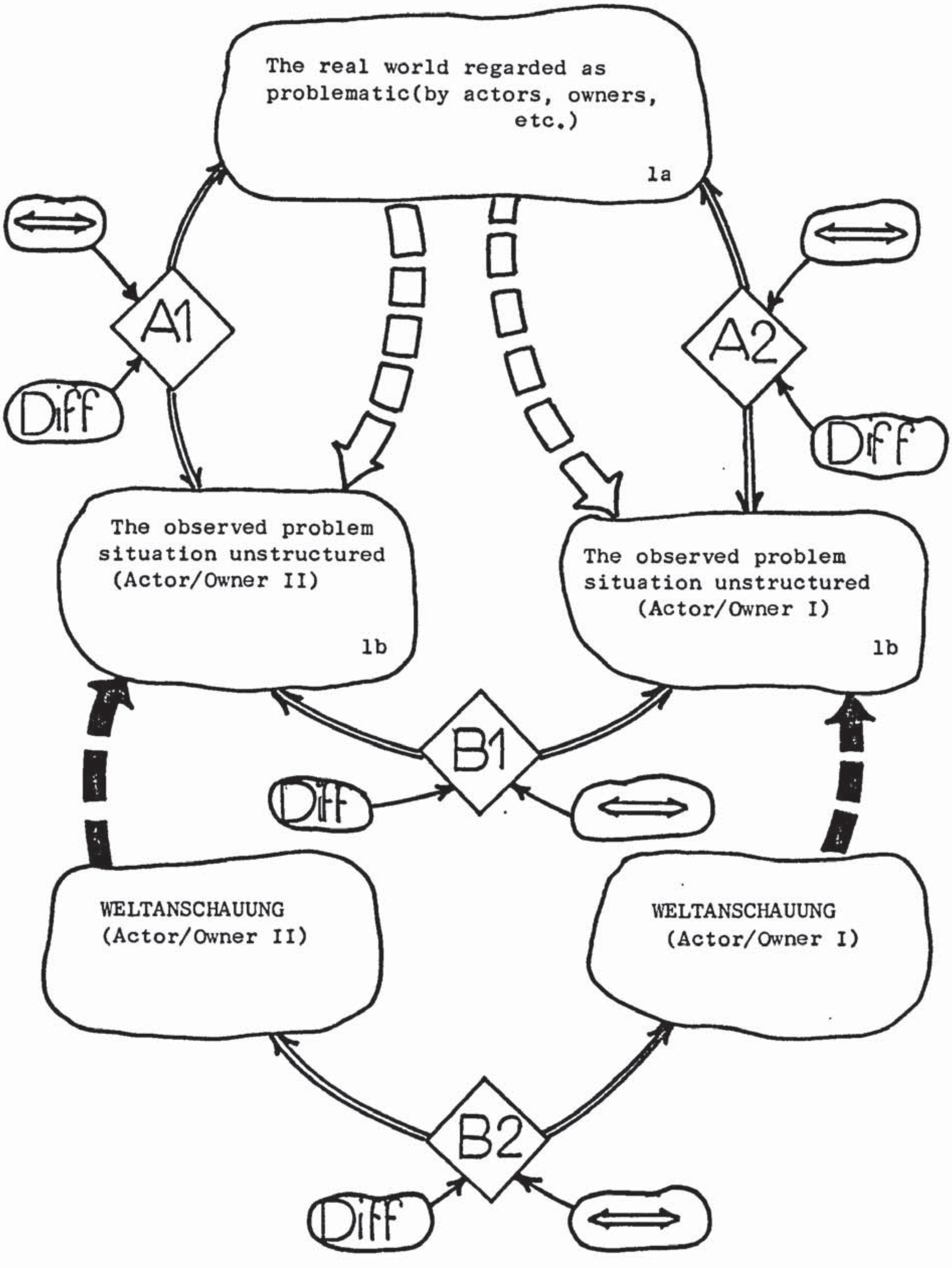


Figure 5.6.

Analogous Relationships in Multiple Weltanschauungen Relationships the number of analogies increases by the power of two (i.e. the number of analogous relationships equals the number of W's). With as few as four people debating the problem situation, there are sixteen significant differences, and of this set only four are about the compatibility of views with the real world. The other twelve are about important differences between the subjective aspects associated with people's views of the world. This must be a significant source of complexity in problem situations.

Now, since hard science is substantially about "improving" A-type analogies (usually just because of one single W), and soft science is about B-type (usually many, because of multiple W's), one begins to see not only where the large variety in open systems problems comes from, but why it is so difficult. There may be meta language problems, and differences in W's may extend (often do) to differences of opinions about how to proceed methodologically. As additional individuals join the debate, the possibility is that variety may grow dramatically (it may not if additional individuals have W's isomorphic with that of an established actor/owner). The inevitable result is that often the politics become more of a problem than the real world (physical) state of affairs.

The concept of analogy has been extremely useful here, to explore the fine structure of problem situations, and its value and source will be further explored in Chapter 8. In order that the procedural details may be explored, the analogical details will not be shown explicitly in much of the diagrammatic development, but the reader is asked to remember the complex nature of these relationships in considering the subsequent development which will proceed by adding the first procedural step to the basic model of Figure 5.5b.

5.4. Extending the Model into Procedure

Having explored the underlying structure and mechanism within the classical. open systems problem situation, the effect of these underlying dynamics on procedure will be explored. Of particular importance is the way in which the multiple W feature discussed in 5.2 remains influential, and this feature is felt to be sufficiently important to necessitate it being shown as a central feature of the model. Figure 5.7 shows the model extended to include the first procedural step.

It is worth stressing that Cloud 2 represents a stage in a process, so that one would not wish to stress the differences between Clouds 1a, 1b and 2 so much as the difference between the processes associated with 1, and the additional processes required to move to 2. The processes associated with 1 (depicted here) are essentially about how each individual actor/owner comes to have a view which is essentially private but not necessarily exclusively his own, and since this is built up from a basic, preceptual model, one must conclude that these processes are always there. However, in order to proceed to 2, actors/owners must make their unhappiness "public" and enter what Checkland has called a "debate" in which they, together, at least agree that they have a (common) problem, and possibly that it has certain boundaries (not that they necessarily agree about all the boundaries).

This problem structuring is the basis on which, in the first place, a group come to own a common problem, and subsequently communicate (possibly with varying degrees of success) their assessment of any remedial action, in Cloud 7, to one another. It is interesting to note that the W's of the group are still present and active in

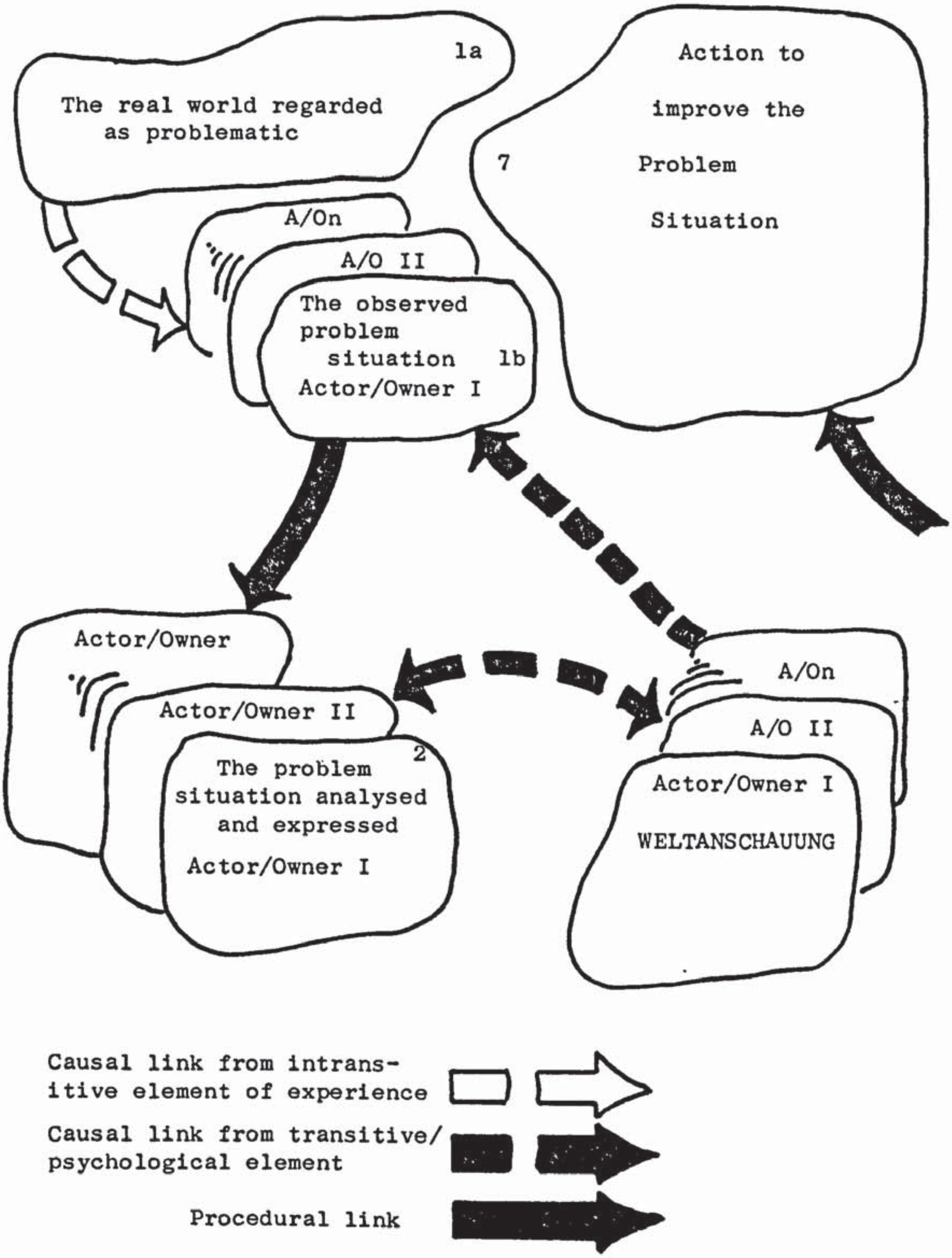


Figure 5.7.

Model Extended to include

First Procedural Step

"controlling" perceptions, so this is illustrated with a link between W's and 2.

The information exchange involved in moving to 2 may (but may not) involve a reduction in the number of differences between views of the problem situation, i.e. analogies of B3-type are "improved" and this experience can at least, in principle, modify W's so that the link between W's and 2 must be shown as being bi-directional. It is interesting to note that although the number of views may reduce, in moving to stage 2, the modification to W's that accompanies. This and the reduction in views itself, result in the number of lb's being reduced so that any difference in the number of views of the situation will only be evident over time, and the same number will always be evident at any one time. This is important to stress since this model is not intended to be an account of a linear process. One can see that,as the process leading to 2 unfolds, there is a conceptual cycling from lb to 2, and through W back to lb. Indeed, any significant modification to W's, even at a later stage of the procedure, will modify lb's either in number or content. Any reduction in number, however, is not literal since each identical (isomorphic) lb is differentiated (Diff) by belonging to different persons.

5.5. The Model and Systems Thinking

Cloud 3 in the methodology of Checkland is "Root definitions of relevant systems". Checkland has stressed that soft systems problems involve conflicting objectives, and this stage is intended to make explicit not only the system seen by actors/owners, but also the character of the Weltanschauungen"which makes their root definition a meaningful one for them". The view taken by the author is not dramatically different, although it has seemed important to stress the all-pervading nature and role of Weltanschauungen in this work, to an extent not found elsewhere in accounts of the Checkland methodology. The nature of root definitions, the CATWOE elements, and the essentially sentential character of these concise system identifications has been discussed in Chpaters 3 and 4, and no point will be served by re-examining the issues here. However, one still wants to stress the central role of Weltanschauungen and the two-way nature of the connections which link Clouds 2 and 3 to W's, and explain and facilitate the need to constantly re-examine the work and ideas of the earlier stages. This is illustrated in Figure 5.8.

This link is more important in Cloud 4 since the relevant systems are not simply identified, but modelled in depth. Once again, it is not proposed to go into great depth about the nature of this stage, since the nature and relationship of sentential and iconic models have been extensively covered in Chapters 2, 3 and 4. However, it is important to note one or two interesting features, the first of which is relatively trivial, but necessary if the reader is to follow the detail of the diagrammatic convention followed here.

In representing stage 4, the multicloud convention, which was thought vital in underlining the existence and importance of multiple subjective views of problem situations in representing earlier stages, is not employed, and this is potentially misleading, particularly where this is taken to indicate that multiple views cease to exist at this point. Single clouds do not at any stage represent only single views, but at this stage it is likely that anyone deliberately

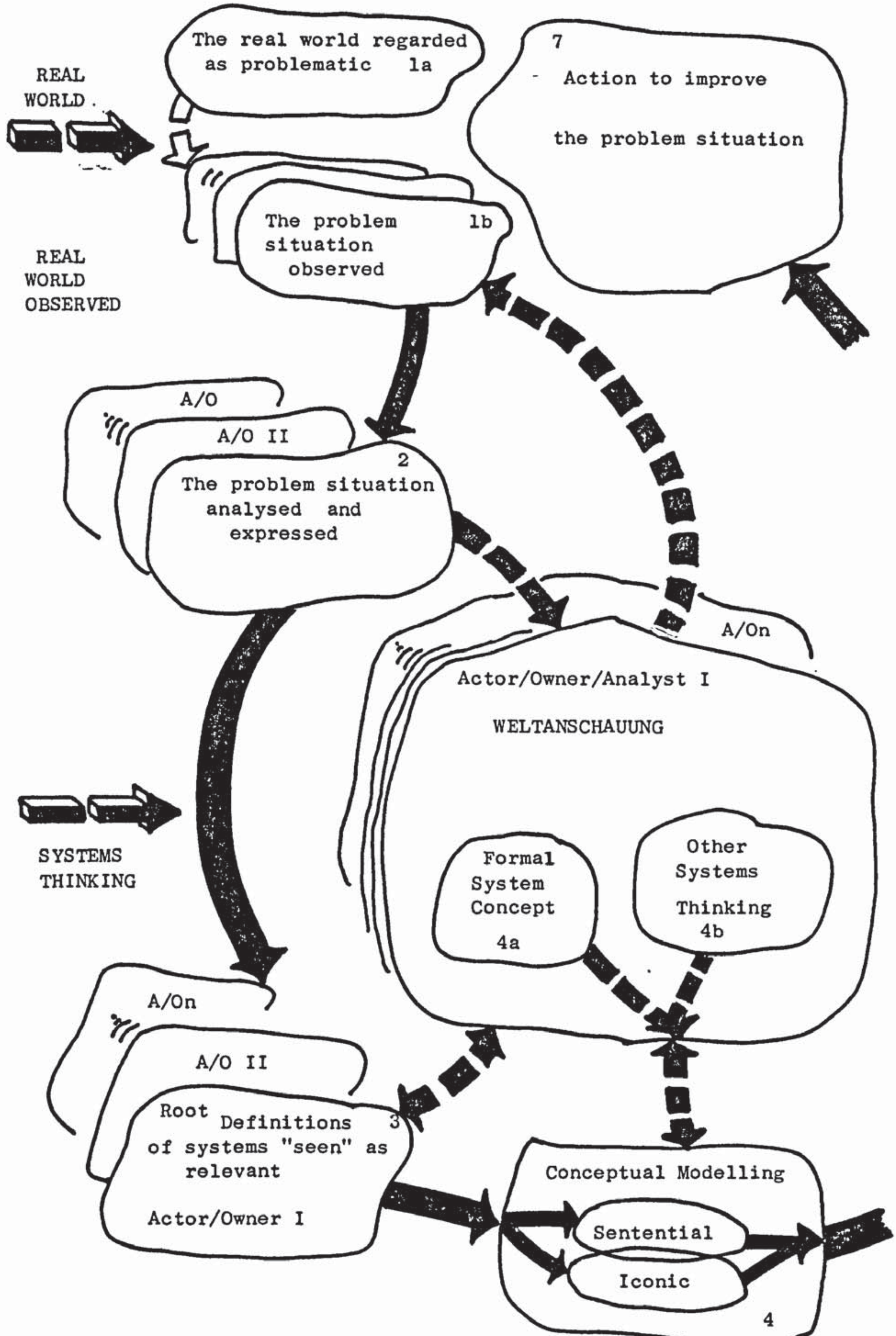


Figure 5.8.

The Model and Systems Thinking

following the methodology will be acting co-operatively in the execution of the method, if not in the alleviation of the problem situation. Conceptual modelling will either be carried out by a consultant or analyst who feeds back the models for validation, or by the primary problem owners themselves, but in either case, the full range of W's that are responsible for there being a range of relevant systems, will not necessarily be fully active in this modelling process. This, of course, will not be the case with interpretation and assessment of the results of the modelling process where subdued W's will reassert themselves. The single cloud, therefore, serves to stress the co-operative character of this stage. As with the other stages, the conceptual link to Weltanschauungen may lead to a return to any or all of the previous stages, to bring about a re-awakening of the activities already completed.

The second, perhaps more important feature of the model associated with this stage of the methodology, is the arrangement of Checkland's "Formal System Concept" and "other systems thinking". The view that conceptual modelling needs to be validated using these elements, springs from a W, and a very particular W at that. However, despite the prominence given to W's in the methodology of Checkland, one of the most important features of the approach, namely the all-pervading role of W's and the place within a W of systems ideas and the systems approach, is not sufficiently stressed. Once one appreciates the central role of W's which this work has tried to make clear, one can appreciate not only why problems in what Checkland has called "human activity systems", are so difficult, but also the mechanism involved in coping with them.

5.6. Comparisons Leading to Action

When the modelling activities of stage four are complete, the process has developed to the point where the symptoms have been explored and expressed, along with such understanding as exists, of the associated systems and productive mechanisms. Cloud 5 is a formal expression of a process which will tend to happen naturally as a result of having developed the debate in this particular way. The conceptual models are compared with the expressed problem situation (4 with 2), and this will tend to focus attention on the issues associated with people's understanding of why the symptoms are as they are, and not otherwise. Checkland often describes his approach as a means of structuring a debate, and at this stage it should be at its most intense simply because it may well be the case that such different W's as exist may not only identify different, relevant systems, but also embody different models of method.

As with previous stages of the methodology, these differences arise from, and are supported by the relevant W's of those concerned, and thus, stage five must also be shown with a link to the central nest of W's. The link is, once again, directional because the debate is highly likely to modify some W(s) in a significant way. Classically, stage six, the identification of desirable/feasible changes "emerges" from the debate, so that it should be possible to implement some changes which carry a reasonable degree of support from problem owners and actors. Once again, the clouds may be seen as representing stages in what should be a continuous process. However, it is interesting to note that these clouds are more like the names of processes themselves, which is in contrast to Cloud 2 which identifies the completion of a process, a state of affairs. This is the difference between a transformation and an output in system terms.

At this point, the basis of the complete iconic model of methodology is established, and this is depicted in Figure 5.9. The stages five to seven cover a process in which W's :(a) support and are modified by a debate in Cloud 5 ; (b) form the basis for changes seeming reasonable for the actors/owners in Cloud 6, and (c) are modified by Cloud 7.

In their essence, the mechanisms (processes) involve actor/owners in exploring their own views of the problem situation and that of significant others, to find some common basis on which to change the situation. These types of methodology are not simply a means to an end, but may be an end in themselves, for even where no deliberate action to change the problem situation is forthcoming, the process of examination and re-examination implicit in these approaches may lead actors/owners to see the situation differently, so that problematic aspects may melt away.

Now, the fact is that not every actor/owner may be as well disposed to systems thinking as those who embrace the type of W that includes Checkland's 4a and 4b elements, so that where this type of methodology is wielded by an analyst or consultant to help a "lay group", care must be taken to produce sentential and iconic models which are intelligible to system thinkers (the systems W) but also to these individuals in terms of their W's. The role of system thinker as psychotherapist and mediator between W's may prove to be crucial in many situations. The merits of being able to deploy a range of modelling

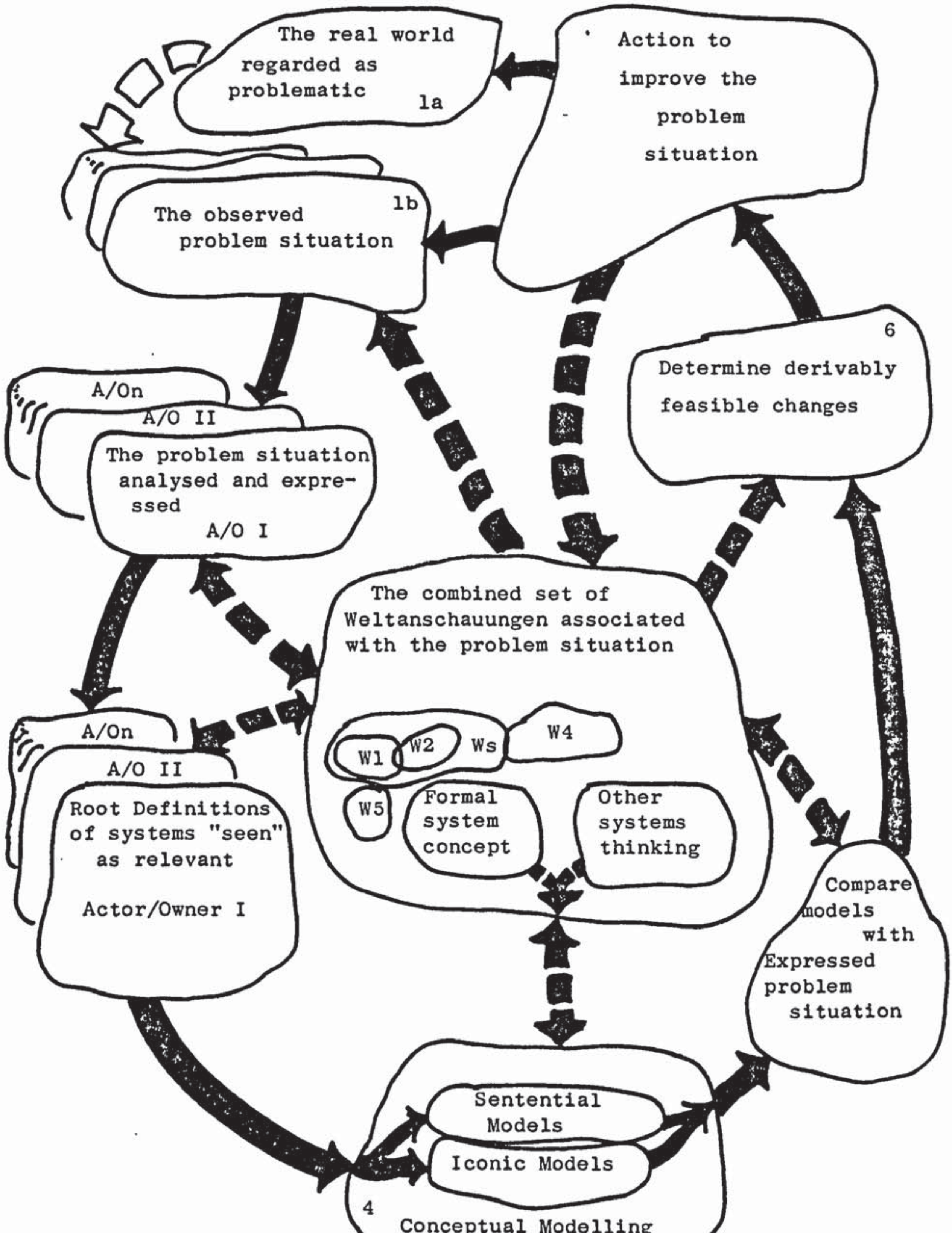


Figure 5.9.

An Iconic Model of Open Systems Methodology techniques are well worth stressing, for a system thinker may have to do better than meet his fellow half way.

Some consideration is given in this work to ways in which the available repertoire of techniques (ways of viewing things) can usefully be supplemented (see Chapter 8), and this springs from two main reasons. The first is as a means to a fuller understanding of the features and processes involved in open systems problem solving. The quest has been for genuine (iconic) explanation, but deeper understanding has brought the realisation that the very same approaches can supplement conceptual modelling within the methodology. In addition to viable system modelling already discussed, it has been possible to add entailment meshing, cognitive mapping and repertory grid as tools to achieve fuller, deeper explanations of the differing views of significant actors.

These approaches are described in more detail in Chapter 8, Checkland's accounts stress the need to develop rich pictures of the problem situation, to identify and model relevant systems defined by significant W's themselves. This may not always be necessary, but in some instances it may be crucial, particularly where actors/owners find each other's views difficult to comprehend, or unintelligible. The causal mechanisms responsible for such a situation are the W's themselves, and therefore, iconic modelling must capture the important parts of them.

In the previous section on systems thinking, attention was drawn to the way in which a variety of modelling techniques might be usefully employed to supplement the approach of Checkland and provide iconic models of relevant systems, plus some of the important features of the W's associated with them. However, this is not the only area where some development might be useful. The "political" aspects of the debate can present the greatest difficulties and these will be especially difficult if significant actor/owners do not appreciate the significance and naturalness of differing W's. There is little doubt that where significant W's have been modelled, the debate associated with 5 and 6 will proceed in a qualitatively better way as a result of the understanding of significant viewpoints that exists. The one thing that is missing, however, is an iconic model of the political processes themselves. A more recent part of the research reported here has attempted to enhance understanding in this area, and some details of this are reported in Chapter 8. Of specific value in this respect is the kind of hypergame analysis originated by Peter Bennett (1977) and developed in collaboration with Malcolm Dando, Christine Huxham and others.

The opportunity for a synthesis between the methodology of Checkland and hypergame analysis, plus the various other techniques mentioned in the previous sections seems great, although this work can do no more than point the way further research might be developed. There is no doubt that this type of open systems methodology requires considerable filling out if it is to be understood and usefully employed by a wider audience than the present systems community.

Whatever approach is employed during this most political part of the methodological process, and however many times problem solvers cycle back to earlier stages, the logical "result" of the process is represented by Cloud 7. This cloud has two domains but forms one cloud on the basis that whichever domain is active, the result is that the observed problem situation (1b) changes in some significant way, either because actor/owners act co-operatively to change the real world (i,e, instal a computer, take on extra employees, change operations in some material way, etc. etc.), or because actor/owners come to see the problem situation differently as a result of the methodological processes they have engaged in. It is for this reason that the model of method given here has two links, one to 1a and one to 1b. In reality, it is unlikely that people will cross the real world or the perceptual bridge in a mutually exclusive way, but use both channels simultaneously and to varying degrees, depending upon circumstances, and particularly other significant problem owners.

5.7. Concluding Comments

The most significant aspect of the methodological model described here is that it captures something of the character of the underlying mechanism at work in open systems methodology. To the extent that it is successful, it is an iconic rather than a sentential model of method. To the extent that this model can be related to a model of science (c.f. Chapter 3), it can be described as scientific and is, at the very least, in the spirit of science*.

In attempting to uncover some of the underlying structure, the complete set of analogous relationships associated with 1a, multiple 1b's and multiple W's themselves, has been seen as particularly important, and requiring overt illustration in the model. This has allowed

* P.B. Checkland, Lecture given to the Interdisciplinary Higher Degrees Scheme, 1 December, 1980.

a meta view of method in which such things as Formal Systems Concepts (4a) and other systems thinking (4b) have themselves been seen as embedded in a W. The two remaining areas in which this model makes a useful contribution to understanding is in the recognition of the need for iconic modelling within the methodology itself, and the need to support the political process where possible. Taken together, all these differences define a model which is strikingly different from that of Checkland, although the influence of Checkland's ideas is readily acknowledged.

In conclusion, it is interesting to speculate why the differences discussed above should exist, and why it is that Checkland himself has not elaborated the methodology along the lines indicated here. The author believes that the differences have their roots at the most fundamental level of epistemology and ontology.

At the epistemological level, Checkland distinguishes between two kinds of knowledge (Checkland, 1976, 1978). The first is "Public Knowledge", and defines the areas of"hard systems thinking which is, for Checkland, the rightful domain of traditional science. This knowledge is about "repeatable happenings, always checkable by anyone", where problem solving involves shared objectives between participants and a model of method centred upon the idea of reducing differences between desired and actual (objective) states of affairs.

By contrast, there is the subjective knowledge associated with human activity systems. This is not necessarily "public" since at the ontological level, these systems are not "real" (objective) but exist only as mental constructs in the minds of social agents. Each agent may construe his shared (objective) social reality as a unique human, or set of human activity systems, by virtue of having a unique (though not necessarily so) set of objectives or uses for the shared system(s).

The result is that Checkland begins with an epistemological distinction between these two kinds of knowledge, and uses it as the basis of a distinction between two ontological domains : real world systems and human activity systems (this does represent a slight reduction of Checkland's actual view, so that the reader is recommended to see Checkland (1971) for a fuller account of the range of systems envisaged).

"...the repeated happenings always checkable by anyone, seem to justify a belief that there is a special kind of thing responsible for the happening - namely 'physical reality'".

P.B. Checkland, Personal Correspondence
2.10.80.

Now, the problem with this is that one is quickly led to circularity, since shared views are the only things which have any accessible substance. One might ask to what extent one is justified in talking of repeatable happenings since they may not always have been so, nor may they ever again. One must, in part, support the distinction between kinds of things, and vice versa, and this circle is made vicious by the fact that the real world itself is not directly accessible to any method at all ; for what is present in observation is mental states, and the real world : existence must be antecedent. This itself evokes the problem of other minds, but these considerations form no substantial part of this work.

The line taken by the author is that observations of physical and social phenomena (see Chapter 3) are not different in any fundamental respect except insofar as people do seem to generate more shared views and objectives about the former. Thus far, not really different from Checkland. However, the existence of a real world is taken as true, not by inference from "public knowledge", but as a matter of philosophical prejudice. The argument from public knowledge is , in quality no better an argument than the justification for the existence of God, which is signalled in the question "Can so many people be wrong ?" - they clearly could be. No justification is felt to be necessary since, for the author, this question is not seriously negotiable, being more like a core theory (Lackatos, 1970), or core construct (Kelly, 1955).

The analogical model given above, and its interpretation in the model of method and process do yield some differences, but these definitely have their origin at the deeper level. Specifically, one cannot say that human activity systems do not exist except as mental constructs, and physical reality does. This is because one cannot distinguish epistemologically between them (both are known to men in experience as mental states). One does distinguish, for the reasons given, but this cannot justify either the view that human activity systems are not machines (Checkland, 1980),nor, for that matter, that physical entities are. Any such distinction must rest upon an assumption for which arguments about public knowledge are rationalisations.

The real value of the line taken here is that it allows a much richer interpretation of conceptual modelling and enables closed (hard) and open (soft) systems methodology to be distinguished on the basis of complexity rather then epistemology (see Chapter 3), and successfully characterises the mechanism involved. This richer understanding will be partly illustrated by the case material in the following section.

At this stage, the main objective of the first block of this thesis is substantially met. The work set out to explore the nature of complex problem situations, and work towards a usable framework for handling them. This quest has involved an exploration of the relativistic properties of problem situations, and the character of any suitable framework for handling them in Chapter 2. In Chapter 3, Checkland's methodology was introduced as a serious candidate to fill out the framework, and aspects were identified in the context of a Realist framework. Chapter 4 was concerned to identify ways in which approaches such as Beer's (1972) viable system modelling could complement and strengthen the conceptual modelling proposed by Checkland. In this chapter, an attempt has been made to pull the ideas together to generate an iconic (explanatory) model of the problem handling process. This has required the blending of a Realist framework with open systems methodology and a diagrammatic convention based in Pask's (1975) conversation theory.

INTERFACE - PART I to PART II

The work reported in Part I was necessary for the author as a result of the experiences with George Ellison Ltd., The major objective was to identify a suitable approach to OPS and this has been achieved. Some important mechanisms underlying the methodological process have been identified and these have served to stress the importance of W's and the relationships between them. Care has been taken to explore the ways in which Transcendental Realism, Organismic modelling, and aspects of Checkland's methodology can be combined to produce a model of methodology which has more explanatory power than models so far available.

In Part II, some details of the experiences which prompted Part 1 are investigated. Although Part II may be read first, the discussion draws on the framework of Part I in places. The material is aimed at showing that the author's approach was centred upon one particular methodological W. The two chapters of Part II are concerned with two different phases of the project.

Chapter 6 deals with the first year when the company situation was stable. The author's activity is characterised as concentrating upon correspondence relationships. Aspects of GE were investigated and any discrepancies between the "facts" and managers' beliefs were pointed out. This approach involved a particular methodological W and the reason why this worked well is identified.

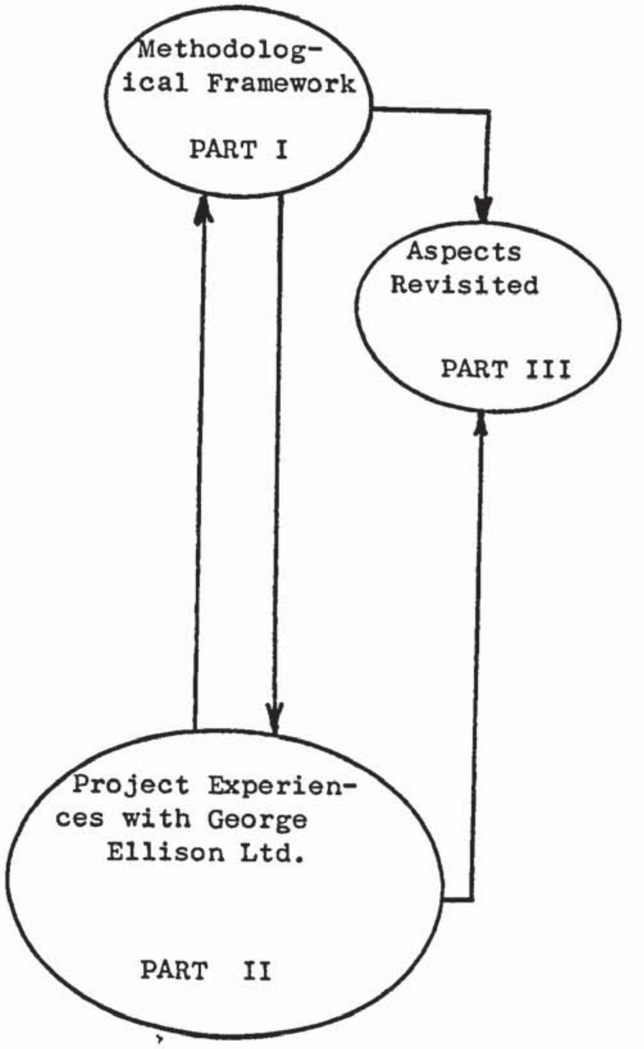
Chapter 7 deals with some of the activities of the project after the first year. During this time, the company was financially unstable with many aspects of the organisation changing rapidly. The failure of the "correspondence approach" and the W behind it is noted. Examples are given to support a belief in the need to examine the coherence between the views and the W's of key people in the problem situation.

In many ways, the content of Part II is complimentary to Part I, and may be read first. It is worth noting that while the order of these first two parts is not critical, some knowledge of both is necessary before dealing with Part III.

Part II :

Project Experiences with

George Ellison Ltd.



<u>Chapter 6</u>

The first year of the project
The success of a single W

<u>Chapter 7</u>

The second year of the project
The failure of a single W

<u>Figure II</u>

<u>The Content of Part II and its Structural Relationship with Other Parts</u>

Chapter 6

The First Year of the Project

6.1. Introduction

Part 1, Chapters 2 to 5 have been concerned to identify some important features of problems as well as a suitable framework for tackling them. This difficult task was felt to be necessary in the light of the author's experience with George Ellison Ltd., Having explored the possibilities at differing levels of conceptualisation in the early chapters, so as to arrive at an explanatory model of method in Chapter 5, it is now thought useful to look at some of the details of the project experience.

This examination is seen as having value in two areas. Firstly, it should be interesting for the reader to understand something of the problem situations that have prompted the long process of theoretical investigation reported in Part 1. The main theoretical work, although for the most part carried out after the project work, has been reported first in order to allow the second advantage. This is the opportunity to view the events of the project work through the developed methodological framework of Part 1. In this way, the practical work can serve to illustrate at least some of the important lessons that the author has learned.

The project experience will, therefore, be the focus of this and the following chapter. This chapter will be concerned with the development of the first year when the author was searching for suitable problem areas upon which to focus the main effort of the project. The next chapter is concerned with events after the first year when the project environment was significantly different. These two phases had strikingly different characters and this has been the basis of the separation between these two chapters.

This chapter begins with a brief discussion of the year's activity and this is followed by an outline of a conceptual framework developed at the time. The core of this material is contained in a report circulated within the sponsoring organisation entitled "One Year On : Impressions and Proposals", and is included in Appendix D. A great deal of the value of this chapter will be lost to the reader if this report is not read before examining the main body of the chapter. It is particularly important to notice the style of approach and the accent upon fairly straightforward empirical techniques. This seemed to work reasonably well until the research environment became unstable. the final section contains an assessment of this work.

6.2. Exploring in a Strange Land

At the beginning of the project, no-one had a clear idea of what the work would be ultimately centred upon. The Company's view was that there were a number of areas that might benefit from this type of research, including new product development, corporate planning, marketing, production, etc. The central concern seemed to be to recruit quality labour with future needs in mind.

It was agreed that the first year should be given over to familiarisation with the nature and the operation of the sponsor, and determining the direction and programme of work in the remainder of the project. It was decided that free exploration of the possibilities required terms of reference that would allow the author to claim legitimate access to almost all areas of company activity, including financial information, and the following title and definition were discussed and agreed for this express purpose :

COMPANY RESPONSE TO CUSTOMERS

A study of the process whereby a medium-sized company reacts to customer requirements - the study will embrace the complete process, from the receipt of enquiry through to issue of manufacturing instructions and completion of the order, and will point to improvements in company performance in these areas and effect on personnel.

These terms of reference were recognised as provisional and were expected to be subject to revision during the second year. The primary concern was to build up a working relationship with members of G.E. and to acquire a broad-based knowledge of the company's operations. This led to specific work on the order processing system, conversion rates and time lags between quotations and orders for switchboards, and the 1976/77 sales forecast. A by-product of this activity was a good understanding of production planning and accounting systems which allowed the author to make constructive comment upon the company's activity during the year. It is not proposed to discuss this work in deatil here, but the reader will find a reasonably full account of it in Appendix D.

The author feels that this work was particularly valuable to the company, and some important changes resulted, principally in the financial/product model used in the standard costing system. Despite this, the end of the year report contained comments upon many factors relating to cash-flow, product development and production planning which were not treated with the same concern by many of the managers. Although the author does not claim to have foreseen the precise events of 1977, the dangers were evident, and were recorded in the first year report.

It was intended that this first year's work would establish a conceptual framework and a positive direction of study. The proposals produced by the author seemed to satisfy all members of the supervisory team and pointed towards an exploration of perceptual gaps in management thinking. The background for this was a classification of company response to customers according to the objectives of the action involved. This conceptual framework is briefly discussed in the following section.

6.3. .The Conceptual Framework

The conceptual framework constituted a model of the company's activities arranged in categories with the broadest categories being expressed in the most abstract terms. These categories were unfolded through layers which became progressively more specific in naming activities. The model was based on two main assumptions.

1. Customers behave rationally, i.e. they attempt to satisfy their needs as they perceive them, with the minimum expenditure of resources.
2. Companies behave rationally, i,e, they attempt to satisfy the customers' perceived needs, as the company understands them, with the maximum advantage to themselves. Clearly, the only customer needs relevant to the company are :

a) Those which the customer cannot satisfy without interaction in the market.

b) Those which the customer can satisfy with a smaller expenditure of resources by interaction in the market.

"a)" relates to deprivation through lack of endowment and other contingencies which generate shortfalls against needs, while "b)" relates to differences in efficiency and productivity arising from specialisation.

Company responses were divided into three broad categories, according to objectives :

1. Attempts to determine customers, customer behaviour and perceived needs.
2. Attempts to satisfy customers' perceived needs.
3. Attempts to influence customer behaviour and perceived needs.

These categories were unfolded down to the level of specific activities such as analysis of area engineers' reports under "1", manufacture of switchboards under "2" and export missions under "3". This scheme is described in detail in "One Year On : Impressions and Proposals", pages 28 to 36 (Appendix D).

Consideration of this scheme of classification, its intricacies and complexities, plus the empirical work of the first year, led the author to postulate the following hypotheses as targets to test in the remaining work :

1. Customer perceived needs $\neq$ company assessment of customer needs

and/or

2. Company variables $\neq$ company assessment of variables.

In order to further compare managers' beliefs with "actual" states of affairs, work was proposed in the following areas :

1. Market segmentation and channels of distribution
2. Buyer values and behaviour
3. The Area Engineers
4. Pricing policies.

These proposals were discussed and agreed with the supervisory team.

At this point, the project seemed to be developing satisfactorily. The work done seemed useful and everyone associated with the project seemed happy. It is interesting to note that the bulk of the author's effort had been channelled into finding out what were the actual states of affairs in various areas of the Ellison organisation. Comparisons with the beliefs of managers were done by asking managers, who, one felt, should know, what they believed particular states of affairs were. The author was concerned with the correspondence between these and actual states of affairs, and it did not occur to him that differences between beliefs might be very important.

This now seems to be a mistake in the light of the theoretical framework of Part 1 of this thesis. This type of error will be looked at again in the methodological assessment, but first it is thought useful to briefly assess the work of the first year in general terms.

6.4. An Assessment of the Work

From the practical viewpoint, the year's activity was extremely useful, both to the author and the company. The author had the opportunity to gain an "inside" knowledge of a very wide range of the company's activities which would have taken many years in "normal employment". By the end of the year, the author had gained confidence not only in dealing with the research *per se*, but also the people, ranging from the most senior management to the shop floor.

From the company's viewpoint, the author's work was reasonably well-received, although some managers had reservations. The senior financial manager, for instance, thought that the first year's report was somewhat harsh, and that suggestions that the company's future was not assured were questionable. Others, by contrast, believed that it was generally beneficial to have someone around who was questioning the received wisdom of the management.

It is clear that there were substantial pay-offs to the company. The spin-off in the form of amendments to the standard costing system have been mentioned above, but this exercise was sufficiently successful for the company to rely on the author for basic sales forecasting in the remaining years of the project.

On the academic side, the picture does not seem so good. Firstly, the proposed scheme of work was not followed to a great degree in the remaining time of the project. This arose principally because the financial difficulties, which were commented upon in the first year's report, came to a head in 1977, so that the company was only able to continue with the financial aid of a number of external agencies, including the Government's temporary employment subsidy schemes. The pressures generated by this situation resulted in work on activities which did not bind together with a common theme. These activities could be described in terms of the initial theoretical framework mentioned above and described in Appendix D, but as a model, the framework did no more than identify some interesting interrelationships ; it lacked any deep, explanatory power, i.e. it was sentential not iconic. (See Chapters 2, 4 and 5). Even its descriptive power may be questioned since in itself, it failed to identify areas of concern.

There was a second area of weakness in the theoretical framework. as well as lacking explanatory power, it developed in relative isolation from any other academic approach, and this meant that there was little, if any, supporting literature and, more important, no methodology to guide the conduct of the remaining activity.

6.5. Methodological Assessment

Seen in terms of the methodology developed in the first main section of the thesis, this part of the work seems acceptable, particularly when seen as a move from the unstructured problem situation to the problem situation analysed. Despite this, we shall see that there were special reasons which would make it dangerous to generalise this first year as a model of how to proceed in the early stages of a complex problem situation. It will be suggested that inspite of considerable pragmatic value in the form of knowledge gained of the company, and contribution to the company, certain special features require closer examination. To begin with, some of the more superficial methodological aspects of the work will be considered. This will be followed by an exploration of some of the fundamental features from which lessons can be learned.

The term "problem situation" is particularly appropriate, and seems to reflect the unstructured nature of the project and the lack of a clear, organisational problem that the author could work to improve. By the end of the first year, the general situation had been analysed, and the statement of hypotheses about perceptual gaps represented a statement of a problem that was agreed by the organisational representatives.

The process of analysis did not only identify elements of the company's activities which would form the focus of further research, but also ruled out some possibilities. The most significant of these was the "production problem" which focussed upon the material requirements, planning and control system, and its associated accounting systems. A central part of this problem was computerisation.

The basis of the decision to concentrate on sales and marketing areas of the organisation were as follows :

1. Development of systems related to the production problems was effectively controlled by a management services manager who was unco-operative to the point of being obstructive.
2. By contrast, a number of key people within the sales and marketing recognised the possibility of a useful symbiotic arrangement. The Marketing Manager and the Sales Manager/Director were particularly co-operative.
3. The marketing dimension seemed to offer the possibility of encompassing the broad, corporate planning which the intiators of the projects were keen to explore.

This decision provides another example of a plan that was not adhered to because, at a later stage, in the project work, questions about which computer system to have for production seemed to the author to run parallel to some considerations relating to sales/ marketing information. The result of this was that the author became involved in a debate which aimed to settle the same question about data processing in general and material requirements in particular.

These developments could not have been foreseen, but they provide an interesting example of the weakness of an approach to problems in social organisations that assumes a clear problem which can be followed by the execution of a neat algorithm to arrive at a solution. What really happens is a complex set of social interactions which constitute a debate about a partially shared reality (actors may reference a common reality, but have differing interpretations of it) in which views and attitudes change end develop to alter the problem situation in a way that is just as significant as any "material" change(s) in the situation.

What observations, then, can be made at a more critical level ? It will be argued that the problem situation at this stage was methodologically influenced by a single W which tended to focus upon "A" type analogies, as described in Chapter 5 above. This had the curious effect of putting the method first and the problem second.

To explain these remarks, one must begin by considering the idea of a single W. At first sight, this seems unlikely since the theoretical work of this thesis has characterised organisational problem situations as involving a number of W's. In order to understand this, one has to return to examine the motivation of the company in participating in collaborative research. A central concern of the company was manpower planning and the need to make longer term provision in the area of quality management. However, the project was arranged at short notice, and these two factors resulted in the vaguest possible outline agreement about the contents and the programme of work. The company was not especially concerned since its prime objects were being met as far as they could judge at that stage ; and the University representatives were not concerned since they took the line that the researcher's first job would be to sort out what the project would be concerned with, and what the program of activities would be.

There is no doubt that the project could have developed satisfactorily from here, although this situation contained a very dangerous trap. The researcher was anxious to establish himself, whilst the company was concerned that the researcher should meet the University requirements. As a contingent fact, the researcher construed his role as a kind of consultant who would find that things were "wrong" and put, or recommend how to put them "right" in an academically respectable and reportable manner. We now have the basis of the first claim. There were plenty of differing W's but none of them were concerned in a central way about how the work should be conducted. The researcher, by contrast, did have some preconceived ideas about what would be respectable procedure (Popperian - find some ideas and test them), which involved asking people about their organisation, or aspects of it, and checking what one took to be reality ; hence the preoccupation with time lags and conversion ratios in Appendix D. There were other W's, but it was the researcher's that set the methodology, and therefore the character of the investigation.

It should be becoming clear by now that this had to lead to a concentration on "A" type analogies. After a year of testing some specific propositions obtained from key managers in the organisation, the general hypothesis described in Section 6.3 were reached. In a nutshell, this amounted to saying that many managers were out of touch with the reality they influenced. This is illustrated in Figure 6.1.

In effect, the researcher's role was to illuminate the "Diff" (difference) and this is an "A" type analogy concerned with correspondence truth.

There is little doubt that this type of work is of genuine value but as a problem, it was not widely shared with the operational line sales management, to whom the author thought this knowledge should have been important. One can only assume that they were able to exist without too much difficulty, with an approximate rather than an accurate picture of this dimension. It was political constraints that encouraged managers to co-operate, rather than a need for the information generated, so there is a genuine sense in which a tacit method existed which went round looking for problems (of the right type) to grind.

The other W's around were not really concerned with the information pursued by the research, but rather more with coping with the possibly disruptive influence of the researcher, given that some top management favoured having a student about. Concern for the areas investigated often arose only in terms of the political implications of the author's activities. This would arise where a manager was defensive about his activities and preferred to keep the author out. However, reactions

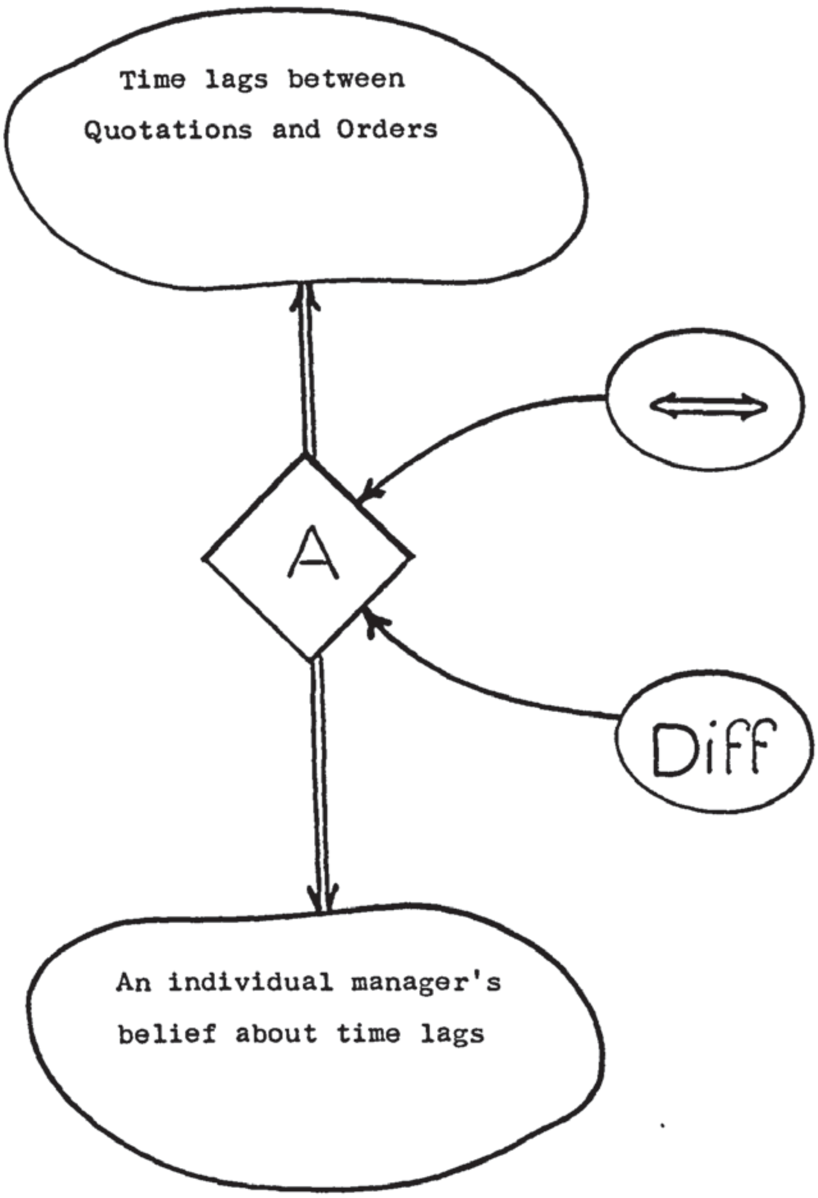


Figure 6.1.

Analogy between Real and Believed
Time Lags

to the author were mixed. "Good to stir the pot" say top management ; "Good to neutralise this chap,"say some managers. Moreover, difficulties were minimal at this stage since some managers said "Good to do something for the firm," and "Especially good if it helps me", and as has already been shown, project activities drifted into areas with co-operative managers.

In conclusion, it can be said that the weakest aspect of the structuring that emerged from the first year's work was the lack of appreciation of the need for a realistic methodology, and failure to recognise that a planned programme of work was likely to need revision, even without the special circumstances of this project. Especially important was the single W influencing the conduct of the work and the accompanying feature that no-one outside the researcher genuinely "owned" the problems investigated. They were a means of being a good student, a means of training a student, a means of training a manager, etc., depending upon the perspective.

In the Spring of 1977, the company had to declare publicly its insolvency, and the restructuring that followed inexorably changed the situation. The researcher was pushed, as much by circumstances as individuals, into problem areas where multiple owners and accompanying W's existed. We shall see in the following chapter just how complex some situations can become. Not least of this difference was that the author became a problem owner himself. There were genuine organisational problems pursued for their own sake in the midst of debate and controversy, in the face of which, the inadequacy of the methodology was, perhaps, inevitable. This sprang mainly from a tendency to test for correspondence truth between managers' views and the "real world", allied to a failure to recognise the importance of the coherence relationships between managers' views.

As with the first year, the successes of the remaining project time did not satify the author, and it is a preoccupation and a dissatisfaction with the failures that has led the author to pursue and build up the complex of ideas described in the first five chapters of this work.

Chapter 7

Project Development After the First Year

7.1. Introduction

This chapter is concerned with developing the project story begun in Chapter 6..An attempt will be made to give some insight into the range of activities undertaken and some care will be taken to stress the methodological features which were significantly different from the general characteristics of the first year's work (cf. Chapter 6).

The year began with a small investigation into GE's outwork department. This was undertaken at the request of the Sales Manager, Mr. JB, with the knowledge of the industrial and academic supervisors. It had, to a small degree, some of the elements that were to make aspects of the later work very difficult. It was, for instance, work on a problem that was genuinely "owned" by members of the organisation who were looking for help. Almost all the W's involved were compatible, and despite the increased complexity compared with the project work of the first year, the author had little trouble in successfully applying the kind of closed system approach envisaged during exploratory phases of the first year. An outline, with reports and other relevant documents are included in Appendix E and should be consulted for more detail. It is interesting that the only opposition to the author's recommendations, from the Sales Office manager, was easily dealt with (see Appendix E), due to the good management of Sales Manager, Mr. JB. However, the author did not understand the opposition, or that it stemmed from and represented a different W.

From this time onwards, the project environment effectively changed, principally because of a company-wide financial crisis and the changes in management and organisational climate that followed it. A good deal of the early part of this chapter describes the financial crisis and some of the more important changes that followed. This treatment is thought to be necessary in view of the effect upon the company as a project environment, the types of problems tackled by the author and the general demand made upon the methodological approach taken.

As the account unfolds it will become evident that the company and project situation were being influenced by some very strongly held and differing W's. However, the author did not formally construe these in terms of the kinds of open systems methodology described in Chapters 3 and 5, but was motivated to pursue a kind of organismic modelling (see Chapter 4). This was a helpful improvement on the previous framework since it seemed possible to map many aspects of the problem situations onto this type of model. However, in its original form (Beer, 1972) this type of approach did not, in itself, draw the author's attention to the significance of differing W's. Also, it did not, in itself, constitute a methodology. The result was that the author came to feel a need to set this approach within a suitable methodological frame. The development that followed is recorded in Part 1 of this work.

Differences in W's gives rise to a kind of politics (among other things) which real world managers sometimes become skilled at. The later work of the project shows that the author was becoming "politically aware", although the conceptual framework to describe this process was lacking at that time. In terms of the declared objectives of the author, many of the campaigns embarked upon were failures. However, seen within the developed methodological framework of Chapter 5, one can say that the debate was, perhaps, as important as the outcome. However, this was not a part of the author's W at the time, and the deep sense of ineffectiveness and difficulty in understanding the motivation of some managers was a strong stimulus to investigate and develop the ideas recorded in the first 5 chapters of this work. The detailed discussion in this chapter begins with a description of the financial crisis of 1977.

7.2. The 1977 Crash and some of its Implications

As part of the first year report the author had commented upon the general operation of the company, and a number of anomalies were itemised (see Appendix D). Specific reference was made to a product development project (APE) which was insufficiently planned and poorly executed with extremely adverse effects upon cash flow. As the project progressed, the company's financial situation grew steadily worse. By the spring of 1977, the situation was so serious that the senior management were forced to acknowledge that the company's future was in question. However, the compnay did not pass into the hands of the receiver, but this was only prevented by three important factors, any two of which, most managers felt, would not be sufficient to save the company.

1. After suitable negotiations with unions, a Temporary Employment Subsidy was obtained from the government.
2. The Japanese switchgear company, Mitsubishi, with whom GE had an agency agreement (also discussed in the first year report) made a loan of approximately £300,000 at what were low interest rates, in

exchange for undisclosed rights, arrangements or options. This has subsequently been converted into a 20% shareholding.

3. Assured by the confidence of Mitsubishi and other factors, the company's bankers, Barclays, were persuaded to substantially increase the overdraft.

The first factor underlines the extreme seriousness of the company's financial situation, since the unions were required as signatories to a declaration to the effect that without the government money, they believed that the whole work force would be redundant.

It is difficult to say very much about the Mitsubishi loan beyond the obvious fact that they had their own reasons for supporting the company. Many of the GE management believed that they were anxious to establish themselves in the UK market, but required to operate through the mask of one of the oldest manufacturers in the industry. In view of the lack of progress in GE factoring of Mitsubishi products (see first annual report) during the previous years, Mitsubishi may have been keen to:(a) establish some degree of control so as to influence marketing policy to a stronger degree ; (b) ensure the progress to date was not lost through the disappearance of the company and (c) not take full control which might have defeated their objective by changing the external image of the company from classically British to Japanese. It is not clear to the author if the whole company was ever on offer. Whatever the facts, it is certainly true that visits from the Japanese company became more frequent over the following couple of years, and a small party of GE managers visited Japan.

The author is not at all certain what the bank's conditions, or their effects were. The view expressed here may not be wholly accurate but it is one that was held by key members of the middle management right across the company's activities, and as such, constitutes relevant information.

The first major effect to be attributed to the bank's influence was the arrival of two consultants to assess the state and requirements of the business. One consultant was a general business consultant, and one was a financial specialist. They soon made their presence felt by interviewing many, but not all of the middle and senior managers. It became a matter of some concern and bewilderment to the author and a fellow researcher, associated with the company, that these consultants showed no interest in discussing the general state of the company. The researchers felt that it was possible to provide a broad picture and a perspective that was valuable, through not being too closely associated with any sectional interest.

Apart from encouraging the bank to support the company financially, the most signficant change that seems to have resulted from the consultants' work was a change in effective leadership. The managing director since (and before) the 1973 split with the Ellison holding group was Mr. PS, who had a 50% shareholding. The sales director, Mr. JP and financial director, Mr. DW held 50% each of the remainder. Clearly, the shareholders ruled the boardroom, but it was said that they did not agree on numerous matters, and that the two minor shareholders clubbed together to oppose Mr. PS. However, the inevitable result was a "stalemate". In the wake of the financial collapse there were many managers who felt that Mr. PS had failed the company and were therefore prepared to back a general movement to displace him from effective control of the day-to-day activities of the business. Mr. PS moved from MD to Chairman of the company, responsible for long-term planning ; Mr. JP moved from sales director to General Manager (these duties seem to have been indistinguishable from the role of MD), and Mr. JB moved from sales manager to Sales Director. It is said that these moves involved a shift of share balance with Mr. PS losing his majority shareholding but this was not a simple shift from 50% - 25% - 25% to 49% - 25.5% - 25.5% because an employee share participation scheme a little time before had unbalanced these figures. If the consultants did recommend that Mr. PS's controlling interest be broken, it is difficult to see that there could be any choice in the matter with the bank making this a condition of support.

After a settling-down period, Mr. JB was replaced by a new MD, Mr. BH, in September 1977, who has held the position since. Mr. JB moved back to head of sales under the title of Commercial Director. Mr. JB had departed by this time with the sympathy, and to the regret of most people.

Immediately after the financial crisis, the board instigated a package of cost reducing measures which included a complete moratorium on outgoing telephone calls before noon each day. This package also included a redundancy programme aimed at reducing the labour force by about 10%. The then marketing manager, Mr. DB, was included in the programme and this was disruptive to the project because he was one of the managers with whom the author enjoyed a reasonable degree of co-operation and trust. Mr. JB had the unpleasant task of informing Mr. DB of his fate, but it is clear that the decision was taken higher up, either by Mr. PS, Mr. JP or both. This redundancy is important because it is not obvious that the marketing manager's job was redundant. The fact that the author was pressed to assume temporary responsibility for some marketing activities suggests that the redundancy programme may have been used to expel a manager who was unpopular with some key senior people.

The inevitable effect was that the planned programme of work slipped still further behind, and the autonomy of the author tended to evaporate, so that the research not only shifted direction, but also slowed to a snail's pace. There were compensations in the form of increased knowledge and access to the company's operations, parts of the complex information systems in particular. There was also substantial involvement in decision making at both the operational and strategic marketing levels, though the latter was more in the guise of technical expert/consultant.

Apart from the pressures arising from the events described above, the author was constrained in other ways. Requests were made to all staff to support the company by being flexible, and not putting personal interests before other difficulties. At the same time it was stressed that the company was in severe difficulties, but this should not be communicated to any of the University personnel on the supervisory team for fear that "word" would circulate among the business community, this being detrimental to the general level of confidence with the attendant danger of a further "run" on cash by creditors. This was difficult because it came from the second of three industrial supervisors, and unfair because it required that the research objectives be endangered without any contingency plans.

These factors by no means exhausted the difficulties. The new Managing Director, Mr. BH. declared himself to be unimpressed with the work to date, although he had no detailed, specific criticisms to make of the full set of reports that were provided for his information. His attitude became clearer when he declared that he disliked the idea of people "floating about" the organisation who were not responsible to any of his managers, especially when one might be playing the role of informant to the Chairman ! Although the Chairman had given his full support to the research, there was never any question of such an arrangement, but the author felt himself to be in a particularly difficult situation.

As part of a situation that will be discussed below, the company appointed a Data Processing Manager in Autumn 1977 and after a short time, a memo was circulated to the executive committee to the effect that the company's two researchers would report directly to him (see Appendix F). This was done without any consultation with the author or any member of the supervisory team, and needless to say, one viewed these arrangements and the manner of their making as completely unacceptable. After suitable protests and consultations with supervisors and others, a memo was circulated to reverse the decision, but the fact remains that these events were perturbing and unfortunate in the light of all the other background difficulties.

7.3. Development in Project Focus After the Crash

The purpose of this subsection is to impart an impression of some of the activities that helped to focus and deepen the author's concern with and for the sales and marketing side of GE. All these activities were carried out within the "pseudo-scientific" Weltanschauungen described in the previous chapter and were still primarily concerned with "A type" analogies (see Chapter 5). Since comments have already been made about this approach, it is intended to record only the barest details here, with fuller accounts in appendices. This will enable the discussion to move on to describe a debate which involved a more obvious clash of W's.

The author's position after the financial crash was radically different. Instead of being a relative outsider who was looking into various aspects of the company's commercial systems, one became much more a member of the management team with an informed understanding as to his responsibilities. A central part of the work load associated with these arrangements was a core of activity left by the redundant marketing manager. This included production and/or supervision of production of regular sales statistics and forecasting for budgetary purposes. A reasonably detailed account of these activities may be found in Appendix G.

The pressures leading to involvement in these activities were a curious mixture of personal and external factors. Externally, the author was pressed by senior management to accept more duties, with assurances that demands would be minimised and every possible help would be provided. These requests were made within the context of the company's financial position. On the personal side, the author felt the attraction of being more "on the inside" with greater access to statistical records as well as the opinions of various managers.

The author's involvement in forecasting was, however, to lead to an awareness of what seemed like important deficiencies in the data available for this and other commercially oriented purposes. A short time before the crash, the author had set out a proposal to introduce customer requirements summary sheets into the sales office, to be filled in by the contract engineers who liaised with the customers throughout the whole life of any contract. It was envisaged that these documents would provide a useful record for the engineers, as well as forming the basis of an information system that might, if appropriate be computerised at a later date. Details of this proposal may be found in Appendix H.

An interesting area that was developed under the author's stewardship concernes the distribution of sales-related information to senior and middle management, using graphical techniques to convey information. Some of this work was intiated at the Chairman's request and this involved exponentially smoothed graphs of quotations, orders and sales, while "Z curve" representation was introduced at the new MD's request. It soon became apparent that there were some tensions between these parties, with the result that both these systems maintained their separate and conflicting identities. A fuller account of these developments is given in Appendix I.

From the author's point of view, these graphs with their considerable data preparation represented a commitment which made it very difficult to develop the project freely. From other viewpoints, one must say that few middle managers found these graphs of any value. This is probably because the contents layout and techniques of calculation were designed by others primarily for their purposes, and did not (probably could not) represent the information requirements of a heterogeneous set of managers.

All of this activity served to deepen the author's involvement with the sales organisation, although budgeting activity maintained contact with a reasonably wide set of senior and middle management. The identity of the project was now fairly strongly centred on the idea of developing information systems for marketing and forecasting. It had not occurred to the author that the activities of other areas of the company would become a central concern, but as will be made clear in the next and following sections, questions of resource allocation affect everyone.

To begin to clarify the situation, it is necessary to describe in outline the company-wide debate about which computer to buy for the purpose of production scheduling and planning.

7.4. The Data Processing Debate

Some remarks have already been made in the previous section about data processing and in this section, an attempt will be made to impart some of the interesting aspects of events which took place within the context of a company-wide debate on data processing. The debate began with questions about the desirability of an existing system and progressed to questions about the type of implementation hardware and the general disposition of available resources. Despite the undoubted importance of the issues raised, it is interesting that the stimulus that started the debate was an external constraint, and not the importance of the issues themselves. It took something that managers could not ignore to raise the question, and there is some evidence to suggest that the issues were not taken as seriously as they should have been by those with the effective power in decision making.

There were two important factors which strongly affected the shape and course of the debate. To begin with, there was the 1977 financial crisis which resulted in temporary and not very practical management structure between the time of the crash (March 1977) and the arrival of the new Managing Director, Mr. BH in August/September 1977. Of more importance for starting the debate was the fact that the existing supplier of bureau services providing MRP (material requirements planning) (IBM with the PRINCE system) had given notice that the system would not be available on the existing basis after March 1978, but would operate through a suitable GPO modem to a new centre in Warwick. The importance of this latter point is that this type of arrangement entailed signficantly higher operating costs for a system which many thought was hopelessly inadequate for GE's needs. It is interesting to note that IBM had given notice of its intention to do this some two years earlier, but the GE management had effectively ignored the prospect until final and official notice arrived. Even then, it took some campaigning by particularly interested parties to get the company to take this deadline seriously.

The change in management structure mentioned above is important because the political situation was such that "top" management did not have the confidence to decide the issue themselves. They had, in any case, a natural need to get middle management to look at the technical feasibilities. The Financial Director, Mr. DW, in his role as "information manager" called everyone (including the author) who had any interest/expertise in the production planning, control and data processing areas, to form a task force to examine the suitability of the IBM alternative and other commercial arrangements.

Since a relatively large number of people were involved, some disagreement/debate was inevitable, but this tendency was fuelled by the fact that "bad feeling" about the PRINCE system and those who installed it had been building up over several years, so that most managers were sure that GE needed an alternative but did not know what.

An important outcome from this debate was the acquisition by the company of an NCR 2250 "in house" mini computer, selected primarily on the grounds of its suitability to do material requirements planning (MRP), although it was expected that this machine would go on to serve the needs of other areas of the company.

The principal concern of managers involved with MRP was to meet the need to find and implement an alternative to PRINCE within the imposed time constraints, with production needs as the prime concern. For the author, however, the issues were, in some respects, different and perhaps wider. The author's written contribution to the debate is given in Appendix J. Some of the more important issues perceived by the author are discussed below.

The most general observation of interest is the way in which a debate on a localised set of issues can act as a catalyst for a debate about a wider set of issues. In the case of GE, questions about what to do to cope with material requirements planning led to a general debate about data processing at GE. Generally speaking, managers not directly concerned with production, particularly those in the sales and commercial section, began to feel that the large expenditures being contemplated ought benefit more than just production planning. In particular, the author had some success in convincing key people in the commercial section that information sources relevant to them were being neglected, and that improved information systems were required.

Any underlying concern was amplified by the pressures generated by the post-crash labour shortages. This became particularly acute since there was an effective ban on recruitment, even to replace "natural wastage" losses. Managers wanted to know if a computer could compensate for these reductions in functional capacity.

The first of the author's reports (Appendix J) attempted to set down a case to stress the wider issues. Also, the author felt that some of the actors in the debate were treating their central concerns as though they stood alone, and the dangers of this approach were emphasised in the second paper (Appendix J). In particular, the detailed work already carried out by the author had generated a specific concern for the marketing information needs. Confidence in the author was expressed by the sales/marketing (commercial) department, and the author perceived his role as representing these interests in the debate.

In Appendix A, the forced role of the accounts department in the provision of sales data by product group is mentioned. This generated considerable pressure upon this department which led to the accountant responsible looking at ways in which these duties might be unloaded. It happened that Mr. DB had, some time before his departure, looked at the possibility of doing the analysis of quotations, orders and sales with a computer bureau , so that a specification and quotation already existed. The accounts department began to move towards implementation of this system by asking for a requote.

However, the author felt that this was bowing to short-term expediency (a not untypical situation) and that this original proposal was technically out of date. This, then, provided the main motive for the production of the first paper which was successful in blocking the bureau proposal. It was felt that the provision of an outline design was necessary in order to facilitate the implementation of an acceptable/desirable system for sales analysis and these considerations were addressed.

By the time that the second paper was written, the author had become much more aware of the general issues, and realised that the sales analysis needs were unlikely to be successfully represented. The untimely departure of Mr. JB was a significant factor in this, but the extended nature of the debate was also important, managers could not agree about a solution to the material requirements planning problem, so that the decision to use an NCR in-house, mini computer was taken at the last minute. It is hardly surprising that the commercial needs were given little consideration.

The picture given here would be unbalanced if it were not reported that the decision makers expressed the belief that the MRP needs were such that the computer would have to be reasonably large, and that this capacity would only be fully utilised for a small proportion of the time. This, it was argued, would leave plenty of time for sales analysis and anything else that might be required. However, as will be outlined below, the computer was chosen specifically for MRP and the promised sales analysis did not materialise.

In acquiring a computer, the organisation, in effect, acquired a new institution. Despite the ability of the type of "mini" computer installed to operate without the technical paraphernalia associated with"large mainframes", the installation acquired support staff which soon became a department, and a powerful one at that. This development was comletely unexpected to the author, although support was given to the idea of appointing a DP manager, in the belief that such a manager would probably be interested in the data processing requirements of the whole company. However, the situation remained unsatisfactory and the DP establishment was to play an important part in the remainder of the project.

In terms of the methodological framework of Chapter 5, one can say that there was a set of shared concerns, but there was a multiplicity of views surrounding them. The author's view vis-a-vis the in-house mini lobby have been stressed here but there were other preferences about future developments. The perceptual model can represent this situation, as in Figure 7.1. Although three views are represented, there were several others which were not as openly articulated at the time. There can be no doubt that some of the differences between views stemmed from A type analogies, i.e. there were some misconceptions about the company situation, the technology, etc. However, these differences were less important since a good deal of the debate was concerned, not with "the facts" but with objectives, priorities and the shape that the future should take. The reason,the explanation for these differences can be understood in terms of differing W's and this type of model has already demonstrated that behind each view lies a W. The author did not appreciate this at the time, and so concentrated on fighting the issues. In retrospect, one feels that an exploration of W's might have helped the debate to an earlier conculsion

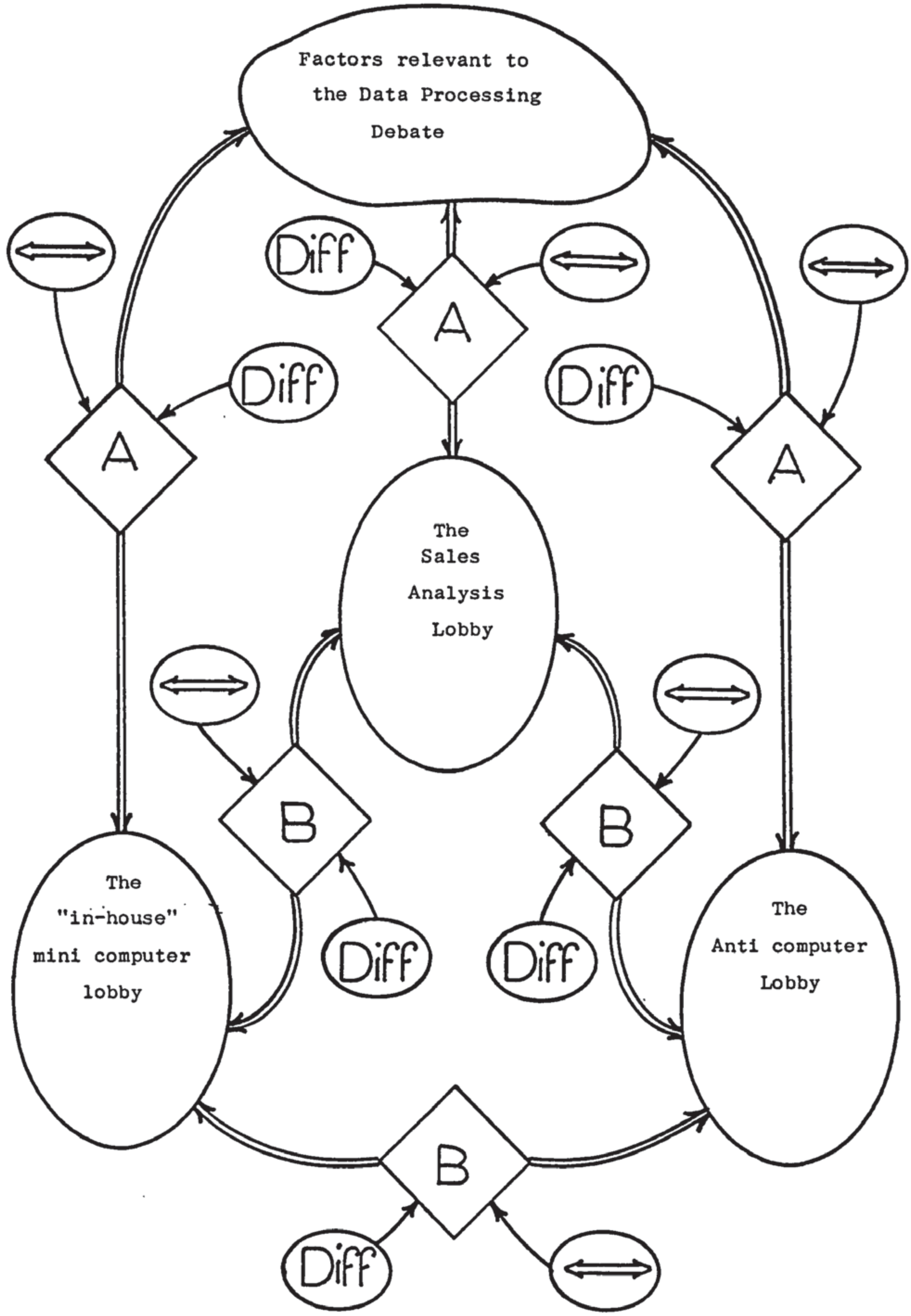


Figure 7.1.

Differing Views in the DP Debate

and possibly a different one. An understanding of the source of differences would have suggested a need for a different sort of debate from the one which took place. Whereas the actual debate was about what was the best thing to do about computerisation, etc. a more fruitful debate might have extended beyond these issues to include discussions between actors about the origins of their differences. This would expose W's and possibly change them.

Having described a situation where differences in W's played a central if unrecognised role, the next section will attempt to describe how the situation developed (from the author's perspective) to involve differing W's, both in terms of the issues debated, and the attitudes of various actors towards one another. Every reasonable attempt will be made to impart a rich picture with some feel for the politics of the situation, However, some caution needs to be exercised since this will be the author's perspective, and this may not find agreement with some of the other actors.

7.5. Post-Computer Issues

The main concern of the author after the acquisition of the in-house computer remained the absence of any signficant progress on the sales analysis system. The remaining story about the author's involvement with the operations of GE will centre upon attempts to remedy these deficiencies. In completing this account, however, some remarks relating to the "politics" of the organisation are necessary, so that the reader can fully appreciate the rich complex of tensions and developments that surrounded these attempts. Some insight into various W's is gained through this process, although these were not the subject of primary investigation at the time.

7.5.1. The New Establishment

Some mention has already been made of the appointment of a managing director in September/October 1977, and this was a key development. In part, this was because Mr. BH was to be the head of the company for the remainder of the project, thus providing stable leadership, something which was lacking for a significant part of 1977. More important was the style and direction of that leadership which seemed to invite conflict with many managers, including the author.

Mr. BH arrived in the late stages of the "which computer" debate and quickly gave his support to the final recommendation of Mr GG, who favoured placing an order with a company who were selling software expertise and a knowledge of manufacturing problems. The suggestion that a data processing manager be appointed was soon taken up. Mr. BH appointed Mr. BR who was DP manager at one of Mr. BH's previous companies (Bill Switchgear).

This, in fact, was the first of a number of controversial appointments by the MD which seemed to foster a feeling of alienation between the "Ellison men" and the "new recruits". Such appointments were to key posts such as Manufacturing Manager, and the "Ellison men" began to declare that the MD had no confidence in them. This was probably a mistaken impression since the MD often said to the author that GE was one of the few places he had taken over where he had not had to dispose of a number of middle managers. However, many people were to comment over the following year on the apparent special relationship between the MD and such people.

The early days of the DP manager's involement were reasonably uneventful. He busied himself by interviewing all the middle management, including the author, about their particular areas of concern. Controversy did not begin until he produced a report outlining his plan of development for DP at GE (see Appendix K).

The DP manager's report contained a recommendation that the author implement a part of the plan :

> "Mr. K. Molloy, with assistance from someone in the sales organisation, be allowed,under the general guidance of Mr. AP and myself, to design and implement a Sales Progressing System concurrently. This would then provide management with most of the information it requires from incoming orders through to the completion of those orders."

When the author heard that such a report existed, a verbal request was made to the DP manager to supply a copy. Assurances were given to the effect that this would happen, but that for the present time, copies were limited to top management (directors, etc.).

At this stage, the author was unaware of the contents of the report, but the news that the MD had informed the executive that the author would report to the DP manager began to circulate (see Appendix F), and this added greatly to the tension. The author was all the more suspicious since the MD had, within a month of "taking the chair", declared his disapproval of the sorts of University/industry collaboration represented by IHD, being against any arrangement which allowed individuals to "float" freely without being accountable on a daily basis to "line management".

As mentioned above, this decision was successfully reversed, but the author did not receive copies of the first memo or the DP report from official sources. In the case of the DP report, the author received the Commercial Director's copy with a request for comment. Some consolation was drawn from the apparent intention to act upon sales analysis but there was remaining anxiety over the question of "When", and the apparent lack of openness from the "new establishment".

7.5.2. An Alliance with the Management Accountant

Shortly after the 1977 crisis, the Financial Accountant (Mr. RR) at GE left to take a position in the south of England within the motor industry. However, Mr. RR's family were not happy, and so he decided to move back to the Midlands after eight months. GE had filled his old post, but were looking, with little success, for a Cost and Management Accountant and were pleased to offer the post to him. Mr. RR returned to the company to find the in-house computer installed and accepted the task of designing a suitable job costing system for the company.

In the meantime, Mr. RR expressed some concern about his department having to complete the analysis of sales transferred from the sales department. In the absence of any progress on sales analysis, and with a growing feeling that progress was not likely to be forthcoming in the near future, Mr. RR agreed to cooperate with the author in an attempt to either provide an alternative facility to the existing machine, or force some action from the DP department.

The first logical steps were to agree on the following principles :

1. Product listings and categories should be internally consistent and compatible with any adopted accounting/reporting procedures.

2. The system should not require any extra labour, and should, ideally, save some.
3. The system should cover areas of management information of importance but not presently available.
4. The system should be attractive from the cost point of view. It was realised that any "expensive" solution would fail because of the prevailing financial climate within the company.

Work began on rationalising product group listings, and the following anomalies were identified as requiring elimination.

Firstly, a confusion over product group "list 35" was felt to require clarification. This was a large electrical transformer housing containing mostly steelwork, with little in the way of instrumentation or active devices. The transformer to go inside, however, was not of GE manufacture and often cost 15-20 times that of the housing. Although customers usually ask for a transformer and housing as an integral entity, these items were treated as separate groups in the accounts on the basis that the transformers were of a very high value (£15-20,000) and a factored item.

This separation was followed by a dramatically different treatment ; the housing made a contribution to the declared turnover of the factory but the transformers did not. This was achieved by entering the transformers in a side account where income and expenditure were netted off to give a "contribution" and this figure was entered as a "sundry income" in the accounts below the trading line. The result was that although contribution was correctly stated, the turnover was understated from a certain point of view.

Secondly, it was felt that the company's activities fell into two natural categories (see Chapter 7) when viewed from the marketing or financial management viewpoint, and these were already nominally recognised in the division between distribution equipment and components but were not recognised in the accounts, i.e. trading statements were not separated. The product listings suggested were aimed at providing a first step to separate accounting.

Mr. RR proposed these and other changes to Mr. DW, the Financial Director. He would not sanction a change in the treatment of transformers on the grounds that the company's accounts were seen by outsiders, the bank, etc., who might not understand why certain accounting ratios had changed unfavourably.

Transformers were not the only contentious issue. The company had been receiving a temporary employment subsidy from the government, and this was also shown as a sundry income which effectively inflated the trading profit. Some might say that this looked like "creative accounting" (Argenti, 1976), but some reluctance to change established accounting practices at a time when the company was having financial difficulties was perhaps understandable.

In terms of hardware, it quickly became apparent that some kind of micro computer-based system was the only possibility that would meet the selection criteria, and work began on finding viable alternatives. The author's links with the University were exploited and candidates for software programming were found who were prepared to work for reasonable rates. This was also a useful source of recommendations for hardware, since experience with some micro systems existed.

The system worked out with Mr. RR was finally reported and proposed by the author in November 1978 (see Appendix L). The author had high expectations for this system since it seemed very cheap to acquire and operate, as well as offering an opportunity to generate DP expertise among the managers themselves, and break down the idea that only "professionals" can do it. An essential feature that facilitated this was programming in BASIC which is a relatively easy skill to acquire. The NCR machine, however, operated with COBOL with the result that only Mr. GG and the DP manager could program new systems. This was, of course, an important factor in the delay in generating a sales analysis facility. Capacity to generate new systems was strictly limited and there was even difficulty in making programmed systems operational as in the case of the nominal ledger system for the Financial Accountant, which was not working reliably, even in 1980. These factors were becoming recognised in some quarters and the Sales (Commercial) department expressed considerable confidence in the proposal.

7.6. Sales Analysis with the New Establishment

The immdeiate effect of the micro computer report was that the DP department moved sales analysis and the requirement of the "front end" of the company from bottom to top priority. Lobbying from the DP department secured agreement that any decision be postponed until they had time to prepare an alternative, using the existing NCR machine. Alternative arrangements were offered in January 1979 (see Appendix M), and these included an arrangement using a micro computer as part of the system, but in general, the arguments were slanted in favour of the in-house NCR-based system.

Mr. RR felt that the merit of the micro as a short-term solution that would leave the company with a generally useful facility for managers, after implementation of a more sohpisticated and larger system. The DP department, by contrast, construed the micro system as a competitor. By deciding to act, the DP department effectively defined new circumstances, a new game (see Chapter 8), which was not a fair basis on which to criticise the micro system. Also, many objections to the detail of the micro system were unfair, being directed towards the incompleteness of the specification, since as much as possible was left undefined because the software people consulted had agreed to work in a fairly informal fashion with Mr. RR, the author and any other relevant manager. A self-organising situation was envisaged, rather than the "you specify it, we program it" type of arrangement associated with software houses, and some professional DP people.

The details of this debate will not be further described, but the sales department agreed to the totally NCR-based system, albeit with some reservations. The planned time of development was six months, but this programme soon slipped behind. By May 1979, there had been no significant developments affecting the reporting of data, although some progress had been made with transferring some of the component sales office paperwork onto the computer, and the component sales manager expressed himself to be very satisfied with this.

In retrospect, one can see that this exercise was partially successful in that the work on the micro system had acted as a catalyst for something that was destined not to be done for a very long time. However, more remained to be done than was done, and the company was as far away from adopting graphics and the kind of manager-based approach to Dp envisaged by the author.

Although the Chairman expressed some confidence, and made it clear that a role was envisaged for the author beyond the project, it was felt that continued involvement with the company on a full-time basis was not conducive to the successful completion of a thesis, and in May 1979, the author terminated employment with GE, with a view to considering the project issues from a distance. This thesis is the result of the work completed since then which has been aimed at strengthening understanding of the organisation and the methodological issues surrounding the project.

7.7. Comment

At this point, enough of the story had been unfolded to enable a number of important methodological and other points to be underlined. The differences in view existing around the "which computer" debate have been commented upon so that it now possible to comment upon the complex of relations that developed around the question of use and control of this and other resources.

As with the other examples, these events show that the author (and others from their own perspective) were working to achieve an ideal solution to the problems perceived. There is no question that by the time that this latest round of debate emerged, the author was much less naive, with the result that some moves were expressly designed to have political impact. Despite this, the author remained too concerned to reach a particular outcome in as short a time as possible, with little regard for the views of some authors. It may have been more fruitful to meet less of the constraints head on, and to think more about the sources of opposition.

The events following the acquisition of the mini computer illustrate perfectly the processes described in subsection 7.3. What was modelled there was the difference in view or perspective centred around a widely shared problem within the organisation. We now have a much richer picture in which the politics are much more complex and difficult. Power changed hands as a result of the financial crash, so that there was not only a difference in view over a set of concerns , but also a difference in the power base of the various protagonists.

The circumstances responsible for the power shift were responsible for an unusual situation. It was felt that the new MD was, to a substantial degree, imposed from outside by the bank's representatives, bearing in mind that the prevailing insolvency robbed any member of the pre-existing company of any real power (no money - no options). A bank nominee, by contrast, is endowed with the bank's power, so that there was no real power balance at the beginning of Mr. BH's stewardship. The new establishment grew around the MD and in effect, fed upon this power. Very little opposition emerged at first, since on the one hand, no-one knew how the situation would develop, or how the MD intended it to ; whilst, on the other hand, only the most senior managers could possibly raise any objection, and they were discredited by their record.

One feels that the new MD must have been conscious of his strong position, and that this must substantially account for the "roughshod" way in which he proceeded.

From the author's point of view, the new establishment came as a wolf in sheep's clothing. This was because one anticipated that discussions with the DP manager would lead to support for Sales Analysis. This view was strengthened when the manager began to canvas opinions about what was needed in the company. What emerged from this process was minimal practical support for the analysis system and, more importantly, a striking difference in W's which did not relate to DP *per se*, but to the role of the author.

The MD had already expressed concern about the role of any IHD student within his organisation, and one gets the impression that he did not regard a resource that he could not directly control as a genuine resource but a hindrance. Now, one expected to negotiate a role with the DP manager, but once again, he did not see this as a requirement. The author was regarded as powerless, like most of the rest of the pre-crash personnel, and therefore could be directed according to their corporate plan. Figure 7.2. illustrates these relationships.

It is not, perhaps, very important that the author was treated in this way, since the formal arrangements between the company and the excessive amount of operational activity being undertaken by the author meant that the author was not powerless at all. It was always possible that the company might terminate its arrangement with IHD, but the cost would have been high in operational terms and the Scheme enjoyed the support of the Chairman. The real importance in this lies in the fact that it typifies what was happening to several other managers who, by contrast, had no significant power base. This situation was to improve somewhat, since eventually, the credibility of the MD ultimately

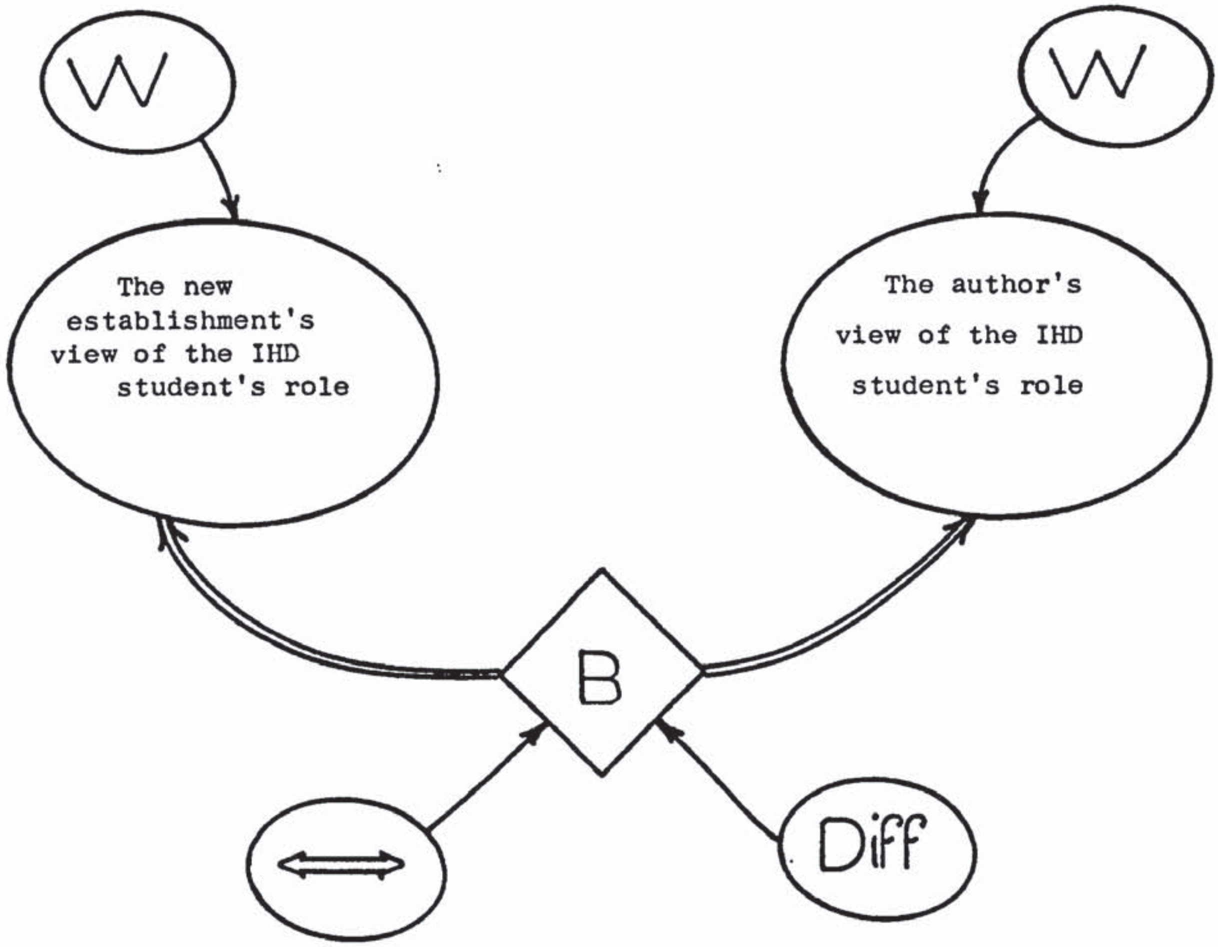


Figure 7.2.

Differing Views of the IHD Student Role

depended upon the performance of the factory, so that as time progressed, compromises had to be made to gain co-operation. Despite this, there is no doubt that there were two principal W's for quite some time : one associated with the new establishment and one with what may be characterised as the "Ellison Establishment".

Behind all the differences of opinion over key issues, those involving the author being only a subset, lay important differences in W. These differences are manifest both in forms of how actors treat one another as well as the views supported in relation to any strategic decision. It is hoped that the events related in this chapter have served to illustrate these features. In Chapter 9, an attempt will be made to characterise these differing W's at a deeper level, while the next chapter will attempt to refine and explain some of the detail of the iconic model developed in Chapter 5 and applied as a methodological framework in this and the previous chapters.

INTERFACE - PART II to PART III

The reader will see from the structure map of the thesis given in Figure P.3. that it is possible to arrive at Part III from 1 or 2. The two previous parts are complementary so that readers with differing interests may take them in a different order.

Readers whose interest is primarily in the theoretical aspects of the work will find Chapter 8 of more immediate value. Readers who are more interested in the organisational issues will find Chapter 9 of more help. Like Parts I and II., these two chapters are complementary, but they both focus on W's.

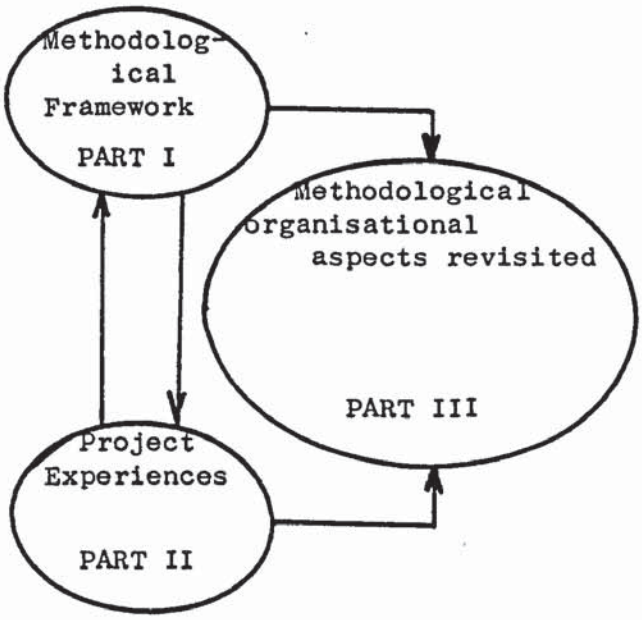
Chapter 8 is concerned to identify W's embodied in other approaches to problem solving which are compatible with the author's model of the methodological process developed in Part I. These can be blended into the author's methodology to strengthen it and provide a broad base of techniques which can usefully enhance OPS ability. Not every approach is helpful because some do not allow the existence of differing W's to be accommodated. Those which are suitable include Conversation Theory (Pask, 1975), Construct Theory (Kelly, 1955) and several others are given.

Chapter 9 returns to the Ellison situation as the author knew it. Some of the organisational issues which now seem important because of different W's, are identified. Differing W's within the organisation are characterised by using viable system modelling. This modelling is only one of the range of techniques that might be useful for this purpose. Chapter 8 describes others. The effectiveness of this modelling must, to a degree, be limited because it has been carried out after the author's involvement, and not at the time. However, it is of value since it illustrates the kind of approach the author now advocates.

Part III :

Methodological and Organisational Aspects

Revisited



Chapter 8

Refinements to methodology
Mutliple W's to strengthen methodology
Conversation theory
Construct theory
Cognitive mapping
Hypergames analysis

Chapter 9

Multiple W's within George Ellison
W's of the past, possible W's of the future

Figure III

The Content of Part III and its Structural Relationship with Other Parts

Chapter 8

Complementary Approaches

8.1. Introduction

The theoretical aspects of this work have already shown the influences of the work of Pask (1975), Kelly (1955) and others. However, these theories often involve a methodology as well, and it would seem possible to use these methods to supplement the basic framework outlined in Chapter 5. All the techniques represent methods that can be an aid in seeing how people see things, and therefore may play a useful role in the investigation of W's. This can usefully supplement the basic methodology, and not only help to uncover the politically sensitive issues, but to handle them.

In terms of the problem situation experienced within GE, this represents an alternative approach and would address the set of problems associated with the company's persistent financial and other difficulties, plus the "political" conflicts surrounding them. The main objective would be to explore the differing views of the company and its future, held and envisaged by as many of the key actors/owners as possible. These differences may be seen as responsible for the failure of managers to agree about the best action, in relation to any particular issue such as computerisation or marketing strategy.

The political aspects of the material requirements planning and the sales analysis system described above are typical of the difficulties and mode of conduct to be found at GE during the author's involvement. The predominant result of this is that the company generates an environment in which it is extremely difficult to get anything worthwhile done. Some middle managers have expressed the view that they find that the organisation seems to absorb all their energy without their achieving very much. Although this is speculative, the author believes that this is because individual efforts tend to cancel out through the political process - a kind of negative synergy - rather than supporting one another. Managers need to explore their own and others' views of the situation in a constructive way.

In order to make these ideas clear, it will be necessary to describe these approaches in more detail than has so far been found necessary. This offers the possibility to enrich the author's approach to problem handling. Checkland uses a common sense "talk-to-the-chap-and-see-what-he-thinks" approach, and the iconic model of Chapter 5 represents the complex of processes involved. There is advantage to be had in using techniques based on more explicit and rigorous theory to explore W's directly.

It has been shown that W's are important in problem situations, but each methodology has its own W. Having determined the kind of approach that is suitable for the more complex organisational problems in Part 1 of this thesis, this chapter will describe some other approaches whose W's seem to be the same, or compatible, with the author's framework. On this basis, this range of techniques could be drawn on as appropriate.

The approaches discussed below are Conversation Theory (Pask, 1975), Construct Theory (Kelly, 1955), Cognitive mapping (Eden et al., 1980) and Hypergame analysis (Barnett, 1977). The W behind each of these incorporates a view of problems which is compatible with the authors views, as set out in Part 2. Combining these approaches offers exciting possibilities for the future development of OPS.

8.2. Conversation Theory (CT)

Conversation Theory (CT) is basically a theory of cognitive psychology which describes knowledge in dynamic terms and can model knowledge structures. CT has been developed over the last twenty years or so by Gordon Pask working with a number of collaborators, including D. Kallikourdis and B.C.E. Scott. The theory in various forms is wide-ranging in application and somewhat difficult to follow in its most technical form. However, work with some of the concepts had been rewarding, since the possibility exists to examine the approach at different levels.

Examination of some of the literature, and several visits to System Research Ltd. to see demonstrations of equipment embodying the theory have led to the view that the approach is a serious source of helpful ideas and techniques. These have relevance to the interpersonal, interdepartmental problems of particular interest in this work. Most difficulties experienced seemed to arise from the esoteric system of symbols and diagrammatic representations employed to represent what many feel are strange, if not difficult ideas. One does not commonly find these representations employed in other fields, so that one must learn a system of representation as well as a system of ideas.

For introductions to Pask's work, the reader is referred to Daniel (1975a, 1975b) and Entwistle (1978). A detailed account of the theory and many of the experiments conducted in its development may be found in Pask (1975) and helpful overviews are available in several papers, including Pask (1979a,b). Some of the basic concepts are outlined below, and ways in which they may be applied to the practical situation at GE are identified.

8.2.1. Some generally applicable basic ideas

Pask's work grew out of some fairly standard work on learning problems related to the acquisition of keyboard skills. Attempts to investigate this area broke down when the methodology of behaviourist science was pushed too far. Pask's response was to develop his own theoretical framework and method.

The approach begins with a recognition of the impossibility of a science of human behaviour which predicates the possibility of studying social and/or psychological phenomena in isolation from (i) the social or psychological milieu in which they occur ; and (ii) the observer carrying out the "experiments" (this is consistent with the ideas developed in the first section of this work). The approach developed sets out to observe sharp, valued, or clearly identified psychological events, and not simple "behaviours" which may or may not be associated with particular psychological events. These sharp, valued events may be characterised as understandings so that a series of understandings constitute a conversation ; a conversation is a minimal situation in which a psychological observation may be made by an observer, although it should clearly be understood that many conversations take place in circumstances which make such observations impossible.

But what is it that is understood in a conversation ? In a conversation, information is exchanged between psychological individuals (systems of knowledge) who dialogue to generate an agreement over an understanding which links systems of concepts. However, a concept is not to be understood in the everyday sense of a static entity which one mentally picks up or puts down, but as a dynamic entity which comes about as an emergent property from the execution of procedures by a program in a computing medium ; procedures which not only generate the concepts but, where stable, feed back their elements to produce the procedures that produce them (i.e. organisational closure - see Chapter 4).

Pask makes a distinction between the entities, the procedures that are executed in a computing medium and the medium itself. An individual processor is a mechanically (M) characterised M-individual while the linked procedures executed in an M-individual are psychologically (P) characterised as P-individuals. Conversations as defined go on between or within P-individuals, the procedures of which are normally, although they may not always be, executed in a human brain. The brain is especially suited to this type of processing which often requires that different sizes and numbers of a priori independent processors be established at different times.

The conditions under which a conversation may be observed require that it takes place through an interface and be regulated by a Protologic (Lp) which the participants modify and agree to be bound by.

Concepts are modelled in the interface so that an entailment mesh (EM) is produced which may be rearranged, subject to the control of Lp to give perspectives within a topic domain, or to join domains by the generation of suitable analogies.

The most recent physical embodiment of Lp is a computer-based system called THOUGHTSTICKER (Pask, 1979b). Conversations take place through this facility and not with it. The models generated represent knowledge structures or belief systems. For the purpose of this study, the importance of CT and facilities such as THOUGHTSTICKER is their potential to model topic domains and the perspectives adopted within them by the actors within the GE debate. In the following sections, some of the details of the modelling techniques will be described, so that the more interesting features of the approach which have been mentioned only in abstract terms above, can be appreciated.

8.2.2. Topics, Nodes and Kernels

A topic may be what a particular conversation is about, or it may be the starting concept for a particular perspective. Within Pask's scheme, topics are represented graphically by nodes which represent (form models of) the concept denoted by the topic name. Systems of nodes represent systems of knowables or knowledge structures and form entailment meshes (EM) which may be modified by participants in the conversation. Entailment is what links nodes and represents the process that must be followed to get from one node to another. Thus, one can say that in the example in Figure 8.1 that the topics T, P and Q are related in such a way that if one knows P and Q, one can derive (entail) T.

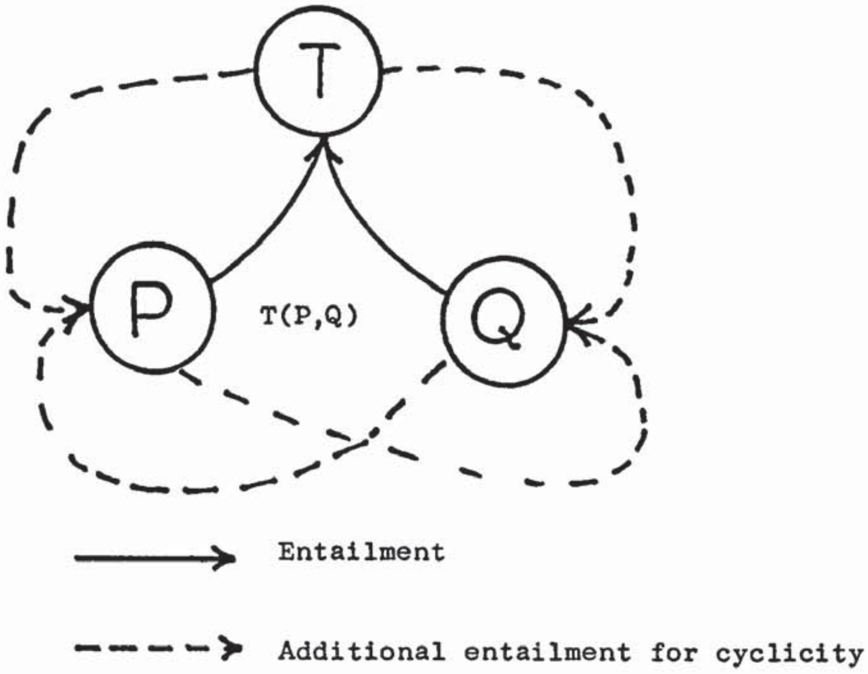


Figure 8.1.

Entailment and Cyclicity

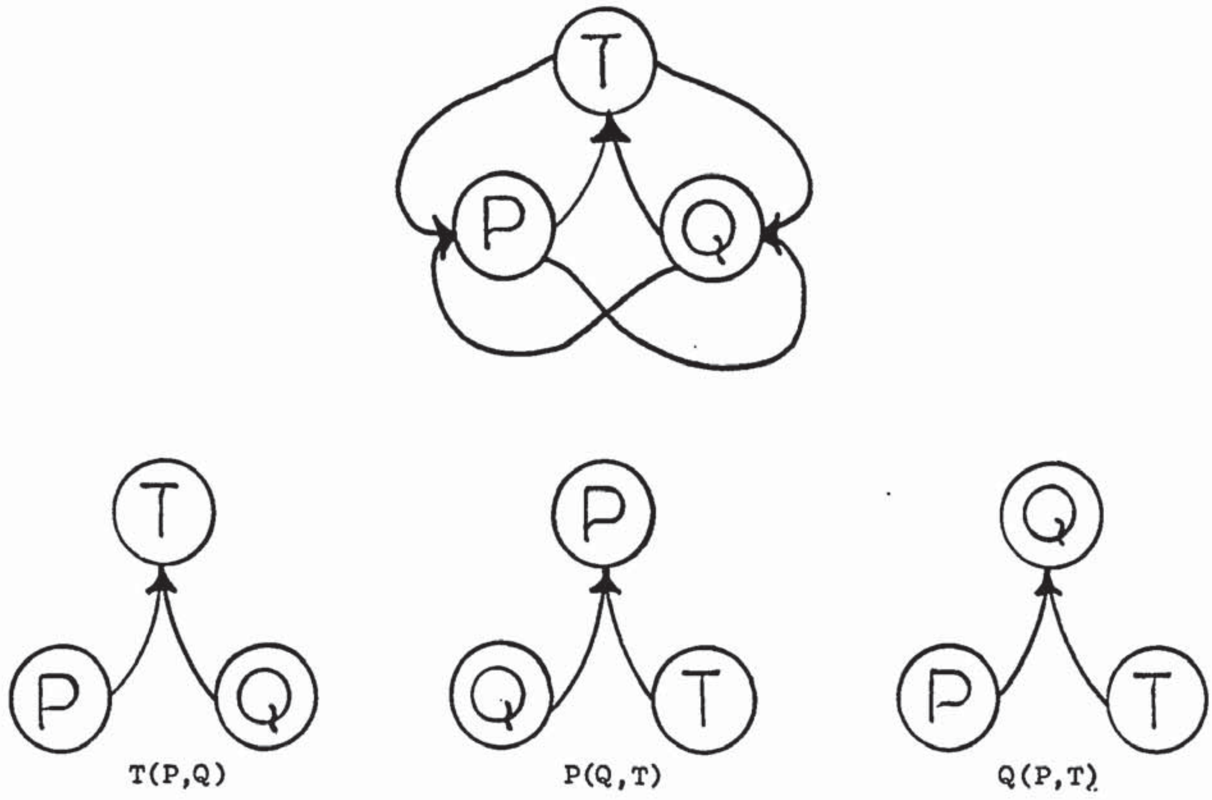


Figure 8.2.

Selective Pruning (Selprune) Against a Head Node

It also follows that if T(P,Q) holds, so does (Q(P,T), and one can generate any one from any two. It should be noted that this only applies where the topic is understood ; such a case is said to exhibit local cyclicity which is a necessary condition for a stable concept. Where a concept is not cyclic it is said to be primitive.

A set of three nodes exhibiting local cyclicity form a kernel which is the samllest stable unit within an entailment mesh, although a mesh may have many such units embodied within it. A mesh may grow by the addition of nodes or connections between nodes as a result of modification by a participant.

8.2.3. Pruning an Entailment Mesh

Individual EM's may be prescriptive as in a plan, or descriptive as in the representations of the principles of statistical inference : both do-ables and knowables may be represented in an EM. Meshes of useful proportions can become quite complex and will always have a head node to which all the others appear to relate in the form of a hierarchy. However, most of the EM will usually be made up of stable kernels and the complex of relations that follows from this makes it possible to prune a mesh to leave any node at the head ; the number of possible prunes is equal to the number of nodes in the mesh.

Now, it can arise that one has an area of thought, a system of ideas or a plan which one decides to record and explore through an EM, and it is likely that one is conscious of particular entailments but not others. An attractive feature of THOUGHTSTICKER is that a participant may record the entailments that are explicit to him and allow the Lp embodiment to insert the implicit relationships. However, this may generate a variety which is daunting or overwhelming which calls for a facility to select a portion of the mesh for consideration. This is not only important in exploring one's own ideas, but particularly vital where the participants are in the teacher/student or knower/ learner roles. There may be many paths to understanding of a particular node, and it is conventient for learners to be able to choose which to follow. The system of entailments specifies what (from a particular view, since a mesh will be your mesh, my mesh, or our mesh) must be known in order to understand what. THOUGHTSTICKER has the facility to select prune (selprune), which involves listing or displaying the set of sets of kernels that can all lead to the head node. An example of a simple mesh and its selprunes against the head node given (a particular perspective) is shown in Figure 8.2.

8.2.4. Analogy

So far, we have been discussing EM's which contain kernels of stable concepts which are linked to one another by straightforward entailment, thus, if I am to understand your mesh, I must have, or acquire an understanding of some of your concepts. However, not all possible relations between ideas are representable by simple entailment. If, for instance, none of my existing ideas are equivalent to yours, then without some other device, I could not possibly break into your mesh. But people with radically different ideas do commonly come to understand one another's views, and the device for this process is analogy. The importance of analogy in the process of discovery in science has been underlined in Chapter 2, and it is specially interesting that Pask, as well as Harre and Bhaskar, stress the role of this process.

Sets of nodes linked by entailment form a universe of understanding where the possession of understanding of some concepts, represented by nodes, can lead to others. The stable existence of such a universe means that all the concepts in that universe are defined, or are definable in terms of all the others (this is reminiscent of Liebnitz's monads (1689). Analogies have the function of joining universes, and Pask defines their nature and role precisely :

> "Here, and throughout, "analogy" has a specific meaning. It is a relation (if unqualified, an isomorphism) between part or all of one universe (x), and another universe (y) that are distinguished. Unless qualified, the distinction is complete, a priori independence.
>
> Both the distinction and the similarity exist in a further, analogical universe U...(and)..."agreement over an understanding", constructs an analogy between participants A and B. To the participants, an agreement has a coherence, or even consensual truth. To an outside observer, the statement "A and B agree" is factually true or false but is an analogy in which the observer distinguishes A and B as perspectives or people, and sees the content of their agreement as a similarity."
>
> Pask,1979b.

This conception of analogy is both precise and commensurate with the realist conception of the source of hypothetical mechanisms. In these terms, the source mechanisms are separate universes of discourse, the components of the mechanisms are seen as having logical or physical interdependence within the boundaries of the mechanisms as they are understood. Analogies build new mechanisms in an analogical universe which connects to the other universes in a controlled way. This control is established and maintained by the specification of (a) distinction(s) and (b) similarity(ies).

At first sight, this process might be taken as the simple linking of knowledge structures which is undoubtedly a valuable activity, since ultimately, it allows A's concepts to be understood in terms of B's. However, it should be clear by now that the mechanism of analogy not only links universes but also generates new ones and thus seems to be a completely adequate account of the generation of "new" knowledge, or new ways of looking at things. This process must then play a central role in the generation of any synthesis.

8.2.5. The practical aspects of CT

In the account given here, some aspects of CT have been described but the fine detail of the approach has been omitted for the sake of economy. In particular, Pask's system of representation for production systems, of which ideas are the products, is especially important. These must be understood to fully appreciate the claim that conversational systems are organisationally closed and informationally open. However, one of the attractions of this approach is that a deep understanding of the theory is not necessary in order to apply it usefully. In particular, if a THOUGHTSTICKER is available, the proto-language (Lp) embodiment of CT becomes transparent to the user so that participants are only aware of the concepts and understandings they are generating. In terms of the methodological framework developed in this thesis, this facility could generally be applied at a number of stages. The first possibility is at Stage 3, instead of "identify root definitions of relevant systems". This would be attempting to identify key perspectives on the symptoms listed in Stage 2. However, the value of this seems limited. The author would prefer to use the approach stated at the fourth stage.

Use at the fourth stage is particularly valuable for two reasons. Firstly, as stated in Chapter 4-5, adequate iconic models of problem situations often requires a mapping of actors' W's, and CT techniques can uncover those. Secondly, the THOUGHTSTICKER embodiment of Lp is essentially a modelling facility in which the conceptual models required by Stage 4 of the methodology can be constructed.

There would also seem to be possibilities in later stages of the methodology, particularly Stages 6 and 7 where political issues are often more intrusive, although the externalisation of W's in Stage 4 should go a long way towards minimising difficulties by making actors much more conscious of the background beliefs which motivate and guide the preferences and actions of others.

In the following chapter, some descriptions of different views of the George Ellison business are given in terms of the viable system model described in Chapter 4. These descriptions could have been given in a CT model, but of equal importance, this approach could also have been used to map the views of the Ellison business, present and future, as seen by key actors in the Ellison debates. Further, this could map actors views of one another, and one another's views, and thus provide a means for working out conflict. It is worth pointing out that this is a course of action that could/should still be considered because of its ability to perform a wide range of roles, i.e. anything that requires the representation of do-ables and knowables. An area that comes to mind is corporate planning, but anything which involves conflicting views, or the necessity to acquire a view would be a candidate. Job descriptions, organisation philosophy/style might just as easily be handed on in this form.

CT is a theory about the processes that support beliefs and how networks of beliefs or concepts are related to form knowledge structures. CT has a system of representation which allows belief networks to be modelled. It is clear from Part 1 of this thesis that W's are belief systems and it follows that they can be modelled with this technique. THOUGHTSTICKER is, therefore, an effective modelling facility for W's. As a result it may be very useful in OPS.

8.3. Personal Construct Theory

Personal Construct Theory (PCT) is centred on the writings of George Kelly, whose principal work was published in 1955. Kelly was working as a clinical psychologist and found the psychological theories of his day hopelessly inadequate to explain the human personality, most preferring to ignore it or reduce it to some convenient physical correlate. Kelly's conception starts with a philosophical stance, just as the Transcendental Realism discussed in Chapter 2 does. TR assumes the existence of a real world and goes on to ask "What must the world (and man) be like for science to be possible ?" PCT starts with the same basic assumption, but goes on to affirm that this reality is subject to "alternative constructions" by those who experience it. Kelly saw man as a scientist, an enquirer who is attempting to make sense of (or cope with) his environment. As with CT, these sets of ideas have developed differently at different times, and in response to different circimstances, and as such, stress different things. However, it is most striking that all these views are compatible, even where they are articulated in a different language, or via different sets of concepts. All three paradigms, research programmes, take a relativistic view of knowledge but manage to make the practice of science intelligible through the idea of a reality that can constrain man both physically and mentally. A man may see the world from one, or several points of view, which may radically differ in terms of what the world is taken to be. However, no man can seriously entertain <u>any</u> conception, construction he likes, since reality will not licence any construction. Through interaction with the world, a man is forced to reject <u>unworkable</u> views. The hypotheses associated with implausible views will fail their tests. Kelly crystalises his view in a fundamental postulate :

"A person's processes are psychologically channelised by the ways in which he anticipates events."

Kelly, 1955.

It will not go without notice that the flavour of these views is not dissimilar from Churchman's view of Weltanschauung, and this leads the author to view all these research programmes, for they have acquired the organisation which gives them the necessary social dynamism, as connected or connectable. One hesitates to claim a synthesis since one is doing no more than point out some connections, some analogies, but is there much more to synthesis than this ? These differing theories, systems of description, research programmes, seem to be differing paths which, as a set, seem to exhibit equifinality, though some effort must be made to generate the necessary analogies to allow one to move from Checkland's universe of discourse to Pask's, to Beer's, to Kelly's, etc. One might ask why it is necessary to make these linkages. The motivation here is to open up a theoretical coherence which will allow the widest possible range of knowledge and techniques to be made available to tackle the extremely difficult and complex problems of modern organisations. We have already seen something of the ideas of Checkland, Beer and Pask, and some of the details of Kelly will be described below. All of the research programmes are important since they are all of potential value in tackling the kinds of problems encountered in organisations such as George Ellison Ltd.

For a detailed account of Kelly's work, see Kelly, 1955, Bannister and Fransella, 1971 and Shaw, 1980a. What follows is no more than an outline, but it is hoped that some insight into the nature of the theory and its methods may be given.

8.3.1. Fundamentals

The fundamental postulate of construct theory is that "...a person's processes are psychologically channelised by the ways in which he anticipates events", and this is elaborated by means of eleven corollaries which may be grouped into the following categories (Johnson,1979):

a) the nature of constructs

b) how constructs develop and change

c) the construct system, and

d) the individual and other people's constructs.

In all of these groups, the term "construct"appears and it will be helpful to state simply that a construct is a discrimination on a bipolar axis so that :

> "A construct is like a reference axis, a basic dimension of appraisal, open, unverbalised, frequently unsymbolised and occasionally unsignified in any manner except by the elementary processes it governs. Behaviourally, it can be regarded as an open channel of movement, and the system of constructs provides each man with his own personal network of action pathways, serving both to limit his movements and to open up to him passages of freedom which otherwise would be psychologically non-existent."
>
> Kelly, 1969
> (quoted in Bannister and Fransella, 1977, p.3).

The nature of constructs is elaborated by the following corollaries:

1. The Dichotomy Corollary

"A person's construct system is composed of a finite number of dichotomous constructs."

2. The Range Corollary

"A construct is convenient for the anticipation of a finite range of events only."

3. The Choice Corollary

"A person chooses for himself that alternative in a dichotomised construct through which he anticipates the greater possibility for the elaboration of his system."

How constructs develop and change is elaborated by the following corollaries :

1. The Individuality Corollary

"Persons differ from each other in their construction of events."

2. The Construction Corollary

"A person anticipates events by construing their replications."

3. The Experience Corollary

"A person's construction system varies as he successively construes the replication of events."

4. The Modulation Corollary

"The variation in a person's construction system is limited by the permeability of the constructs within whose range of convenience the variations lie."

Details of the construct systems are elaborated by the following corollaries :

1. The Organisation Corollary

"Each person characteristically evolves, for his convenience in anticipating events, a construction system embracing ordinal relationships between constructs."

2. The Fragmentary Corollary

"A person may successively employ a variety of construction subsystems which are inferentially incompatible with each other."

The fourth category, the individual and others, is elaborated thus:

1. The Community Corollary

"To the extent that one person employs a construction of experience which is similar to that employed by another, his processes are psychologically similar to those of the other person."

2. The Sociality Corollary

"To the extent that one person construes the construction processes of another, he may play a role in a social process involving the other person."

It is interesting that the term "person" crops up so often in Kelly's views. His theory is reflexive and aims to generate understanding of human personality without reducing it to non-human terms. The importance of the category "person" is also recognised by Harre (1979) who identified repertory grid technique (discussed below) as a useful tool for exposing the fine structure of accounts of social action. For interesting discussions of models of man, see Shotter (1975) and Hollis (1977).

Although the corollaries given above require further discussion for an adequate account, it is hoped that the corollaries themselves will serve to illustrate the"flavour" of the approach. It is proposed to move on to discuss the technique associated with this approach since it is this that has the promise of being useful in the types of organisational problems existing within George Ellison Ltd.

6.3.2. Repertory Grid Technique

The Repertory Grid (Rep.grid) is the central tool of construct theory and is attractive within the context of this work because of its ability to map the construct/belief systems of actors in a way that makes them functionally equivalent to entailment meshes at a pragmatic level. A recent paper by Mildred Shaw (1980b) makes the parallel reasonably explicit by focussing on "entailment". Once again, no attempt will be made to treat Rep.grid technique exhaustively, but the "mechanics" of the technique are sufficiently different from conversation theory to warrant some description.

Considered in its simplest terms, a grid is an X x Y matrix in which the columns represent elements to which the reference axes, a set of constructs, are applied. These elements may be a set of people, roles, things, etc., about which people (those to whom the grid "belongs") think, and for whom the constructs (dimensions) are categories which the subject applies in varying degrees to the elements.

The constructs are represented on the rows of the matrix so that the subject may locate each element on each construct by assigning a number on a uniform scale which is held constant for the grid. The range of scale is chosen for convenience, to give the degree of resolution required by the subject. Each construct is a bi-polar distinction which the subject locates by the point chosen on a scale.

The constructs represented by the rowa of the matrix are not an arbitrary set but are (usually) elicited from the subject in a way that ties the constructs to the elements. The subject says which constructs are relevant to a given set of elements by disclosing which constructs are required to discriminate between elements. This is usually achieved by presenting the subject with triads or diads of elements and eliciting the basis on which elements are "seen" to be different and similar.

Within a construct system, some constructs will be of a higher order of abstraction which leads to the idea of super and subordinate constructs. Hinkle (1965) gives a method of laddering to bring out this structure, which involves repeated requests for explanation of the subjects preferences for particular poles of the construct elicited.

Some techniques have been developed which do not involve elicited constructs but provide a grid on which the subject simply scores. Bieri (1965) has used such a method in an attempt to measure cognitive complexity. In some cases, unipolar constructs have been used, but most researchers seem to recognise the importance of using bipolar constructs.

A considerable number of techniques exist for anaysing both the content and structure of grids. These are well summarised in Johnson (1979) and a useful account, with details of the more useful computer programs available for this analysis can be found in Shaw (1980a).

Once again it should be stressed that the value of these techniques lies in their ability to build models which aid the problem handling process. Viable system modelling may be extremely valuable in providing explanations in the form of iconic models (Molloy and Best, 1980) of social aggregates, thus helping one to understand the macro implications of interdepartmental, interdivisional problems ; but it seems clear that when it comes to the level of the individual, or into individual problems, although viable system modelling would justifiably claim to be able to say something useful, techniques such as Kelly's and Pask's work, at a level of detail, and in dimensions which cannot be matched in variety terms by viable system modelling in its present state of development. However, all of these techniques can be used in a complementary way, so that adequate icons may be generated. This may easily "fit" into a general methodology such as Checkland's in a way that strengthens it (Molloy and Best, 1980). The potential is very much the same as that described for CT in 6.2.5. above.

8.4. Other Relevant Approaches

The discussion in this chapter has been considering approaches that might usefully bolster the modelling stage of methodologies such as Checkland's, and generally form the basis of a different and more useful IHD project within George Ellison Ltd. The theories of Pask and Kelly do not, however, exhaust the possibilities. In this final section, two further approaches will briefly be considered, namely : the cognitive mapping adopted by Eden et al. and the game theoretic approach of Dando et al.

8.4.1. Cognitive Mapping

A brief mention was made in Chapter 2 of the work of Colin Eden and his colleagues at Bath. They have been principally concerned with developing methods to make the role of consultant to managers in organisations effective (Eden and Sims, 1979). This work is firmly based in the Kellyan paradigm, and considerable use has been made of the kinds of repertory grid technique discussed in Section 6.3.2. However, recent difficulties with this have led to the adoption of a different modelling technique, although confidence in Kelly's ideas, as a philosophical position, remains.

Difficulties with Rep,grid technique centre upon a variety-handling problem. One can imagine that grids which have a large number of elements and constructs can become difficult to handle, both in terms of elicitation and analysis. Certainly, the researchers at Bath have found this to be so. (Discussion with Colin Eden, 2 June 1980). This is only a problem where one wants to handle such large grids, and it would seem that the complex problems of management have led the Bath people to a need for a facility which can handle this magnitude of variety.

The alternative technique is based upon ideas by Holsti (1976) and Wrightson (1976) about the operational coding of data that can be used to generate cognitive maps of the sort described by Axelrod (1976). These methods are described fully in Eden et al. (1980).

The mapping process sets out to "capture the interplay of beliefs which the client has about his world", although it is recognised that the process is essentially negotiative between client and consultant, and as such, will not reflect the client's beliefs exclusively. The important thing is that the client accepts the outcome as a valid representation of the problematic issues as he sees them.

The "maps" are represented in the form of a graph, with a modified code to accommodate bipolar relationships, beliefs about causality and beliefs about historical relationships. However, for the purpose of analysis, these graphs are coded in nxn matrices where n = the number of concepts (equivalent to nodes) in the graph, which gives a convenient form for computer handling. Matrices can be easily manipulated, compared or combined by computer software. Techniques have been developed to achieve path analysis and loop analysis. A suitable program enables a client to interact with a computer using COPE (COgnitive Policy Evaluation). The system allows a client to record his own beliefs about the state of the world at a given time, and explore explanations in the form of "mentally simulated history", and consequences in the form of "mentally simulated future". The software also enables the client to obtain the answer to the following question :

"What meaning and significance will the following event have for me, and what processes of understanding the world do I bring to bear to enable me to construe the event in a particular way ?"

Eden et al., 1980, p.83.

It should be noted that beliefs are conceptually distinguished between those which represent preferred (or not preferred) outcomes and those to which no such value is attached. The former (values) are further subdivided hierarchically into Goals, Objectives and Ideals (Ackoff, 1979a, 1979b). Finally, the software enables the client to classify concepts (beliefs) according to the value system they happen to have.

It should now be clear that the description of a Weltanschauung that was given in Chapter 3 relates very closely to the conception of beliefs and values described here. This underlines the possibilities such approaches have to explore W's and thereby bring about a sharable explanation (iconic model) of why people see some part of the world (past, present, future) the way they do.

8.4.2. Game Theoretic Approaches

Many researchers have found it useful to construe social situations as games in which players are seen to have sets of options which combine to cause/produce outcomes. As with the cognitive mapping of the previous section, simple games are usually represented in matrix form with two dimensions to represent each of the sets of options for each player, with the outcomes of all possible options entered in the cells of the matrix. For the most part, this type of analysis has been used as an experimental tool since the nature of the games is manifestly unrealistic, even if they have some properties which are isomorphic with real world situations.

Some approaches, however, attempt to use a game theoretic analysis in a way that claims to be both realistic and applicable in the kinds of problematiques that are typical of social organisations. One is thinking here of those approaches known as metagames, or the analysis of options, and hypergames. Characteristically, these approaches become relevant where differences of opinion exist about what courses of action should be taken, i.e. what decisions should be made, and there is a distribution of power such that none of the recognisable parties enjoys autonomy in decision-making over the disputed issue.

The Metagame concept is due to Nigel Howard (1971, 1975). It is based on the model of decision-making described by Radford (1977, p. 188) and shown in simplified form in Figure 8.3.

Players and sets of players (coalitions) are assumed to exhibit the properties necessary to consider them as negotiating points in a network of meta games which may be individually analysed according to a given methodology. In effect, each "individual" is a power centre which may influence and be influenced by other centres. Where interaction takes place, each centre may have its own Technical and Strategic analysis, but share Interaction with one through to all other centres.

The method employed relates specifically to strategic analysis since techniques of technical analysis are held to be already well-developed (the optimising techniques); meta games uses the analysis of options to attack strategic analysis claiming that this area is neglected. The central idea is that in situations where two parties have power over options which are of concern to the other party, the pursuit of optimal "solutions" often leads to a worse case condition where each party "gets" the option combination they least like, while the pursuit of sub-optimal solutions may lead to stable solutions (compromises that can be effectively policed and maintained) in which everybody is better off with nobody being worse off.

The method involves identifying significant other players, examining possible scenarios, selecting a particular scenario and possible coalition, finding all unilateral improvements and all possible sanctions. In the final analysis, a particular scenario is

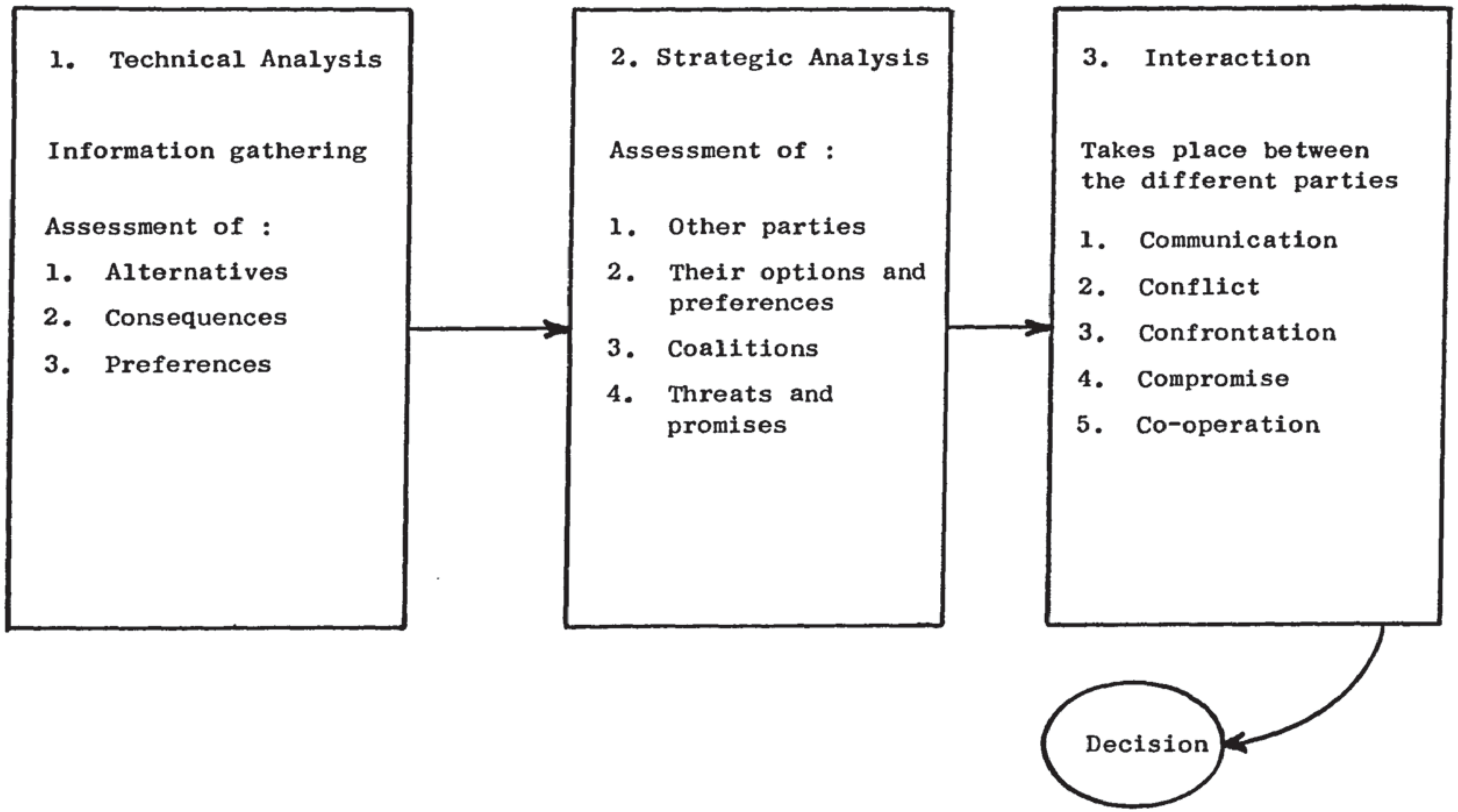


Figure 8.3.

A Linear Representation of the Decision Process is stable and therefore sellable in a coalition if any unilateral improvement is deterable.by suitable sanctions. At a meta rational level, players should see that they are better off with a stable compromise than with an attempt to achieve the optimal when the other party can veto it with impunity. For a highly simplified case to which this type of analysis can be applied, see Molloy and Watt (1980) and for analysis of that case, see Howard (1980).

If this approach is to be criticised, it seems that one might object that the necessity to identify all options and all unilateral improvements and sanctions for all players might generate a variety handling problem. Also, players are conceived to have different options, but not different models of each other's options. In addition, players are assumed to be meta optimisers but they may not be. This approach may be realistic in many respects, but as we have seen, the existence of different observations of the same phenomenon (significant others, etc.) is a central problem in social organisations, so that the shared model assumption is also questionable.

A game theoretic approach which does not assume a shared model of options and preferences is Hypergames :

"The important point to be borne in mind throughout is that in game theory it is assumed that all the players have the same perception of the situation (they see the same game). It is this assumption that is dropped in Hypergame analysis."

Bennett, 1978a.

The procedure of construction is similar to the analysis of options mentioned above except that options are termed "strategies" in this approach. Thus the general procedure is to identify players and strategies, but the players preferences are also "estimated" and ranked. This latter point also makes a departure from the Metagame approach since, although scenarios are sorted into preferred and not preferred (Howard, 1980) - a binary categorisation - the analysis of options does not overtly list preferences in a ranked order.

As before, the method looks for stable solutions, the set of which are said to form the "axis" (acceptable solution) :

> "For an outcome to be in the axis of the hypergames, no player must perceive himself to have an undeterrable improvement from it."
>
> Bennett et al., 1980.

Clearly, the notion of stability here is not significantly different from the analysis of options. The important thing here is that :

> "Since hypergames are intended to deal with situations in which the players may have different views of what is going on, we no longer suppose that the players are correctly informed of each other's strategies and preferences. Rather, each has his own perspective : any move made by one will be interpreted by the others within the context of their own perceptual systems. The hypergame approach towards analysing cases of this order of complexity is to use not a single game, but a linked set of games, one for each player."
>
> Bennett, 1978a.

This makes hypergames compatible with the general stance of the author since the significance of different points of view, perspectives or Weltanschauungen is taken to be of fundamental importance.

It is intriguing that these hypergame models actually constitute sentential models of the players' observations of themselves and other players. The models are essentially black box in nature ; possible inputs are identified (strategies) and the resulting outcome is indicated, in this case by an entry in the appropriate matrix location. The transformation function is, of course, implicit, and no clue as to the mechanism involved is given or sought. However, it is equally intriguing that such models become iconic when we take a hypergame in the overall sense, because although these models do not in themselves explain why people behave the way they do (this does not exclude the possibility that a user of this technique may have other (iconic) explanations of this), they do explain why the pattern of interaction (play) is as it is because the individual's view of the situation may legitimately be said to be logically at a level below the interaction taking place. It is in a real sense casually antecedent to it.

No useful purpose would be served here if one were to describe the methodology of hypergames in detail. The reader is referred to Bennett (1977, 1978a, 1978b) and Bennett and Huxham (1981) for explanations of the approach and its techniques ; and to Bennett et al. (1980) for a particularly interesting case dealing with the dynamics of soccer hooliganism. Enough has been said to illustrate some of the more interesting features, and to point to links (analogies) with the other approaches discussed in this work.

8.5. Discussion

In Chapter 2 we have seen that the problems of social organisations require a methodology that transcends the method of normal "closed" science. Checkland's approach was identified as an approach to these sorts of problems that had a philosophy that was realistic in the light of the realities of human perception and organisational complexity. Every approach begins somewhere (philosophically speaking) and the cornerstone of the reasoning in this thesis has been the philosophy of science exemplified by the work of Harre and Bhaskar, and this has led to a recognition that Checkland's methodology as described in

Checkland's work does not stress sufficiently the need to generate models with explanatory as well as descriptive power. The viable system model such as that of Beer was outlined as an example of an approach that was attractive in this respect. However, difficulties with Beer's work have led the author to work towards a "new" form of viable system model, and this was described in Chapter 4.

The extreme difficulties of the research situations have been related in some detail in Chapters 6 and 7, and the author feels that the combination of techniques and approaches discussed in Chapter 3, 4 and 5 would have constitutes a viable approach if the author had some knowledge of them before the difficulties arose, rather than after. However, one's knowledge of these approaches is, to a degree, accidental, being contingent upon the interests of those supplying advice and recommending literature. Also, it would be an act of great arrogance to suppose that there is only one right approach to the sorts of difficuties discussed in this work. It seems perfectly reasonable to suppose that techniques not overtly using Checkland's approach or viable system modelling might have been equally effective, given that they have certain minimum characteristics.

It is this realisation that has prompted the outlines in this chapter. Pask's conversation theory or the kind of Kellyan approaches described may be perfectly adequate in themselves and all the views discussed may be just as good as viable system modelling at generating iconic models of the difficult aspects of social systems.

A great deal has been said throughout this work about Weltanschauung and these approaches do vary in the degree to which they recognise the existence of differing W's, and the different realities they imply for their users. Viable system modelling is often taken to be modelling the objective reality, the invariance in nature, and while it does provide a functional analogy between many structural forms, it cannot provide accounts of reality that are independent from the modellers. This is indeed apparent to the author in the varying interpretations, in viable system terms, one gets from the "same" organisation with different analysts, and this often manifests in disputes about whether a particular department is a division or not.

The conceptual systems of Pask and Kelly seem freer in terms of what they impose upon the world, but one could not say that they are better or worse for that. The meta game approach, however, seems too restrictive since it assumes for the purpose of the game, that the players share the same W. The Hypergame approach seems attractive, insofar as it sets out to investigate all the detectable W's that are relevant to the problematique, although it seems, but not exclusively, strongly, more sentential in character. It also seems to retain the view of player as otpimiser.

Metagame analysis stresses the value of having this analysis carried out, even where it is done by only one side.. However, hypergames having stressed the differing perceptions, attempt to map the games "seen" by the significant players. This seems workable in some situations such as the soccer hooliganism case, but in many organisational contexts, the need for the analysts to work with the "conflicting parties" must present severe difficulties with trust being difficult to maintain. In short, the problem is, how does the analyst working in the hothouse of organisational politics avoid being categorised as one of the players himself ?

THOUGHTSTICKER is attractive because when it is employed, the theory is transparent to the players. An analyst need only be involved in setting up the interaction, but not necessarily in the interaction itself.

In examining the range of supplementary approaches discussed in this chapter, one has, in effect, been examining some different but compatible Welanschauungen. In exactly the same way that "formal systems concept" and "other systems thinking" must be shown within the central W of the methodology, so must these if one claims them to be useful in the framework. This is illustrated in Figure 8.4.

The supplementary W's are shown feeding into "conceptual modelling" since any of these techniques can make a contribution to this process. What is not shown, and what must be stressed is that these approaches may also make contributions at other stages, as discussed above. One is reluctant to specify exactly which stage would be involved since one feels that this is properly a function of the W employing any of the techniques. On the one hand, one may use all the techniques or only one, or indeed, a modelling or analysis system not dealt with here. The important thing is to recognise both the multiplicity of W's that may be involved in the problem situation, and the multiplicity of W's that are becoming available as a resource to be employed in the problem handling process.

In the next chapter, it is intended to examine just a few of the W's involved in the Ellison situation. Some views of the organisation are probed to try to give insight into the background thinking behind many of the situations described in Chapter 7. Viable system

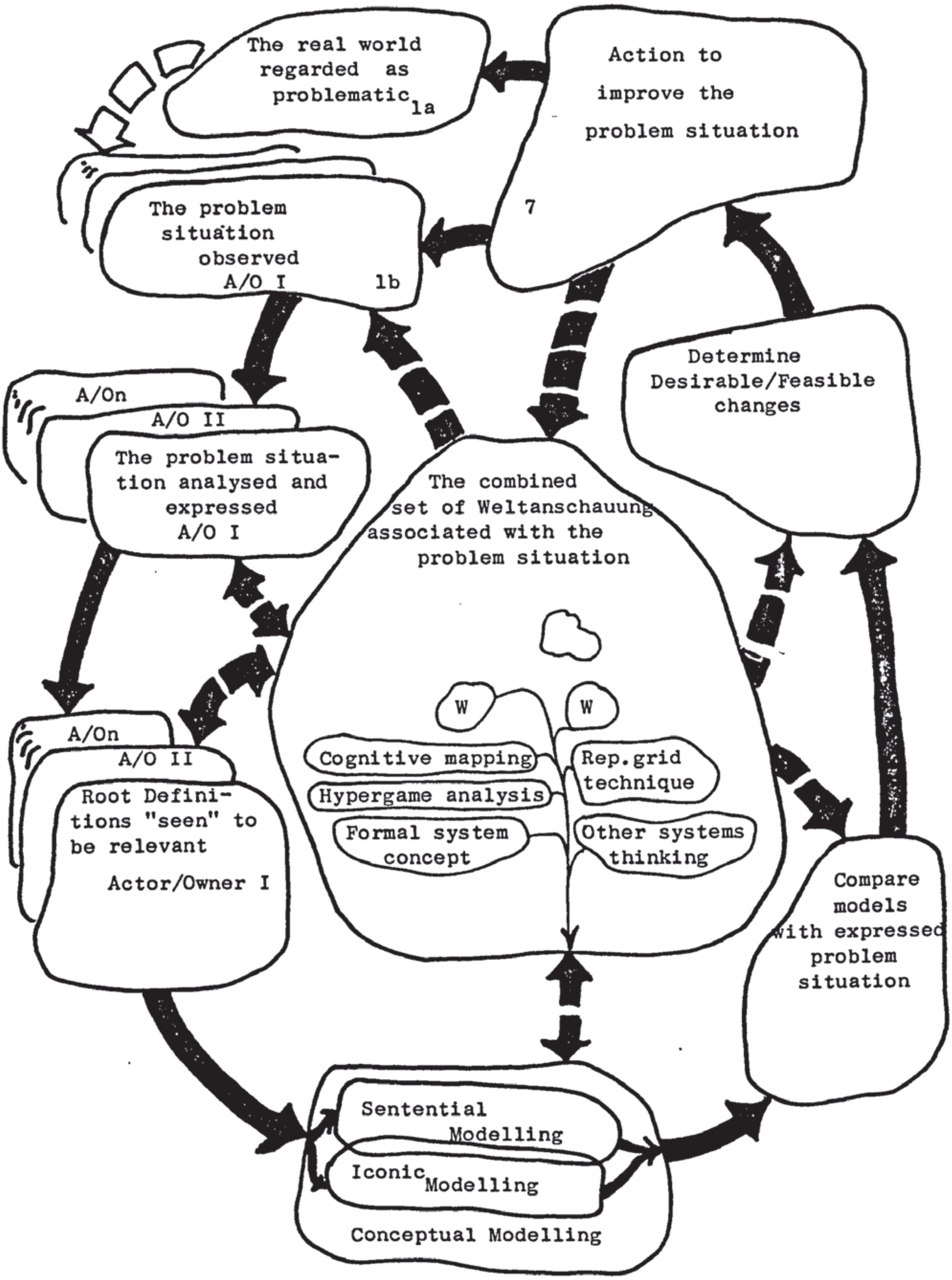


Figure 8.4.

Open Systems Methodology with Supplementary W's modelling is employed for the most part, but it is stressed that almost any of the techniques outlined here would be useful. Together, these techniques represent a battery of approaches which might, in varying degrees, be usefully employed within the context of the more difficult organisational problems.

Chapter 9

The Weltanschauungen of the Problem Situation

9.1. Introduction

The previous chapter was concerned to identify methodological W's that may usefully be considered for application to complex and difficult organisational problems. By contrast this chapter will return to a discussion of the problem situation which prompted the theoretical content of this thesis, but W's remain a central concern. In this case, one will be attempting to illuminate some of the W's that helped to make the situation difficult for everyone concerned. This represents insights which were either not available or difficult to articulate at the time, but which may be uncovered with more facility now that the role of W's is more appreciated, and suitable modelling techniques have been identified.

In Chapter 7, the discussion covered particular issues which were regarded as problematic by the author. It is felt that many of the conflicts inherent in these situations stemmed from dramatically different views of what the organisation was and what it might be. No pretence is made that these accounts are comprehensive or indeed adequate from any other perspective, but they do give a hint of the underlying differences of view which must have played a substantial role in guiding the different aspirations and perspectives which existed (and perhaps still exist) within the organisation. The early part of this chapter will describe the company as it appeared to the author. The later discussion will develop an account of different views.

The organismic modelling discussed in Chapter 4 is used along with root definitions in an attempt to capture these characterisations of the perspectives involved. These approaches have been shown to be compatible in Chapters 3, 4 and 5 through the unifying perspective expressed by Transcendental Realism described in Chapter 2.

The strategy adopted here will be to use these approaches to describe models of the organisation as it was at the beginning of the project, as it was after the 1977 crash, and as it might be. Viewed in this way, these models represent both stages in the development of the organisation, and differences between the aspirations of key members/ groups within it. It is unavoidable that these models represent the author's view of the past, and the author's view of other people's view of the future.

9.2. An Overview of some Impressions of George Ellison Ltd.

At this point, it is helpful to examine some of the different views of GE at a shallow level in order that the reader may have some appreciation of all the perspectives before considering any one in detail. This will be done using a simplified and static representation of the recursive levels of the viable systems identified by each perspective. Four views of the company will be outlined in this way. This technique does not, in itself, describe W's but shows something of the differing concerns that differing W's lead actors to have. When the four views have been described in static form, they will be revisited for more detailed examination using a more complex form of viable system modelling in the next section. The first of these static representations depicts the functional structure as it existed in 1975, and this remained, with minor changes, until the 1977 crash. (See Figure 7.1)

From a descriptive point of view, the disposition of subsystems is fairly simple. At the broadest level, the organisation's activities were split between manufacturing and selling. An interesting feature of the company at this time was the fact that the Sales Office controlled such things as the Drawing Office (DO) and the Bill of Material Department. One might expect that the Drawing Office would be considered as an engineering function, but in this company, most of the work carried out by the DO is related to customers' orders. However, the DO did loan draughtsmen to Engineering to execute development work on new products. The general arrangement shown reflects the importance placed upon customer relations by past owner-managers, particularly George Ellison (the Chief) himself.

The next static representation is of the company after the '77 crash, and the installation of the "new" MD, Mr. BH. He had spent many years in the switchgear industry, but his Weltanschauung was somewhat different from that of the existing Ellison management. These differences were eventually manifest in changes in management structure, and although the hierarchy of accountability is not the sole determinant of viable system structure, some changes inevitably have consequences in this domain. The general disposition of subsystems at this stage is shown in Figure 9.2.

The most notable change in this period was the recognition and elevation of Engineering which acquired control of the testing and standards section of the manufacturing division. This control was functional in the sense of controlling work activities. The labour

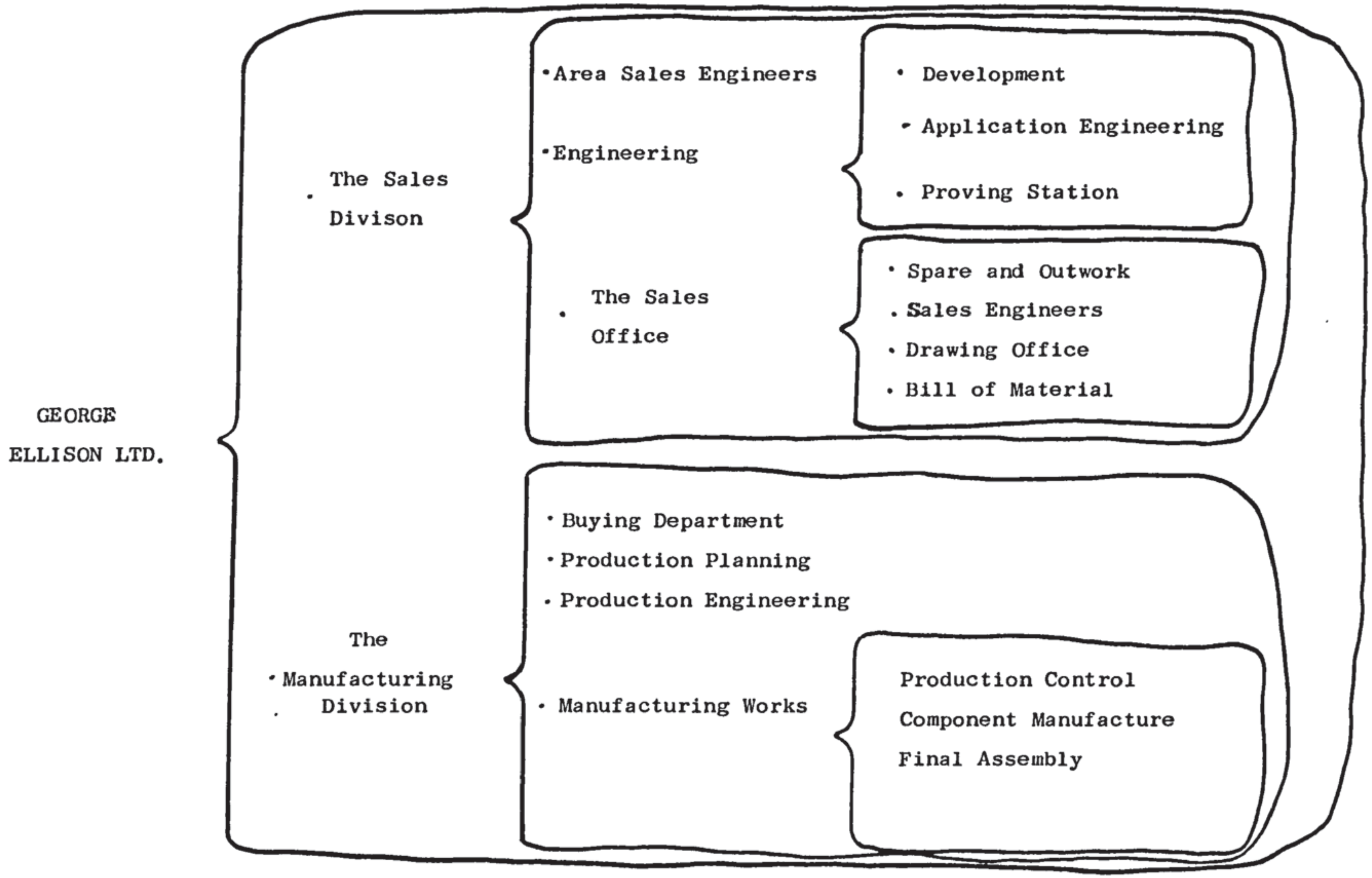


Figure 9.1.

The Functional Structure of George Ellison Ltd in 1975

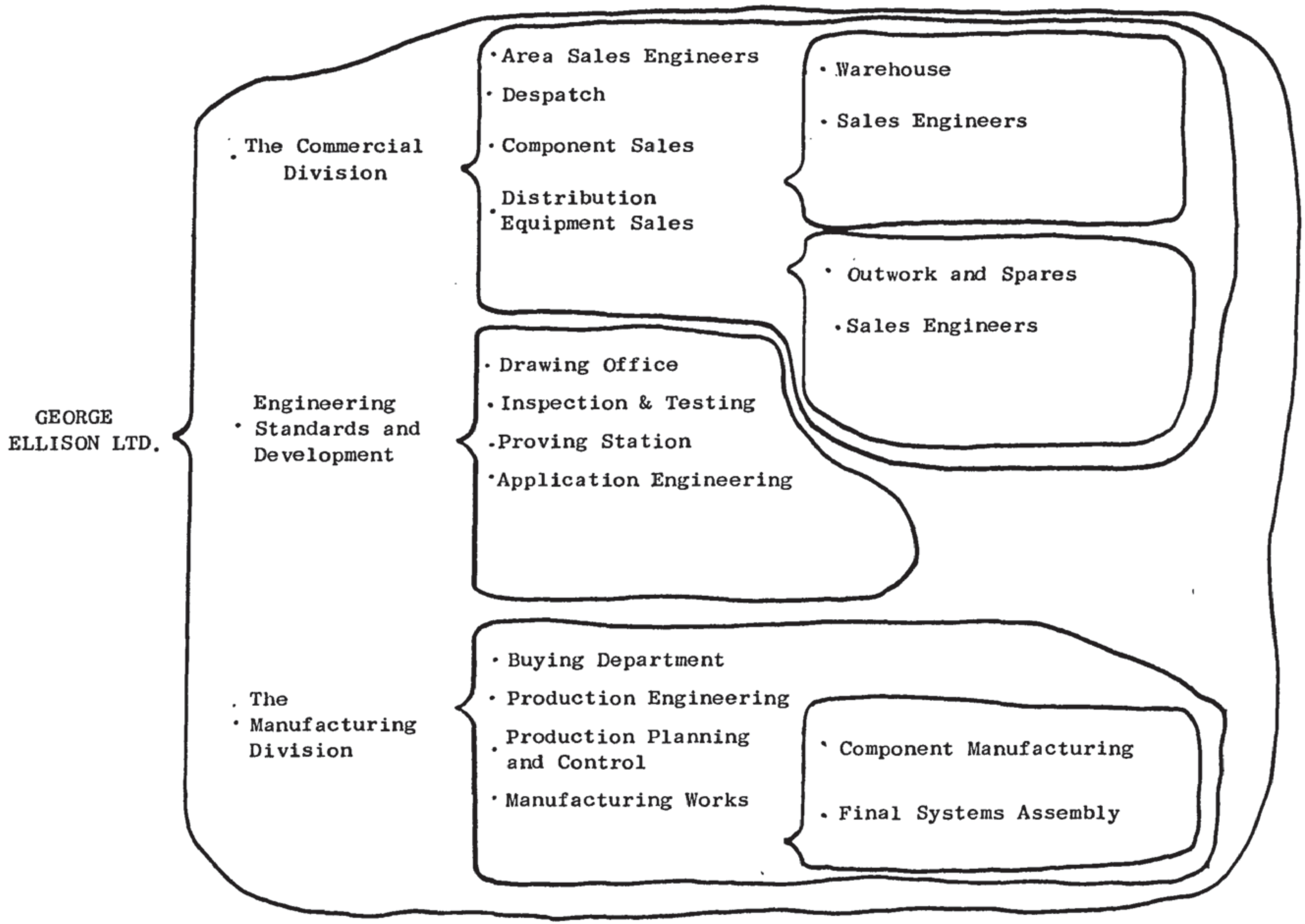


Figure 9.2.

The Functional Structure after the 1977 Financial Crash was predominantly "blue collar" and as such, remained under the jurisdiction of the works management for disciplinary purposes.

Manufacturing also grew in stature, and this was reflected by the fact that the MD continued to manage the division directly (this had been a feature of the interim management prior to, and after the crash). Eventually, a manufacturing manager was installed by the MD. He, like the DP manager, was a past employee of the MD's at another organisation. The ability of this manager to act independently was doubted by most managers, so that the MD, in effect, ran the division as before with the manufacturing manager as a link man. Eventually, this position became untenable from the industrial relations viewpoint, and the manufacturing manager left.

Another difference that is worth some comment is the division of sales into distribution and components. This did not arise as a matter of policy initiated by the new MD, but was a manifestation of a policy pursued by the previous management to broaden the product base of the company by capitalising upon the company's special applications expertise, and expanding into factored products in complementary areas where GE was unable to develop/manufacture economically. Although this was the result of deliberate policy, this policy was not pursued with a whole heart. For comment on this issue, see Appendix D.

The final set of views/models is essentially about the future and how the company might develop and exploit a changing environment if, and only if, some consensus could be reached, or a particular view emerged in conjunction with the power to determine the appropriate goals, and inspired the appropriate implementation functions to pursue them. Before discussing these views/models, it is necessary to make a few explanatory comments about the changes in the switchgear market.

The market has become a difficult and changing environment due to increased international competition and the decline of cushioning factors such as the colonial possessions, and the abilities of British engineers to dictate engineering standards. The move towards cheaper standards in the home market has favoured continental manufacturers but has been particularly helpful to companies who have kept pace with technological developments such as moulded-case switching devices and light-weight air brake devices at higher voltages (11Kv - 13Kv). Much of the author's concern for marketing information systems stemmed from a belief in the need to monitor market developments. This implied a need to gain effective control of those GE systems (including the Area Engineers) responsible for effecting and reporting upon environmental changes.

Some managers believed that the structural changes in the environment "dictate" a change in the industry. Developments over the last 10-15 years seem to indicate that the market favours the very big or the relatively small manufacturer. These developments have resulted in a predominance of large manufacturers manufacturing components and application engineered equipment, and small operators concentrating on application engineered user requirements. The dramatic growth in the number of these small operators has effectively created a second market for those manufacturers large enough to be able to design and manufacture their own components by providing components for these small companies.

Differences in opinion about the future development of the organisation hinge on the degree of modification to the organisation that is felt to be required by these environmental developments. The need for some changes has been recognised to a degree, and is reflected in the establishment of separate selling functions for GE distribution equipment (assembled products) and components (manufactured and factored), so that the need to develop the components side of the business is at least an "espoused theory". The degree to which the organisation intends to rapidly convert this into a "theory in use" has been doubted, and is discussed in Appendix D.

Managers who support the development of this philosophy fall into two groups : the first focusses on the environment (market) and reacts to what is seen as a continuing trend of growth among panel-builders ("panel-bashers") ; the second group take either a manufacturing or accountancy viewpoint and declare that the business falls logically into two distinct types of activity requiring different skills and forms of organisation.

The logic of these ideas about components requires that the manufacturing operation be treated as separate operations with respective producing units being joined to the appropriate sales division. This type was favoured by the author whose suggested changes in product listings was guided by these ideas.

The static representation of this view of the future is given in Figure 9.3. and shows clearly the new grouping of divisions. The essential nature of the two main divisions in this new arrangement is captured in the following root definitions :

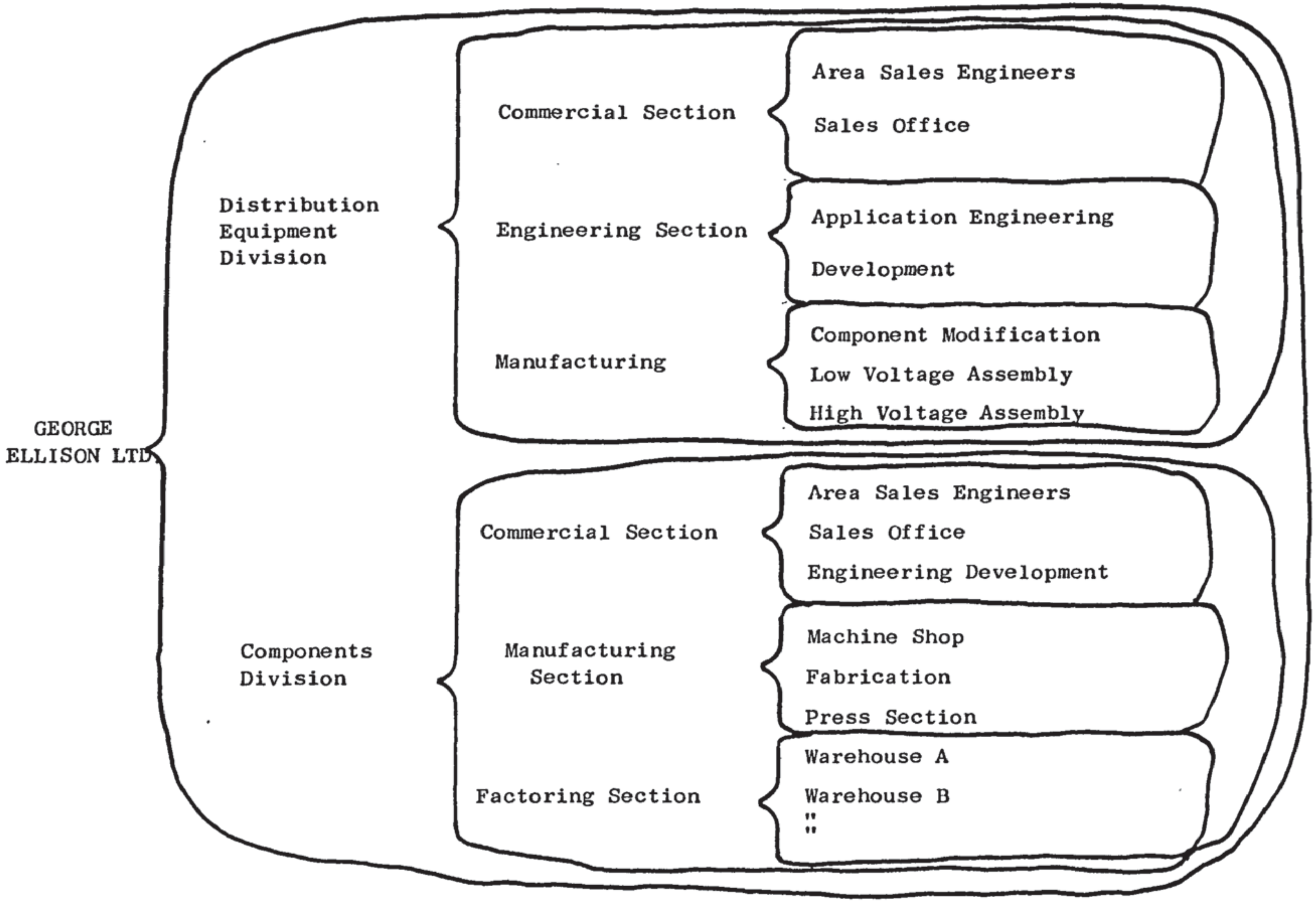


Figure 9.3.

The Logic of Separation Extended

The Components Division

A George Ellison subsystem to sell and supply suitable components, assemblies and devices to manufacturers (asemblers) of hardware systems principally in Electrical Engineering manufacture. This task is to be achieved by manufacturing or factoring with due consideration to economic factors.

Customers - Electrical Engineering Manufacturers

Actors - Implicit - members of the subsystem

Transformation - "supply","manufacturing or factoring"

Weltanschauung - It is assumed that other divisions would enjoy some priority as part of belonging to the same meta system, but consideration of economic factors would have to play a more central part. Behind this is the belief that the components activities are potentially more economically viable, and should be recognised as a business in its own right.

Owners - GE meta system

Environment - implicit - the meta system of "C"

The Distribution Division

A George Ellison subsystem to sell, assemble and supply medium voltage switchgear systems to the specific requirements of electrical users in commerce and industry ; by such means as will afford sufficient flexibility to ensure economic operation.

Customers - "Electrical men in commerce and industry

Actors - implicit - members of this system

Transformation - "sell, assemble and supply"

Weltanschauung - "By such means" implies a range of possibilities to achieve the flexibility which is assumed necessary to meet the growing competition from panel manufacturers. "Specific requirements" is assumed to range beyond the technical domain to include delivery, after-sales service, etc.

Owners - George Ellison

Environment - Commerce and industry - implicit - part-supply industries including GE components.

In this arrangement, the differing nature of the distribution and components business, including the differences in environment served by each, is fully recognised. It should be noted that if the beliefs about the direction of change in the switchgear environment are correct, the business will be forced to develop in this direction, or not survive. This is only one of a number of possible futures, but is worthy of description since s significant number of managers support the beliefs behind it, even if they might differ over the exact form the future organisation might take. A significant variation on this theme focusses on a particular area of expertise believed to exist within the organisation. This would build upon the application engineering knowledge and experience, and a division could be formed to sell electrical engineering problem solving. This would benefit the switchgear division, but would still be a viable consultancy, even when it found that it needed to recommend products of other companies. The arrangement is outlined in its static form in Figure 9.4.

A Root Definition for this additional consulting division might

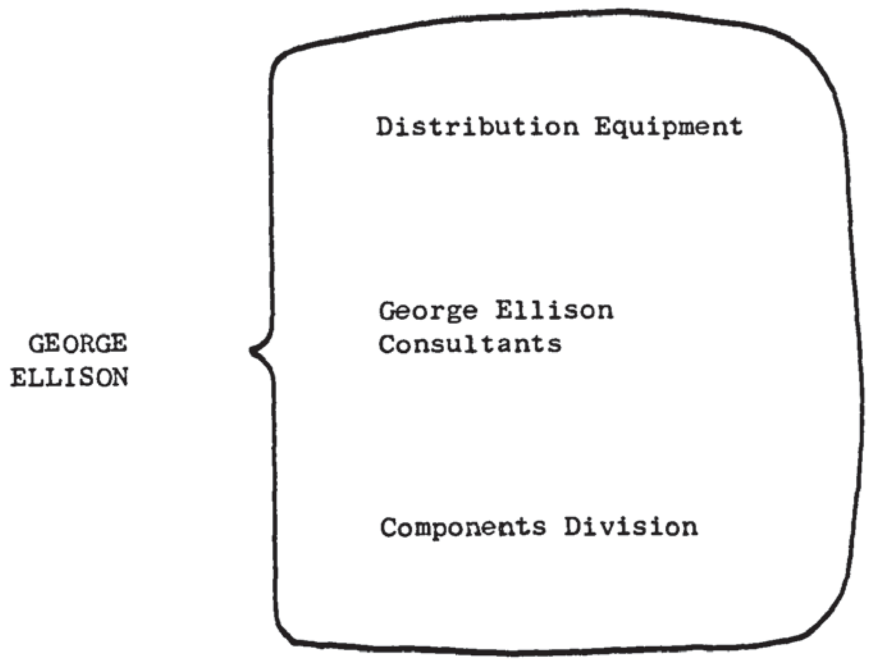


Figure 9.4.

An Organisational Structure for Flexibility be as follows :

A subsystem through which the collected application experience and expertise of George Ellison would be made commercially available to companies lacking the necessary skill and knowledge to identify and specify their switchgear needs.

CATWOE

Customers	-	"companies lacking the necessary skills and knowledge to identify and specify their switchgear needs"
Actors	-	those with the "collected...experience and expertise"
Transformation	-	to make "commercially available", to "identify and specify" switchgear accurately
Weltanschauung	-	It is assumed here that there are a substantial number of companies that would, in fact, pay commercial rates for such a service. The essential character of the service envisaged is "problem solving"
Owners	-	The George Ellison Meta System
Environment	-	implicit - the engineering industry and those who use the products of the electrical engineering industry.

These future organisations should be more flexible, if somewhat specialised in their activities. These specialisations already exist within the functional hierarchy. In these new forms of organisation the whole organisation would, where appropriate, be able to develop and exploit market opportunities. However,care must be taken not to over-prescribe future organisational forms. The important thing is that the company recognise the need to change and develop. This recognition carries a W which is more likely to seek and explore organisational forms that are appropriate for both the aspirations of the company and the environmental circumstances.

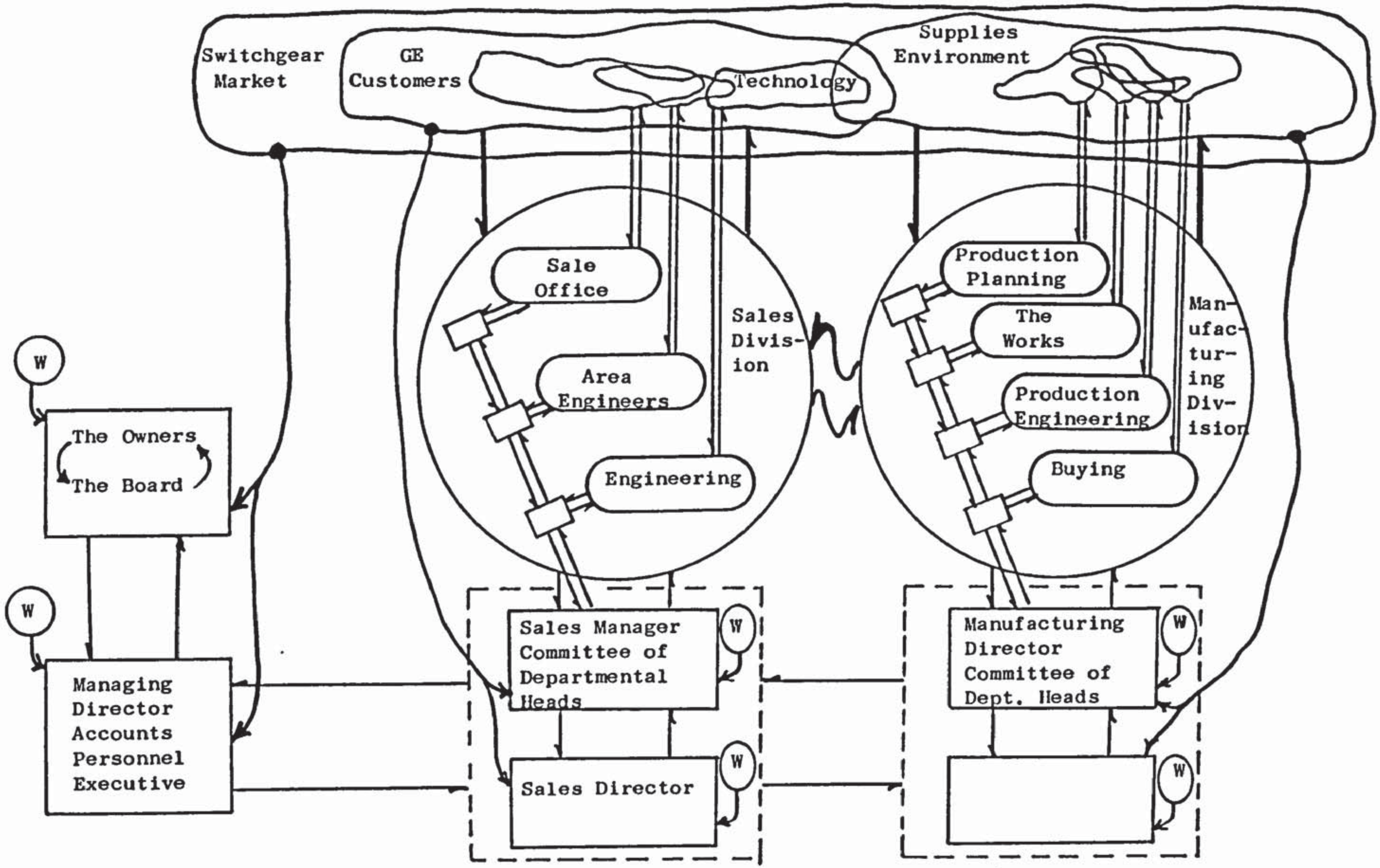
At this point, the introductory examination of various organisational forms is complete. It is now necessary to develop these organisational forms in more detail. This will be done using a more dynamic, diagrammatic representation in the sections below.

9.3. The Company in 1975/76

The arrangement of divisions within and between recursive levels in 1975/76 was substantially unchanged since the 1973 acquisition of the company. Static representation of these relationships was given in Figure 9.2. In this section a dynamic representation will be given using the viable system model reported in Chapter 4. The static representation indicates the pattern of recursive levels and this is reflected in the dynamic model in Figure 9.5.

Policy making at the meta level of this organisation was the responsibility of the board of directors. However, the internal structure of this policy function is particularly complex, mostly because the owners of the company are all active in executive roles, with seats on the Board. This did not prevent a clear statement of objectives through a corporate strategy document (see Appendix L).

At this stage, the dominant personality was the principal shareholder, Mr. PS, and he was in the meta control function as MD as well as the Policy function. The existence of different Weltanschauungen for the policy and control functions has been discussed in Chapter 4,



<u>Figure 9.5.</u>

<u>A Viable System Model of George Ellisons in 1975/76</u>

but it is interesting to note that the occupation of these meta functions by the same people must have had a tendency to make W's the same or similar, i.e. Shareholders $<$ Board of Directors $<$ Executive mangement. Indeed, it may be that there was little difference between the Weltanschauungen of the meta system of the whole company and the meta management of the sales division since the sales director was also a shareholder.

The situation would seem to have both advantages and disadvantages. Advantages might arise from having a clear vision of the future with a disposition of power to carry through the implied policies, and this can be particularly beneficial where the vision is a 'realistic' one. However, where the vision is unrealistic, or the deduced policies do not take account of the real organisational constraints, the concentration of power may easily lead to difficulties. This is a key factor in the mechanism leading to the 1977 crash.

However, differing W's did exist within the organisation. The manufacturing subsystem was strikingly different from the sales division which seemed to enjoy more empathy from the meta system. This difference was underlined by the existence of a manufacturing director who did not have a background in the industry, and whose outlook was at odds with many Ellison people of the time.

These differences may arise for natural reasons. At the lower levels of recursion, differences arise from being in regular contact with the customers and the market in general on the one hand, and being tied to the productive process on the other. The contrast is between an inward looking division and an outward looking division.

This is not to say that either one of these is "bad", only that the differences are natural when understood.

In operational terms, contracts were made with customers by the sales division committing GE supply goods or services at an agreed price and date of delivery. The goods were supplied from the sales division to the market in the literal sense, although this might, at first sight, seem counter-intuitive since the sales division does not "produce" switchgear. This interpretation is justified, despite the fact that the Despatch Department is physically integrated in the works, because this department is "controlled" functionally by the sales division, with the manager concerned reporting to the sales office manager. Functionally, the manufacturing division is a supplier to the sales division which subcontracts work. Each is a part of the other's environment, but their relationship is special because of their interdependence.

Viewed in this way, one can see that the flow of material is from the raw material suppliers to the manufacturing division. After work has been done, and value added, it moves to the sales division, and finally, it moves out to a different part of the general environment, to the customer environment and users. Although this flow may be viewed as the classic GE pattern, one must appreciate that the existence of the components activity makes for another path which does not involve manufacturing exclusively. Mitsubishi components, for instance, do not enter the manufacturing division except where they are incorporated into distribution equipment. In this way, the sales division is supplier to the manufacturing division, so that there is a loop between divisions. (See Figure 9.6.) Each division serves a different

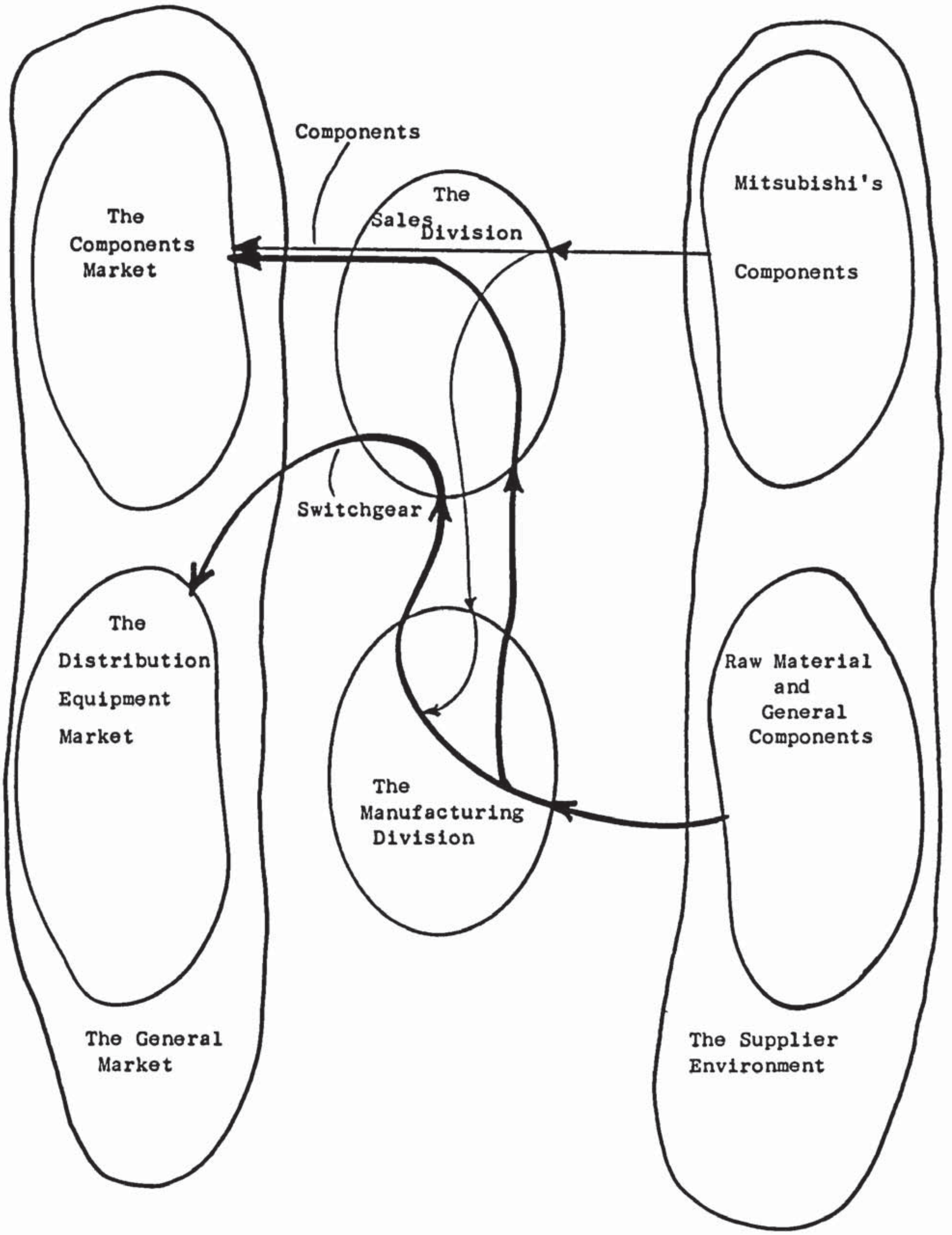


Figure 9.6.

The Flow of Material through GE

market. Each division, in effect, draws from two supplier environments, one from inside GE and one from outside.

These relationships are important because the organisation required for GE to operate successfully is dependent upon the flows that organisation must control. Further, the flows which are selected/ specified as determinants of organisation are themselves a function of the W from which they are specified. There is little more to be gained here from discussing these relationships further. In the next section, features of the organisation after the 1977 financial crisis will be described.

9.4. The Post-1977 Crisis Organisation

This section will amplify the description of GE given in Section 9.2. The general arrangement of divisions and recursive levels has been given in Figure 9.2, and this is elaborated in Figure 9.7. It is not possible to discuss these arrangements exhaustively, but some of the more interesting features are considered below.

The enhancement of the engineering division through the acquisition of Inspection, testing, and the drawing office and its movement to a "higher" level of recursion, supports the view that within the Weltanschauung of the new establishment, traditional attitudes towards the business tend to prevail. It is certainly true that the W's of the Chief Engineer and the new MD have many isomorphisms in the technical domain. From this enhanced position, engineering was well placed to control engineering development and standards, and substantially affect policy on engineering matters.

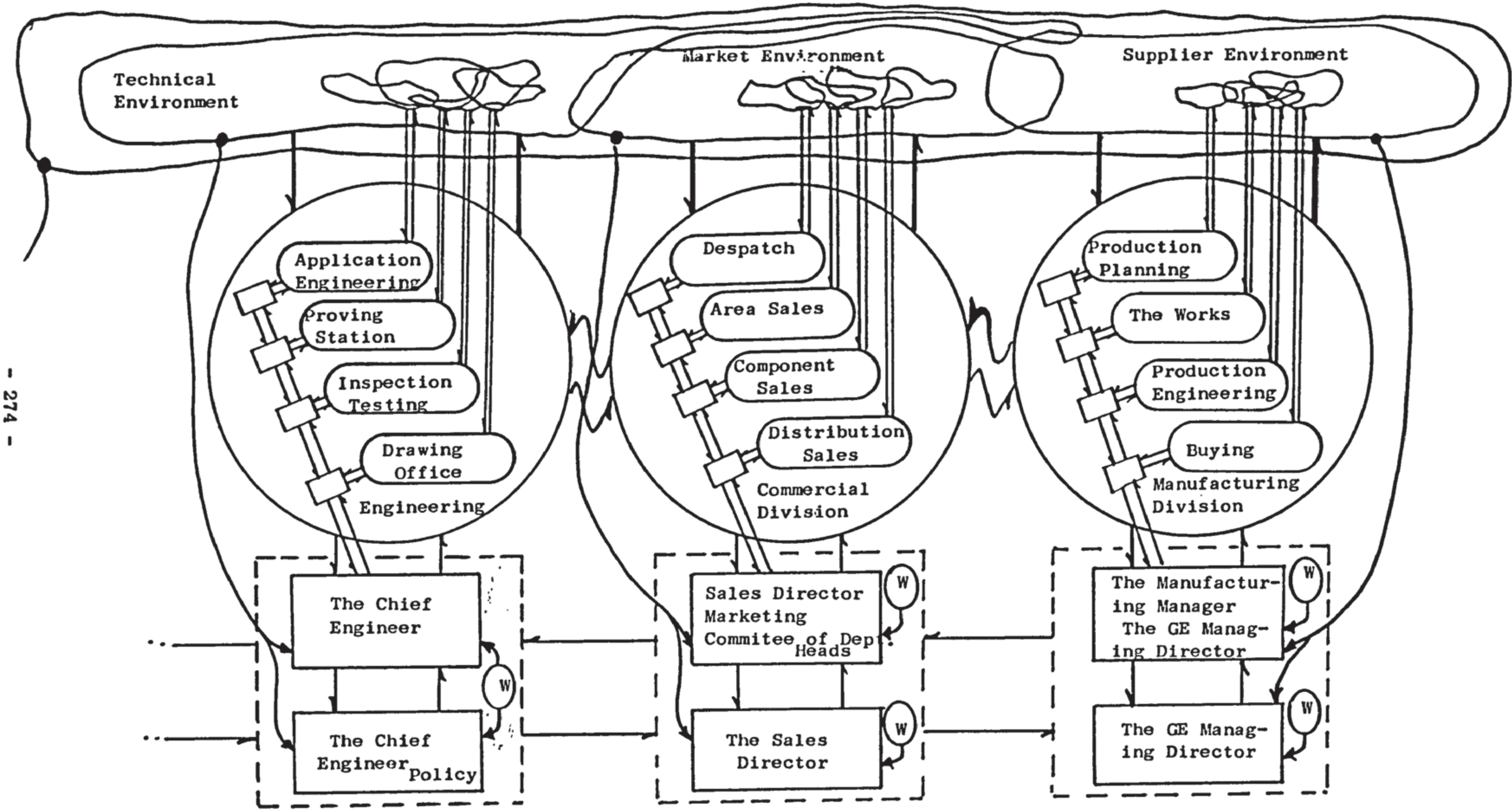


Figure 9.7.

Part of a Viable System Model of GE in 1977/78

An important area of responsibility for this division was/is the development of new products. An optimistic view is that this move reflects a recognition of the necessity to develop new products, and this certainly formed part of the espoused theory of all those concerned with this modification to the organisational structure. Possibilities of developing a new switch at high voltages were being considered ; this would be based on new vacuum technology supplied by Mitsubishi. However, to the author's knowledge, no substantially new development has since emerged from this section and further, no new development emerged during the whole of the author's involvement. The notable exception, of course, is the APE development which was the "big project" that precipitated the 1977 crash. This project was an attempt to upgrade an existing product which resulted in the company overstretching its available cash. Some of the details are recorded in Chapter 7.

As mentioned in Section 9.2., an important development by this stage was the specialisation of the sales office into two distinct areas : distribution (part of the traditional market of the company) and components. The latter was developed by marketing some of the company's traditional products in completely knocked-down (CKD) form, as well as the factored components of other manufacturers, such as Mitsubishi.

Within this organisational form, the sales function for these two product areas was performed by different sales offices with different office managers. The continued failure of the company to raise component sales of Mitsubishi, plus the skilfull pressuring and lobbying of the old sales office manager, made this change inevitable. The fact that components was designated as a target for development by the Board of Directors, plus the growing involvement of the Mitsubishi company added further to the pressures for this change.

An area of dispute at this time was whether components could be effectively sold by the existing sales force, treating GE products as one range to be pushed as complementary technologies. The alternative was for area engineers to specialise on one or other of the present ranges.

These favouring the former view, notably the area sales manager and most of his area engineers, stressed the synergistic effects of having all engineers promoting all products. The opposing view stressed the degree of differentiation between markets and the lack of understanding of the specious problems of panel builders existing amongst the traditional area engineers. It was further argued that components would never get the amount of promotion needed to get it off the ground until there were specialist sales engineers with the specialist skills relevant to this market.

In retrospect, the author now feels that these problems would have been best dealt with by seeking answers to the question : "Are the W's of area engineers compatible with the W's of distribution equipment purchasers and panel builders ?"

It is interesting that the conflict of view over area engineers was also manifest over other issues, principally over questions related to the supply of CKD items of GE origin for sale by the components sales division. In practice, difficulties arose because manufacturing could not generally operationalise sufficient capacity to meet current demand, with the result that delivery performance at all levels of the product hierarchy was poor. This problem was further exacerbated by the low priority given by manufacturing to servicing the requirements of the components division. Component manufacture and the assembly of distribution equipment were physically linked in a linear production process. Any shortage of components hits component sales hardest, because the close proximity of distribution assemblers to the component manufacturing sections makes it easier to marshall components illegally outside the production planning and control system.

Clearly, the possibility for this to happen must have played an important part in the generation of a "production problem". Managers favouring the development of the component activity often said that they believed that top management activity pursued a policy of favouring distribution, but there is no real evidence to support this beyond the absence of any effective action to ensure that component sales got a fair share of those components that were available.

Differences in W's seem to be evident in the different views taken of sales representation and component allocation. Differences in W's will also be evident in the issues discussed below.

At this stage, it seems appropriate to discuss the position of the data processing department mentioned in Chapter 7. The most interesting features of this department centre on its dual roles of systems design and operation. In both these respects, the distributed nature of the communication is very well illustrated. (Molloy and Best, 1981) by the possibility of including this department, or parts of it, in several subsystems and at various levels of recursion.

As designers of systems, DP are generally amplifying the variety of a particular control function. In establishing a computing facility, top management aim to establish greater control upon the company's activities ; in deploying this facility in a particular area, the need to strengthen a control function in that area is recognised at a lower level of recursion. A classic example of this is the material requirements planning system discussed in Chapter 7, although many of the systems considered by the author would have performed exactly the same role in relation to other subsystems.

In Checklandian terms, these acts of design are performed by the "owners" of the system, those with the responsibility and power to change it when and where required. However, it is clear that the same people are actors in relation to other activities, objectives and systems. Questions about the ownership role give rise to some important problems from which some general conclusion may be drawn, and we shall return to this a little later. For the moment, the other role of the DP department will be considered.

Established systems will be operated by the machine system for which the DP department bears a responsibility. As the number of systems grows, the machine is handling more of the channels. It is thus clear that while the DP department is never the whole of the communication function, not, usually, even most of it, it is part of it and as such, functionally distributed throughout the organisation. What is not contained in it, of course, are the W's that will filter the data passing in and out of the system, and determine what the information content is at any point in the system.

As designers, the DP department usually do not design, because they are almost never owners in Checkland's sense. The act of design, for them, is the act of automation by translation of "someone else's" system in their machine. As operators in the automated systems, members of the DP department usually do not operate these systems, but the medium in which these systems operate. In both of these roles, members of the Dp department see themselves as providers of services with no responsibilities for the effectiveness of the services provided. This type of role is often exemplified by the statement "Tell us exactly what you want, and we will give it to you." at the design stage, and "But the system is doing exactly what you asked for" when operation is unsatisfactory. The real rub is that once the system is automated, it is often difficult and expensive for the owner-manager to change it.

The manager, the control function, loses a degree of control over an important aspect of the system for which he is responsible, namely : its shape, form and development. So who gains when a company gets a DP department such as that at GE ? If the dangers are realised, then probably nobody ! The managers helped run the risk of developing a system which, when complete, is in danger of ossification because of the dependence upon others who have their own priorities about whose system should be automated/developed/designed next.

This view of the DP department can readily be captured in the following Root Definition :

A George Ellison departmental system to provide other departments with a means of automating and maintaining the data manipulation systems of other departments, within a computing medium.

The CATWOE elements involved would seem to be as follows :

Customers - "other departments"

Actors - implicit - the members of this department

Transformation - "automating and maintaining"

Weltanschauung - A type of contractual relationship is assumed and is captured in the phrase "provide to other departments". What is all-important in this definition is a view of the company medium as "belonging" to this system. From this springs acknowledgement from DP of an onus to maintain this medium.

Owners - George Ellison

Environment - Complex - the company and a "computing medium"

The idea that the computing medium belongs to the DP department seems to extend to any computer the company might acquire. It would follow naturally that any move to introduce a computer facility under someone else's control is a bad thing. When the author was suggesting a micro computer (see Chapter 7) all sorts of objections were raised. Typical of these objections was the suggestion that it was extremely difficult and dangerous to mix equipment of different types and makes. The computing domain is easier to control if it centralised and thus seems to generate a preference for a centralised facility.

The dangers go even further than has been discussed above, because it often arises that this system for automating other people's systems becomes a bottleneck for organisational development, and the demand for computer services soon outstrips supply. Generally, managers become dissatisfied with delays and may either resign themselves to a higher labour content in their systems, or think of alternatives. Where the latter course is pursued, a manager may run into opposition from the DP department. In GE's case, the reaction to the micro computer proposal illustrated this.

It seems that the idea of a computer facility that was not under their control was uncomfortable to them, and yet it should be remembered that it is the medium they aim to control, and not the systems _per se_ that run in it. The general mode of conduct of the DP department was to support its own survival and growth rather than enhance the survival (organisational closure) of the whole organisation. However, it should be acknowledged that the intention may have been the opposite. A demand is created which cannot be met, but dissatisfied managers are constrained from looking elsewhere because it is argued that "DP is their area/responsibility/concern."

But does it have to be like that ? It will be argued here that it does not, and that the essential difference must lie in Weltanschauung of the DP manager/people. It may be necessary for them to construe themselves as having investments in other people's systems so that they become part owners of the systems they help to develop/automate. They must allow the owners of systems to become part owners of the computing medium as well. Their roles should be construed by others as helpers in organisational development from whom managers can get help and knowledge. The importance of this latter will become clear below.

As for the managers concerned, it has become clear to the author that they cannot afford to abdicate the development of their systems to a DP department because, as stated above, DP may construe the situation differently. The only hope is to make use of the company medium, as both a development and an operating tool, as widely available as possible, and for managers to be the systems designers in the way good managers have classically been. Managers must acquire DP skills, just as they must become skilled in handling people, etc., and the DP department could help greatly by performing the role of educator. As such, it would belong more properly to the personnel department than the accounts department where it is presently situated. In functional terms, however, it would remain as part of the control function enhancing control variety at different levels of recursion. In the final analysis, managers must manage their own data processing and where they use "DP men", they must be able to manage them so that "the tail does not wag the dog."

Throughout this work the idea of Weltanschauung has been central in explaining why an observer will see different features of organisational behaviour as important or significant. Undoubtedly, the predominant W in this work is that of the author, but an important question here is : what can be said about the underlying assumptions, the W's mentioned so far ?

The most significant feature seems to be the degree of conflict ot incompatibility between these W's. These different sets of assumptions lead to differing judgements about how the company's performance can be improved in various areas. There are polarised views about how the company should be organised to face its future market/environment. It might even be said that most polarised differences have this basic conflict underlying them.

9.5. A First Look at the Future

So far, in this chapter, the "shape" of the organisation as it has existed, and as seen from a particular perspective, has been described. The existence of different Weltanschauungen within the organisation has been noted and the ways in which these relate to some of the "story" in Chapter 7 have been explored. In this section, an organisational arrangement that does not yet exist is described. The author feels that this arrangement represents a logical development of some of the ideas and developments already discussed. However, it must already be clear that not everyone would agree that this does represent a logical path for development. It should also be noted that although the form of representation is the author's, the basic philosophy "belongs" to a group of established GE managers. The principal supporters would be those in the sales division, particularly those supporting the move towards factoring through component sales.

The possible future described here takes some of the environmental developments already described as important, namely : the development of a significant number of panel builders. The market is seen as undergoing a process of segmentaion and development which can equally be viewed as structural alterations in the supplier/industry system. GE is weak in terms of the strengths of both large and small members of its own industry. GE cannot materialise economies of scale of the larger companies such as GEC, nor can GE match the flexibility and responsiveness of the small, panel building companies who also have economies of scale (small scale) i.e. low overheads. It should be said that anyone who has what has been termed a manufacturing outlook or a strong identity with the company's past products/philosophies will probably not share the same enthusiasm for this type of development. A static representation of this form has been given in Figure 9.3, and Figure 9.8 depicts a dynamic version of this arrangement. The essential feature is that the separation between components and distribution is extended to manufacturing.

Each of these new divisions has a set of activities which are internally consistent, i,e, the business they are in is clearly defined. The compnent division sells components which need to be right for the market it serves. It would manufacture the Ellison system of steelwork and switching devices as well as the components for other distribution systems such as Lambar. An important point is that it would do this manufacturing with what essentially is the existing production capacity. It would also factor switching devices and related items such as the Mitsubishi range.

The Distribution Division sells products which will be employed in user applications. It is essentially an assembler of switchgear and distribution equipment, although the tailoring of standard systems to the particular needs of individuals would be a central feature of the activity. The application expertise built up over the years would be used to concentrate sales effort where this division's strengths lay.

Components would usually be supplied from the component division, but the overriding philosophy would be that this division would have to be viable in its own right, so that any failure to supply the required components within an acceptable time would be legitimate grounds to use another supplier. There may be reasons to use more than one supplier anyway, but this decision should lie within the autonomy

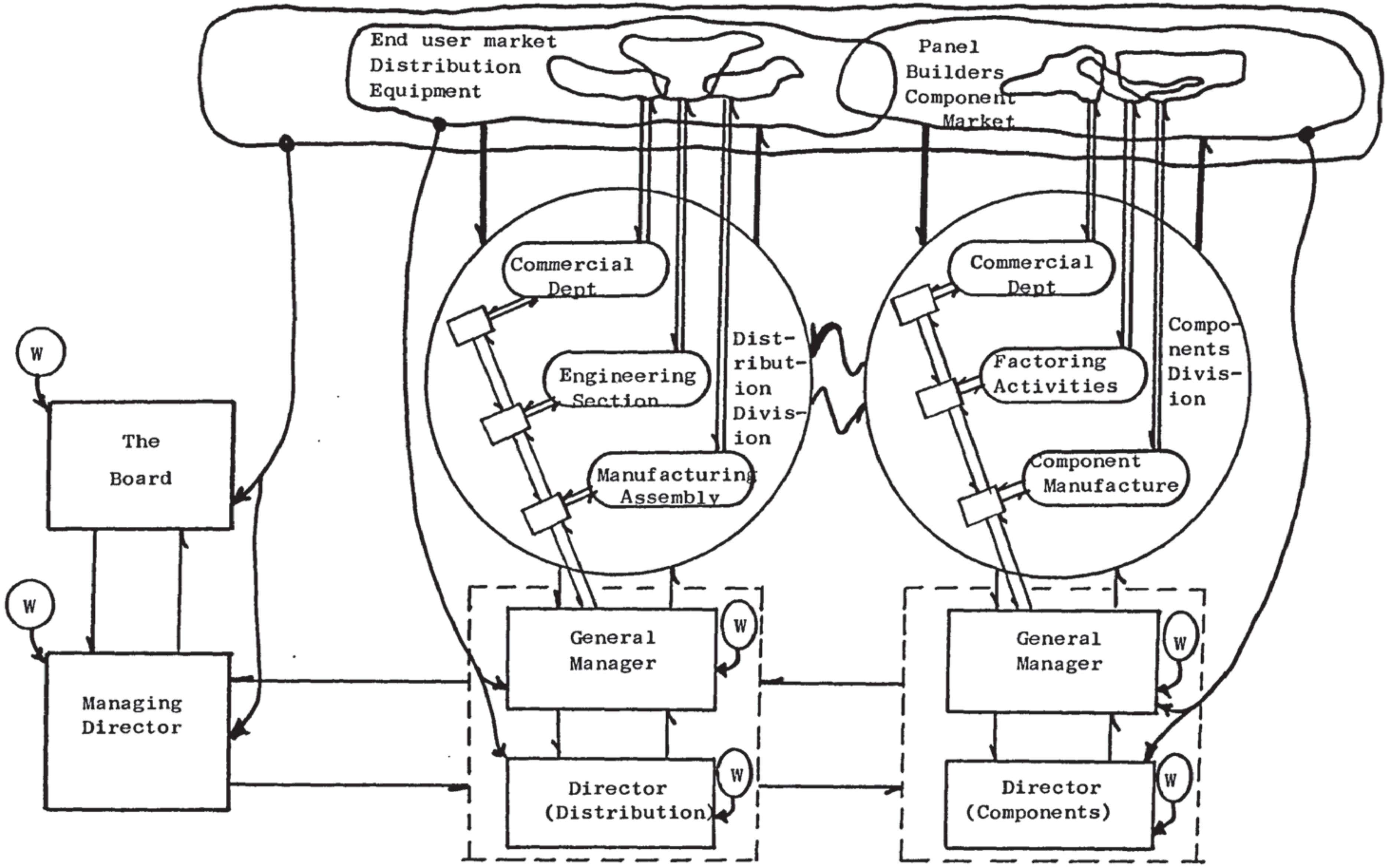


Figure 9.8.

Logical Divisions

of this division, with the meta system saying nothing more than preferential consideration should be given to each division by the other.

The other side of this coin is that the distribution division would not be essentially different from any other customer (panel manufacturer). As such, distribution needs would not override all other requirements, but would receive the same priority as any other good (large) customer. Components would have to develop its own philosophy and exploit the whole market for all its products, and the same general point applies to Distribution.

But why is it that component manufacture and distribution assembly cannot be operated together as one division ? They do operate as a unit at the moment, but the present situation supports the view that they are naturally different types of activity which do not go well together. More importantly, many managers think that this is so. Also, the existing "front end" differentiation is less effective because the logic of this thinking is not carried through to manufacturing.

An example of the indesirable effects arising from this lack of functional separation between component and distribution manufacture is provided when one considers events related to the supply of components to the component sales division.

The attitudes of the existing manufacturing personnel are strongly identified with the traditional distribution nature of the business. A tradition of "get the job done" somehow, and a pride in being able to "pull something out of the hat" when a customer is in real difficulty has encouraged the self-organising powers of the manufacturing people. This is no small part of the reason why it has proved so difficult to bring the manufacturing unit under control so as to produce "efficient", co-ordinated operation. This property is also responsible for component sales not getting as fair share of such components as are available. The whole manufacturing system is directed towards the production of distribution equipment.

Difficulties can easily arise for component sales as a result of thinking being directed towards the most efficient cost effective manufacturing arrangement, with only distribution requirements being considered. An example of this arose in 1978 when the company was attempting to raise its productivity to become viable after the 1977 crash. Various details of design in some standard components were being considered for amendment, and a number of changes were instigated with the specific aim of reducing the cost of manufacture involved. One of these was an amendment to door panels which consisted in the deletion of the welds in the four corners which stabilised the door section by greatly increasing lateral stiffness. Typically, an individual customer requirement would require that some equipment, such as instruments (ammeters, voltmeters, etc) be fitted in some of these doors, so that this stiffness was important where the quantity or weight of instruments was very great.

However, it was decided that the residual stiffness in the door section was sufficient to carry the weight of the instruments required by GE customers. The specification of such doors was changed with immediate effect, and without notification to the sales department.

The important point here is that the doors of this new specification were eventually supplied to panel manufacturers through the components sales division, some of whom declared that the residual stiffness was not sufficient for the instrument arrangements typically required by their customers. The fact is that when considering the minimum requirements of the market, only that part served by the distribution division was taken into consideration. This does not make sense even within a philosophy of "do what we presently do, but better", and it makes even less sense when one begins to question whether it is wise to go on doing what is presently done, and if it should be done in the existing way.

Other examples of changes centred upon the existing major, rather than the likely future, patter of business. These included changes to standard paint colour and type of material which were not favoured by the component market. The result of one such round of value engineering was that GE lost one of its best component customers.

If component manufacture were functionally separated from distribution, it would be brought more directly into contact with the whole of its market, and would become more dynamic and efficient as a result of having to compete openly against other component sources, even for the GE distribution business. None of this would require any significant physical separation of activities, but there would be some dramatic changes in the hierarchy of control which would naturally be reflected in the pattern of accountability.

A change in the arrangement of company accounts would also be a logical step, with separate divisional accounts being prepared for both of these now major divisions.

The author, whilst collaborating with Mr. RR (Management Accountant) on the micro computer for sales analysis (see Chapter 7) project, proposed a product listing which would have opened up the possibility of separate accounts. This was supported by Mr. RR, and agreed by the Financial Director, although some important product definitions were not accepted.

The main purpose of this section has been to describe a line of development that might be consistently pursued from the existing organisational situation. It has been no more than characterised in the account given in this chapter. This view of the future represents a perspective which the author believes was held by several key people in the GE management. It is, to a degree, articulated here, but how much better it could have been to articulate it within the organisation through the IHD project.

Interesting though the possibility of splitting the company's operation between components and distribution equipment is, it does not exhaust the possibilities. A further possible development is discussed in the next section.

9.6. Other Futures

The picture of the future characterised in the previous section represents a dramatic step forward along a particular line of development. As a possibility, it is recognised by many of the GE managers who do not all construe this possibility in the same way. Some see it as an opportunity that must be taken in view of the increasing pressure upon the existing organisational arrangement from a changing environment. Others, by contrast, would not recognise the inevitability of such developments, and would see moves in these directions as dangerous and inviting unnecessary difficulties. Behind this is the view that the existing past forms of organisational operation are viable if operated with sufficient efficiency, and furthermore, they could be. Holders of this view may envisage different organisational forms to those discussed here, but the author has little knowledge of these.

In terms of the logic of the organisational form described in the previous section, the model outlined does not represent the final development. However, in moving beyond this, one cannot claim that very many managers seriously entertain this development as a realistic or likely possibility. Despite this, the logic of the argument is strong, and the possibility is entertained by some managers. This further development is dynamically represented in Figure 9.9, and has been outlined in Section 9.2, Figure 9.4. The developed version would contain three principal divisions, two of which would be the distribution and the component divisions discussed in the previous section, although the distribution would be slightly modified internally in order to facilitate the third division.

This organisational form would aim to exploit the application engineering expertise that has been built up over many years of manufacturing for the electrical distribution and utilisation industries. In the process of finalising the requirements of distribution equipment that an individual customer may require, a great deal of negotiation will often take place in which a client may"take advice" from GE contract and application engineers. The long-established name

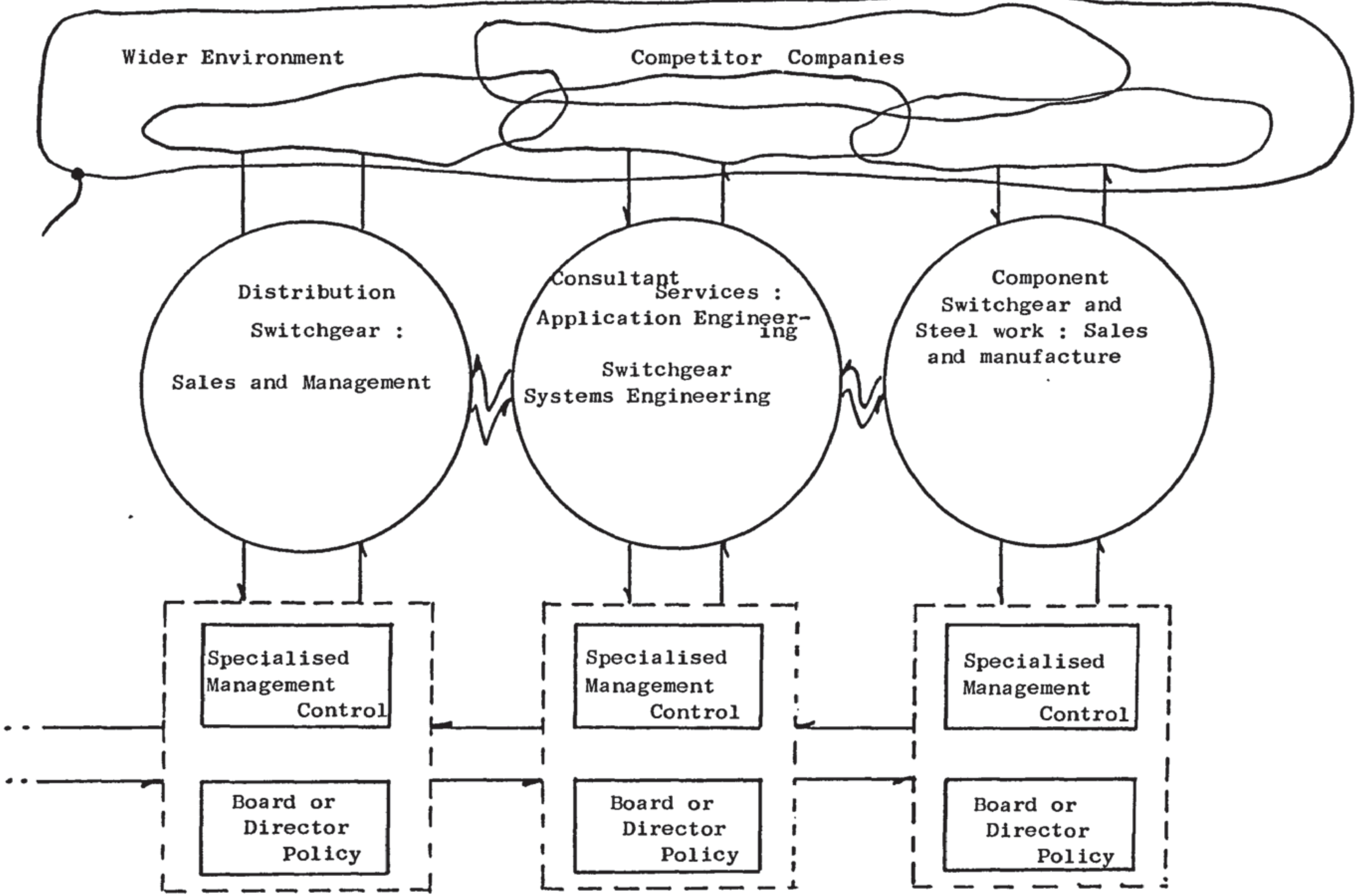


Figure 9.9.

A Separate Identity for Consultancy

of the company and the general reputation often characterised in the phrase "Rolls Royce of electrical switchgear" lends authority and confidence to any advice offered. A tradition of giving the best advice is discernible and area engineers are often asked to advise customers so that the representative/client relationship is unlike the "typical" salesman/potential customer relationship.One of the company's best salesmen has said that where he honestly thinks that a customer would be better off from a technical standpoint, he would recommend the equipment of a competitor. However, price or delivery would never figure in such a judgement.

The belief embodied in a proposed consultancy division is that the expertise that at present sells distribution equipment could itself be sold and still promote the existing activities of the company. There would, in effect, be sales synergy in which customers could, in principle, be referred to the organisation best able to help, although it is envisaged that the major pattern of referral would be from the consultancy to other divisions of GE.

Another area of GE activities that is a strong candidate for divisionalisation in the functional sense, is the spares and outwork area. Presently, this activity comes within the distribution sales division, although,like some of the despatch personnel, much of the implementation labour is administered and, where necessary, disciplined under the works system. Its viability as a functional division does not depend on any of the possible general arrangements already discussed being implemented, but might be pursued, whatever the direction of general development.

Some interest has been shown in the post-1977 era, in improving the operation of spares, particularly the stockholding control area in which a high value of basic components, often containing considerable quantities of copper, is held for product lines going back 20-30 years. This is obviously a straightforward area in which the NCR computer could do stock control. This area operated with a large degree of autonomy and this suggests two important points. Firstly, the operational level of the spares activity could probably benefit from some tightening up, especially since the attitude amongst many of the personnel was that the customer must be helped, regardless of cost. That is what they saw as the purpose of their system.

The company policy on spares and service was that it should operate as a commercially sound operation, but in practice, decisions to discontinue a current product or the spares for a past product were not usually preceded by a systematic study of the financial parameters . Divisionalisation in the viable system sense would tend to raise awareness of these types of questions, so that uneconomic activities are not continued, and also that discontinuations do not take place unless they are really warranted.

The service side of this operation includes what GE terms "outwork", and this operation (breakdowns, off-loading and erection) uses labour otherwise employed in the spares department, where a spares requirement might be assembled and packed. Outwork is also one of those anomalous products that is not shown as a product in the company accounts. Like the income from the sale of transformers, and the temporary employment subsidy, outwork was shown as a sundry income and like these items in income could be relatively large (£8-10k per month). Once again, conscious divisionalisation gives a logical basis on which to organise the accounts so that one can ask of every viable system that one recognises, "Is it financially viable ?" as well as viable in other senses.

Like other suggestions for future organisational development, questions might be asked about the saleability of these services and skills in relation to other company products. Also, questions about the role and value of these services in relation to other GE activities would need to be asked, so that synergic effects would become fully valued and recognised. This ought to lead to some healthy questions about transfer pricing. Once again, the results of such internal debates would be reflected in the accounts.

The self-conscious nature of the change of emphasis of this new division might find expression in the following root definition :

> A subsystem comprised of electrical fitters and their managements to supply switchgear and related services to any customer with particular short-term needs. Operation must be economic and compatible with the generation of synergic effects with the products of other GE divisions.

The CATWOE elements perceived are as follows :

Customers - those "with particular short-term needs"
Actors - "electrical fitters and their managements"
Transformation - "supply" - generation of synergic effects

Weltanschauung - The main assumption is that this activity is viable in its own right and should therefore be free and suitably resourced to exploit its own environment. However, its special relationship with the rest of GE is overtly recognised.

Owners - The George Ellison Meta System

Environment - George Ellison as suppliers of material skill and customers plus all users of electrical switchgear.

9.7. Concluding Remarks

It is important to remember that the RD's given here are really only illustrative of the author's Weltanschauung, although every effort has been made to identify other differences where they have been apparent. The important work to be done in GE is to identify the "powerful" Weltanschauungen within the company, and to assist the individuals and groups concerned to explore their own thinking and that of their colleagues/opponents. The author is content to have shown how some of them might have looked and how they seemed from the one perspective that is presently available. The development discussed may not be realistic or viable, and there is no doubt that some will think so ; but the conflict generated by clashes of Weltanschauungen need to be resolved somehow, or there is a danger that the company's general situation will never substantially change.

There will always be perspectives within organisations, and the resulting clashes of view can be, and sometimes are, seen as battles which some feel they must win. (The author has himself been guilty of this). But the fact is that such clashes provide opportunities to see and explore the views of others and the possibility of new and different organisational forms and functional arrangements. What is most important is that the debate takes place and that the actors recognise the value of such activity. The techniques described in this thesis such as Checkland's methodology, viable system modelling, hypergame analysis and cognitive mapping are a means to help and facilitate this debate. They not only provide necessary tools for action research, but they are becoming necessary tools for the actors in the debate itself.

EPILOGUE

At this stage, the thesis is complete so that it may be useful to recap on some of the points made. This will serve to stress the features of the work which are interesting, and the ideas that are valuable.

The experiences and investigations which have led the author to write this thesis are as diverse as they were unexpected for the author. The process has been difficult to cope with, but extremely rewarding. The structure and content of the thesis reflects, to a substantial degree, the richness of this process. The resulting thesis is, therefore, potentially difficult for readers to cope with. Efforts have been made to guide readers through the work by the provision of a readers' guide, and suitable interface material between each part. The author hopes this has been successful.

Looking over this work it is evident that the content falls into three categories. The first of these categories consists of those aspects which are essential to understand the author's view of OPS. The important aspects here are Transcendental Realism, the methodology of Checkland and the author's iconic model of the methodological process.

The second category is made up of elements which were essential to the author. Without these elements, or others to play their roles, the author could not have reached his present level of understanding of OPS. The elements here are various philosophies of science, Organismic modelling and some related ideas, e.g. conversation theory, Construct thoery, cognitive mapping and hypergame analysis.

The third category consists of the elements describing the organisational situations and issues which prompted this work. To some extent these elements play a role in Category 2 since they do, in part, illustrate many of the ideas of Category 1. The author feels that there is a good deal of value in having recorded details of all three categories. Together, they provide a cautionary tale, and some guidance for others who may attempt OPS.

During the course of the work leading to this thesis, the author has substantially changed his views on OPS. This change is very clear in the contrast between the author's approach to the organisational problems described in Chapters 6 and 7, and the account of OPS methodology in Chapters 5 and 8. Since this contrast reflects what the author has learned, it is worthwhile concluding this work by characterising the two views of OPS involved. The model implicit in the author's original approach to the problems of George Ellison will be considered first.

It seems to the author that he shared an assumption about the proper role of a researcher with key members of the sponsoring organisation. The shared image of a researcher was of someone who "finds things out", who "gets at the facts" where others find it too difficult or cannot find the time, etc. In short, a sort of scientist. Insofar as the author was seen as an action researcher, the implication was that he would "get things done" and "put things right".

For the most part, the author was faithful to this ethos. He did find things out. For instance, he found out about conversion rates and time lags between quotations and orders ; he found out and implemented what was the "best" system for the outwork department, etc. "Putting things right" seemed the same, whether one "tinkered" with the world or informed relevant managers that their beliefs were out of step with the world.

This thesis has tried to underline that this mode of conduct involves a W which focusses attention on "A type" analogies or correspondence truth. As an approach to OPS it shows itself, in the author's experience, to fail in the more complex problem situations. If seen as a Popperian test, then one must reject the approach.

However, the author has made it clear that he does not wholly accept the Popperian view. It is clear that the correspondence approach can be effective over a range of situations and it has been suggested in this work that this range equates to the lower end of a complexity dimension.

Turning now to the author's views that have emerged from the work recorded above, it may be useful to begin by stating that the author believes that correspondence relationships between facts and beliefs are important. But it has been shown that in the more complex organisational situations, there are other relationships which become progressively more important as complexity increases. Unlike the concept of variety, it may well be possible to measure this complexity in real organisations since it equates to the number of W's involved. However, one should not forget that W's will be viewed through a W.

Not least of the changes that have emerged is the author's view of "the facts". The W that the author shared with the sponsor saw"facts" as immovable and unchanging entities to be found out and changed where necessary. The author has retained the idea that the world has an underlying structure. It is layered and consists of real mechanisms which, in part, produce the phenomena we call "facts". In addition to this, the author now recognises the role of a socially and psychologically generated element (a W) which contributes to the production of facts. Therefore facts become more variable and negotiable than was previously thought.

To the extent that there are shared or compatible W's in a problem situation, correspondence work may be very valuable. However, this thesis has shown that differences in W's can easily arise, and where this leads or contributes to a problem situation, it is vital that the methodologies employed recognise the necessity to investigate and reconcile differences in views and W's.

What is involved here is a shift of emphasis away from correspondence work towards coherence work. If actors in problem situations cannot resolve their differences, they need to understand them. Without this it is difficult to see how action to improve problem situations can sensibly come about.

The author has come to see the importance of W's in problem situations but it is also apparent that W's play an important role in the construction and execution of methodologies. Once problems and problem situations are viewed as the subjective and variable entities they are, an important defining feature of any suitable methodology is defined. Methods used must allow that the area of concern may look different from the viewpoint of different actors.

The author has chosen to model the mechanisms of problem situations by adapting the Checkland scheme, but it is clear to the author that this W is compatible with Conversation theory, Contsruct theory and the other approaches identified in Chapter 8. The author does not understand why more of these W's have not been put together before. It seems clear that the more complex organisational problems demand the most powerful and flexible methodologies that can be contrived.

This work has not attempted to systematically cover the whole of OPS, which would have been impossible, given the available resources. The thesis does try to say something useful about OPS by reflecting something of the author's learning and the processes behind it. For the author, it points the way for future learning, but it is only a beginning.

APPENDICES

APPENDIX A

The Sponsoring Organisation : George Ellison Ltd.,

A.1. The Sponsoring Organisation : George Ellison Ltd.,

A.1.1 Biographical Details of George Ellison Ltd.,

The founder of the organisation was born in 1873 in Cheshire. Education at the Manchester Grammar School was followed by an apprenticeship in Switzerland. His education was completed by a course at university and at the age of 21 he emigrated to the USA. Four years elapsed before Ellison returned to Europe to start a switchgear factory in Paris. Experience in the States with General Electric and Westinghouse Companies had clearly fostered insight and understanding of the growth potential for electrical devices.

In 1906 Ellison disposed of his French interests and opened a manufacturing company in Warstone Lane, Birmingham. This venture had 23 employees, including the Works Foreman from the French factory. This venture flourished and by 1915 had a second set of premises in Birmingham with Branch Offices in London, Newcastle, Sheffield and Glasgow. Employees now numbered over 300 and the business continued to grow under the tight control of "the Chief". By 1920 the business had transferred to its present premises in Perry Barr. Land acquisitions continued at the Birmingham site and included the site of Buffalo Bill's famous rodeo in 1902.

The major dvelopment in the 1920's was the establishment of a secondary company, Ellison Insulations. During this period both primary and secondary companies became registered as Limited Companies.

Consolidation continued through the 1930's with the building of new office blocks and the acquisition of nearby land for the construction of a Proving Station capable of electrical destruction tests on high current equipment.

In the early 1940's Ellison Insulations Limited was renamed TUFNOL Limited and production was directed towards the war effort. The second half of the 40's saw the generation of a Division of TUFNOL to meet the need for specialised high pressure presses. This Division later became Ellison Hydraulics (Birmingham) Limited.

The 1950's saw continued growth in relation to the insulating material side of the business. By 1954 a marketing company, George Ellison S A (Pty) Limited was formed in South Africa.

In 1955 George Ellison died at the age of 82.

Decline in the fortunes of the Ellison organisation seems to date from the 1950's. The period of high prosperity seems to have been closely related to the founder. Many employees who remember the old man say that he took "bad" advice in later years and allowed effective control to slip away to individuals who lacked his visionary insight. If this is so the seeds of decline must have been planted in the immediate post-war period.

In the 1960's all Ellison Companies were re-grouped under a new Company structure: George Ellison Holdings Limited. The family retained control with George Ellison (grandson of the founder) as Chairman. During this time a number of acquisitions took place. George Ellison S A (Pty) Limited acquired a 49% share in Vanrow Engineering and Materials Limited. George Ellison Limited (the switchgear company) acquired Evered and Company Equipment Limited, a hospital bed and ward equipment manufacturer.

By the early 70's the cash flow situation within the Holding group was desperate and this cannot have been helped by the acquisition of of a yacht building, repair and laying up business called the Falmouth Boat Construction Limited.

For the founder, the core of the business was the switchgear company and other activities were spin offs. Ellison aimed and succeeded in producing the highest quality switchgear of its type in the world, and the customer was his first and last consideration. However, "the Chief" did not recognise that the 1950's would see a sharp downturn in the product life cycle of the "oilbreak" switchgear which he helped to pioneer. He believed it to be the ultimate solution to reliable interruption of high current circuits. New technology did arrive in the 1950's and George Ellison Limited had to employ consultants to design their equipment. However, technological developments were not all that Ellisons failed to anticipate. The customer centred business philosophy of the parent company went against the new post-war ideas of high volume standardised products where the customer takes it or leaves it, but takes it because of the reduced price. Ellison would have said that "people will buy my products because they are, in every way, the best" but often customers neither need, nor can they afford, the best.

By the time that poor profit performance was manifesting cash flow difficulties, the "identity" of the business had shifted away from the switchgear activities and the decision was finally taken to dispose of the switchgear company on the grounds that this was the least profitable product area with the least growth potential.

A number of factors may have been over-looked. Firstly, the switchgear premises were Head Office for the whole group and many people have expressed the belief that many group overheads were not being accurately distributed in the accounts, thus making switchgear appear less profitable. Secondly, the switchgear premises were, and still are, grossly under-utilised. Efficient organisation of production facilities may have yielded increased profitability. Thirdly, lack of managerial expertise was a significant factor. It had become a tradition to get the job done, almost regardless of cost, which was not, and still is not, known for individual jobs.

The assets of this business had gone for a long hibernation and therefore the switchgear company had a great deal of latent potential.

In its present form George Ellison Limited dates from 1973 when three members of the pre-1973 senior management acquired the failing company with the backing of Barclays Bank. The object of the new owners was to transform the switchgear company into a viable organisation with an assured future.

Survival was the immediate concern. The Company began to disentangle itself from the holding group. Many group overheads, such as the Publicity Department, were dispensed with. Towards the end of 1973 the work force fell by approximately 13% mostly due to a redundancy programme. Invoice factors were employed to improve the cash flow situation. A requirements planning package was introduced, based upon an IBM system, to control stock and work-in-progress.

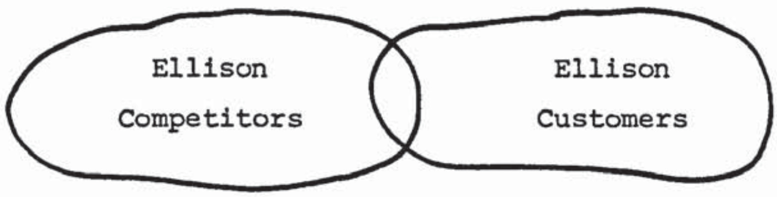
The Company has survived but manifests signs of gross instability. The first full year of trading (October 1973 to September 1974) produced a break-even financial situation while the second showed a small profit. The third year was disastrous. Cash flow pressures grew rapidly and the Company moved to the brink of extinction.

A.2.2 The Products

George Ellison Limited (GE) manufactures industrial switchgear and distribution equipment in the range 230 volts to 11K volts. In addition to manufactured items the Company factors switchgear of related types as a means of serving a wider market and following new technology.

The tradition of the organisation is strongly manufacturing. From its inception the organisation has manufactured with innovation as the dynamo driving the development of products and techniques. The relative decline in the fortunes of the organisation seems to be loosely tied to its failure to stay "up front" in the development of new technologies. Since the war this failure has necessitated a growing proportion of factored items in GE's turnover.

The demand for GE's products arises out of the need to control the flow of electricity in the distribution system between power stations and consumers of electricity. This demand is met by GE (and its competitors) both directly and indirectly by sales, in the former case, to consumers predominently in the industrial sector and by sales, in the latter case, to manufacturers who in turn sell to consumers in the industrial sector. It is evident that the class of GE competitors and GE customers overlaps as follows:



This apparent contradiction arises because GE sells the components that it uses to manufacture its own switchboards to other switchboard manufacturers who would take a proportion of the end user market by sourcing from elsewhere anyway.

Although the function of the equipment produced by GE is essentially electrical, the high currents involved in many applications (up to 4,000 amps) necessitate heavy equipment which involves many mechanical problems. Efficient interruption of high power circuits requires rapid separation of current carrying contacts which in turn necessitates complex mechanisms to achieve this function. Problems of access and maintenance generate further problems, as do safety considerations. The design of this equipment aims to solve an electrical problem within a given set of constraints but the area for the designers solution and the manufacture of that solution is essentially mechanical.

The core of the electrical problem in high power circuit interruption is the arc which is produced when the circuit is interrupted by the separation of current carrying materials (contacts). The presence of this arc means that the circuit is electrically closed even though it is mechanically open. This phenomenon can be sustained over relatively large 'gaps' once the arc is established and these gaps are larger than that required to start the arc. Apart from the failure to meet the central function of the equipment the existence of such arcs causes serious damage to the equipment which can, in extreme cases, result in destruction, but may simply lead to a marked reduction in the useful life of key components. These effects are increased at higher voltages.

The need to kill arcs quickly and efficiently has lead to the development of different technologies which are characterised by the method of arc suppression employed as follows:

Technology	Description
"Oil Break"	The circuit is mechanically open in oil, the in-rush of oil mechanically disrupts arc. Cooling effects further reduce arc life. This technology developed by Ellison and others. Now virtually obsolete below 660V and becoming obsolete above. The Ellison products above 660V is still oil break.
"Air Break"	The circuit is mechanically opened in Air. Arc normally well supported in air thus special techniques required to disrupt and kill the arc. GE technology uses the large magnetic field produced when the circuit is interrupted to deform the arc in to shoots which break up and 'kill' the arc. Some manufacturers working with voltage beyond the range of GE (above 13K volts) employ Air blast techniques to disrupt arcs.
"Special Gases"	The circuit is opened in an inert gas under pressure. Several gases have been tried but the most successful (commercially) has been sulphur hexafluoride (SF_6). A combination of this gas and the 'blast' techniques from advanced Air technology has produced some successful designs for very high voltages (national distribution). GE is not in this market or technology.
"Vacuum"	The circuit is opened in a vacuum. This seems to be the ultimate in pole separation techniques. Arcs are extremely difficult to sustain without a conducting medium. Contacts move a very small distance to achieve efficient interruption and

'wear' is minimal. This technology is becoming well established at higher voltages that GE operate with. However, techniques are improving and mass production is making vaccum technology more attractive at lower voltages. This technology lies completely beyond GE's ability to develop. However, the possibility exists to develop a vacuum switch which employs a GE manufactured mechanism with imported 'vacuum bottles'.

The technologies briefly described above relate to switching applications which may be subject to extreme stress, i.e. the device may be required to operate at currents that are many times the normal rating of the circuit it is controlling when a fault exists. These devices, known as breakers, must have a "fault make, fault break" capability and will normally control a number of sub-circuits which do not have this capability.

Sub-circuits will normally be controlled with devices that have "fault make" capabilities only. The most commonly employed device at GE for this purpose is the fuse switch which overcomes the danger of opening the circuit when a fault is present by protection with fuses. These fuses break the circuit in the event of a fault, thus ensuring that the device is never operated to break a circuit with a fault level of current flowing. The "fault make, fault break" equipment described above will have magnetic devices for the detection of extremely high faults and will operate the device in the event of a failure in the sub-circuit protection devices.

Sub-circuits may be protected by devices not employing buses for the protection of circuits. The most notable of these are "moulded case circuit breakers" (M.C.C.B.) and "miniature circuit breakers" (M.C.B.). These have the "fault make, fault break" performance of the traditional breaker with the cheapness of the fuse switch. Cheapness is achieved by using plastic moulding techniques and the minimum material to achieve fault performance. Moulded devices only have a life of a few fault operations, while breakers may have a considerably longer life.

In summary, the following devices may be identified:

Device	Description
Breaker	- high performance device with full fault "make and break" capability. May be of several technologies: oil-break, Air break conventional, Air break-moulded case. GE manufactures oil-break for applications above 660V (normally at 11KV). Air break

devices at these voltages is bought in (usually from Germany) if specially requested by a customer. Below 660V GE has abandoned oil-break and relies mainly on Air-break devices of its own design.

Isolater	- a device with very low interruption performance used to make a circuit safe (usually for maintenance) after interruption by another device. Often employed where the high performance of a breaker is not required to reduce costs. GE makes these devices in oil-break but Air-break applications rarely require them.
Fuse Switch	- a device with "fault make" capability only. High rupture capacity fuses isolate the controlled circuit in the event of a fault. The fuses are mounted upon a moving carriage which forms an integral part of the switching device. The main advantage is its simple construction and relatively low production cost. The main disadvantage lies with the used fuses, since a circuit which has shown fault conditions remains inoperative until fuses have been changed.
Moulded Case Circuit Breaker (M.C.C.B.)	- a very modern design of switch which combines the protection capabilities of the traditional breaker with modern (cheap) materials and extremely high volume production. At the higher currents these devices can only tolerate a few 'short circuit' faults, but in practice this performance is often sufficient. The traditional breaker has tended to remain popular but the new technology is improving in performance thus gradually penetrating the higher current applications.
Miniature Circuit Breaker (M.C.B.)	- technically this device is almost identical to the M.C.C.B's described above. They are designed for the low current application and have "fault trip" devices which automatically disconnect a faulty circuit. They are practically suitable for installations, normally fused, since the switch may be closed (without the maintencance operation associated with fuses) immediately the fault is cleared.

The remaining products may be divided into two classes:

1. Systems

These again fall into two types, distribution and switching. The former consists principally of a laminated busbar trunking system for the distribution of electricity within consuming premises. Its special features include a high degree of flexibility in the placing of tap off points and very high electrical efficiency. The latter consists of sub-stations which switch and control the flow of power to various machines or distribution systems. These may be constructed from collections of the above products.

2. Individual Components

These are, in effect C.K.D. versions of the above products. Usually they will consist of complete switching devices but with steelwork supplied as individual components. In some cases only steelwork may be supplied.

APPENDIX B

A Short Review of Some Philosphies of Science

B.1. Introduction

The material of this appendix is intended to supplement section 2.4.1 in Chapter 2. The discussion contained in that section is a summary of the material here. Four interpretations of scientific activity are given beginning with the least plausible (positivism) and moving through crude falsificationism and to the most plausible (sophisticated falsification).

B.2. Positivism

'Positivism' is the general term for those theories of science which characterise the proper activity of science as seeking on the one hand to confirm theories about phenomena by striving for a correspondence between the predictions of theories and the 'observed facts', and on the other to bring more of the worlds' observed phenomena under ever more general theories. This approach is unashamedly reductionist since it incorporates the idea that ultimately the whole of the worlds' observable phenomena is explicable in terms of a simple set of related axioms which generalise phenomena.

An important consequence of this is that the positivist thinker conceives himself as dealing only with closed systems (those amenable to experimental technique) since the theories are made up of sets of laws which generalise the phenomena from which the laws are derived, (inferred or induced). Further, theories are never falsified since they are only held to be applicable over the range of phenomena from which they were generated. Patterns of phenomena which do not correspond to patterns covered by existing laws/theories fall outside their legitimate range of application and call for laws/theories with a wider range of application.

Postivist science may be characterised by consideration of its four central principles:

B.2.1. The Principle of Accumulation

This principle embraces the notion that scientific knowledge consists of discovered "facts" of the past and grows by the accumulation of well attested "facts". Scientific activity then becomes the pursuit of "invariances" in the patterns of phenomena in nature so that the scientist can bring new phenomena (facts) of an old kind (invariant in type) under existing laws.

These laws will be expressed in the form of a hypothetical conditional, if ... then ... and generalise the constant conjunctions of invariant facts in the system under consideration. The idea of constant conjunctions may well date back to the ancients but is often attributed to Hume, the father of modern empiricism, and remained central to empiricist thought along with the implicit assumption that the world is a closed system. Indeed, it becomes clear that, a closed system is defined by having constant conjunctions, so that given a known set of initial conditions successive states may be predicted by virtue of the constant conjunction, the laws held to govern the system.

The idea of the invariant fact stems from the positivist belief in the 'pure observational term' or 'brute fact' so that only statements which have verifiable consequences are held to be meaningful. Theoretical terms such as 'atom', electricity, etc, only have meaning by virtue of their reducability to observational terms, while terms which cannot be defined are considered metaphysical and meaningless. The logical positivist followed Russell in his beliefs that the material things of everyday experience and constructions out of the ultimate components of experience, sense data or 'simplies' so that:

> "you can get down in theory, if not in practice, to ultimate simples out of which the world is built, ...
> ... (and) The only other sort of object you can come

across in the world is what we call facts, and facts are the sort of things that are asserted or denied by propositions, and are not properly entities at all in the same sense in which their constituents are." Russell 1918.

Ayer qualifies this view as follows:

"What one must not say is that logical constructions are fictitious objects. For while it is true that the English State, for example, is a logical construction out of individual people, and that the table at which I am writing is a logical construction out of sense-contents, it is not true that either the English State or this table is fictitious, in the sense in which Hamlet or a mirage is fictitious. Indeed, the assertion that tables are logical constructions out of sense-contents is not a factual assertion at all, in the sense in which the assertion that tables were fictitious objects would be a factual assertion, albeit a false one. It is, as our explanation of the notion of a logical construction should have made clear, a linguistic assertion, to the effect that the symbol 'table' is definable in terms of certain symbols which stand for sense-contents, not explicitly, but in use. And this as we have seen, is tantamount to saying that sentences which contain the symbol 'table' or the corresponding symbol in any language which has the same structure as English, can all be translated into sentences of the same language which do not contain that symbol, nor any of its synonyms, but do contain certain symbols which stand for sense-contents; a fact which may be loosely expressed by saying that to say anything about a table is always to say something about sense-contents"

Ayer (1936 pp 85-86)

Ayer goes on to dispose of metaphysics as follows:

> "It should be mentioned here that the fact that the utterances of the metaphysician are nonsensical does not follow simply from the fact that they are devoid of factual content. It follows from that fact, together with the fact that they are not 'a priori' proposition. For it will be shown there that 'a priori' propositions, which have always been attractive to philosophers on account of their certainty, owe this certainty to the fact that they are tautologies. We may accordingly define a metaphysical sentence as a sentence which purports to express a genuine proposition but does, in fact, express neither a tautology nor an empirical hypothesis. And as tautologies and empirical hypotheses form the entire class of significant propositions we are justified in concluding that all metaphysical assertions are nonsensical." Ayer (1936 p 56)

Figure B.1. shows a crude model of the positivist interpretation of the growth of science.

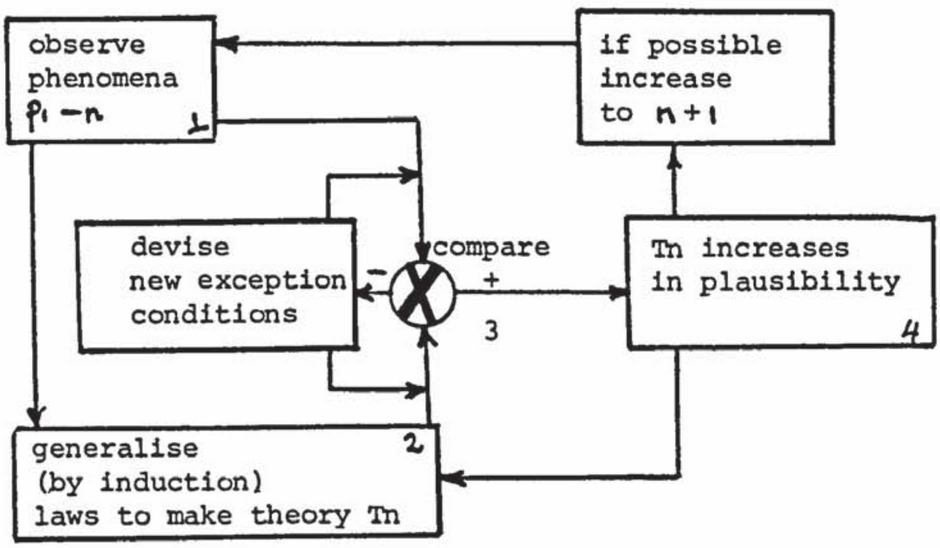


Figure B.1 The Growth of Science (Positivist view)

In this model new phenomena either confirm existing generalisations or generate new ones in 2. New theories do not contradict an old one since the old theory is only held to be valid for the range of phenomena that generated it. '(3)' is the testing stage, the controlled experiment, in which the scientist attempts to verify the theory and, where successful, the plausibility of Tr increases, '(4). A main aim of positivist science is to bring as much of the world's'facts' under appropriate theories as possible, thus n is increased to n+1 wherever possible.

Against this view of science one might consider that science does not seem to progress by the steady accumulation of facts but in step functions so that the discovery of 'new facts' alternates with theoretical advance.

B.2.2 The Principle of Induction

Inductive reasoning is the basis on which the positivist scientist builds firstly his laws and subsequently his theories; theories being no more than collections of laws governing related phenomena. This process, the bridge between (1) and (2) in Fig. B.8 involves generalising from particular facts and this presupposes: an invariance in 'facts' wherever, whenever, and by whosoever experienced. This view is also found in classical empiricism.

> "In reality, all arguments from experience are founded on the similarity which we discover among natural objects, and by which we are induced to expect effects similar to those which we have found to follow from such objects. And though none but a fool or madman will ever pretend to dispute the authority of experience or to reject that great guide of human life, it may surely be allowed a philospher to have so much curiosity at least as to examine the principle of human nature which gives this mighty authority to experience and makes us draw advantage from that similarity which nature has placed among different objects. From causes which appear similar, we expect similar effects. This is the sum of all our experimental conclusions. Now it seems evident that, if this conclusion were formed by reason, it would be as perfect at first, and upon one instance, as after ever so long a course of experience; but the case is far otherwise. Nothing so like as eggs, yet no one, on account of this appearing similarity, expects the same taste and relish in all of them. It is only after a long course of uniform experiments in any kind that we attain a firm reliance and security with regard to a particular event.
>
> Hume (1748)

These influences are still apparent in some modern writing:

> "The scientist looks for general laws, or universal properties of the form: whenever an event of type a occurs, an even of type b occurs" Taylor (1970 p 7).

The clear implication here, although expressed with caution, is that 'like causes' produce 'like effects', but it is argued in Chapter 2 that although the world is taken to be a structured reality, the categories of experience into which this reality is mapped are potentially, if not contingently, variable in a way quite consistent with whatever structure <u>may</u> objectively exist. This not only qualifies the laws we may choose to infer from particular 'facts' but also the 'facts' themselves so that one must conclude that there can be no 'brute facts' at all. At the law level it will always remain that the data (the observed facts) will have to be treated as a finite set which can, in principle, generate (for the positivist), support (for more coherent views), an infinite number of generalisations or hypotheses.

B.2.3 The Principle of Instance Confirmation

This is the principle that provides the rationale for (3) in Fig. B.1 embodying the idea that the degree of plausibility of a law is directly related to the number of instances that have been observed of the phenomena described in the law. Failures to verify the law in the test (3) would be rationalised as a failure in the ceteris paribus assumption. The controlled experiment (3) sets out to isolate a particular closure, a particular system, so that a failed test amounts to a failed experiment and not a failed law. Successful tests, however, add to the credibility of the law.

The principle of instance confirmation falls by the same type of objection as the principle of induction since it depends upon the following reasoning:

Tn implies Phenomena (Pl)

Pl is confirmed (observed)

∴ Tn is confirmed

(T n Theory and P 1 Phenomena)

No number of positive instances of P2 reduced the liklihood that Tn is false.

B.2.4 The Principle of Simplicity

This principle follows the positivist's reductionism. The world taken at the atomic level as capable of a complete description by simple facts will be more accurately described by a simpler theory (set of laws) since this brings more phenomena under fewer laws, than will a less simple theory. This principle (Ockham's Razor, Kapp, 1959) has often been used in a developed form to choose between competing theories (Schlesinger, 1963) and has been cited as a way out of the difficulties of induction mentioned above.

Clearly this principle is inconsistent with a holistic view of science since an explanation, which denies emergent properties, however inadequate in other respects, will necessarily be simpler than one that incorporates them. Further, the idea that the world is governed by simple laws seems to be counter intuitive since the discoveries of recent science seem to show that the world is more complicated than ever imagined.

B.3. Crude Falsification

This interpretation of science is exemplified in the writings of Karl Popper (1959, 1963) and is closely related to the positivist account given above. Both this and the previous interpretation share the same account of explanation and prediction as will a presupposition of closed systems, so that laws of nature are seen as general statements of correlations among phenomena. However, the major difference between them lies in the claim that theories have no sound logical origin in 'facts' already known. Only of the modus tollens form of reasoning, shown below, is recognised as valid:

Modus tollens $[(p \supset q) \cdot \sim q] \supset \sim p$

Theory 1 implies observation 1

$\sim$ Observation 1

Therefore $\sim$ Theory 1

Theories may be disproved but not proved and evidence is only valuable in so far as it tends to FALSIFY statements. Failure gives corroboration to a theory but always retains its status as a hypothesis, a conjecture.

Falsification does not have a logic of theory generation, only a criterion of testability which guides the scientist to test that, amongst the available theories, which has the maximum empirical content, i.e. takes the most risks. Popper accepts and advocates the view, argued above, that observation is theory laden so that there can be no pure observational terms in the scientist's vocabulary but stipulations that the business of science is to examine (test) those theories which have the maximum empiricial content in their statements. This leads to a demarcation principle as follows:

Science	-	Metaphysical & Empirical content;
Non Science	-	Metaphysical content only;
Pseudo Science	-	Metaphysical with pretentions to empirical content.

What separates science from pseudo-science is method. The pseudo-scientist does not specify conditions for a failed test in advance and characteristically explains events, post hoc, rather than predicting them. A model of the falsificationist view of science is given in Fig. B.2.

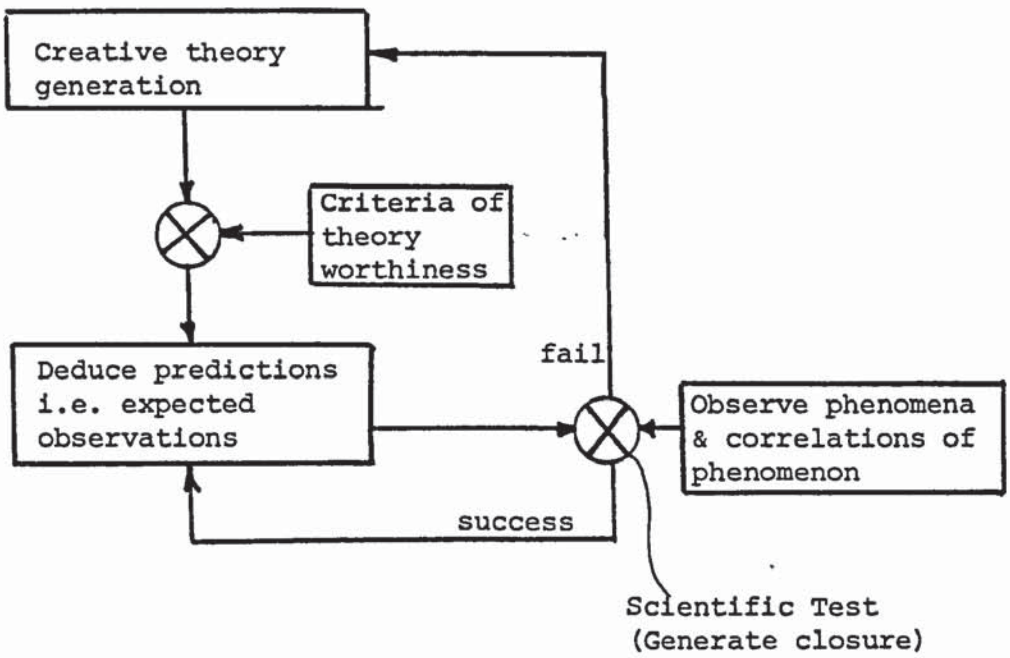


Figure B.2. A Model of Falsification

Progress in science takes place through a process of creative leaps in which conjectures about how things go on in the world are systematically falsified to progress towards a set of true hypotheses, i.e. verisimilitude.

Crude falsification may be criticised in the areas of theory generation and testing. The falsificationist scheme has a criterion of testability but theory generation does not proceed according to any logical principle. Positivism has induction, although it may be doubted that this is a logical principle.

Theory testing is of concern because the workability of the falsification principle seems as doubtful as the verification principle due to the multiplicity of hypotheses within any theory. The version of modus tollens given above must be modified as follows:

$$\begin{array}{l} \text{Theory 1 } (H_1 + H_2 + H_3 \text{ ......}) \text{ implies observation 1} \\ \qquad \text{observation 1} \\ \hline \text{Therefore not } H_1 \text{ or not } H_2 \text{ or not ... } \genfrac{}{}{0pt}{}{\text{and}}{\text{not}}\ H_1 \text{ and } H_2 \text{ and ...} \end{array}$$

Consider Beer's organismic model which has many sub-hypotheses. It assumes the law of requisite variety, principles of recursion, functional specialisations and so on. Now if an analyst were to make some predictions of the behaviour of an organisation which failed does one reject the whole conception, or one, or a number of the hypotheses. Clearly logic cannot tell us which to reject. It will not do to suggest that each hypothesis be tested in turn since this view places each hypothesis above test. Even on a temporary basis this would introduce a degree of relativism which would negate the validity of the controlled experiment and negate the conjectural status of hypotheses which was central in distinguishing falsification from positivism.

B.4. Positivism and Falsification - the shared Paradigm

Both these interpretations of science hold prediction and explanation to be symmetrical (see Chapter 2) so that deducable observations are predictions before observation and explanations after.

They are also based upon the same Aristotlian principles of reasoning known as the square of reasoning which is illustrated in Figure B.3.

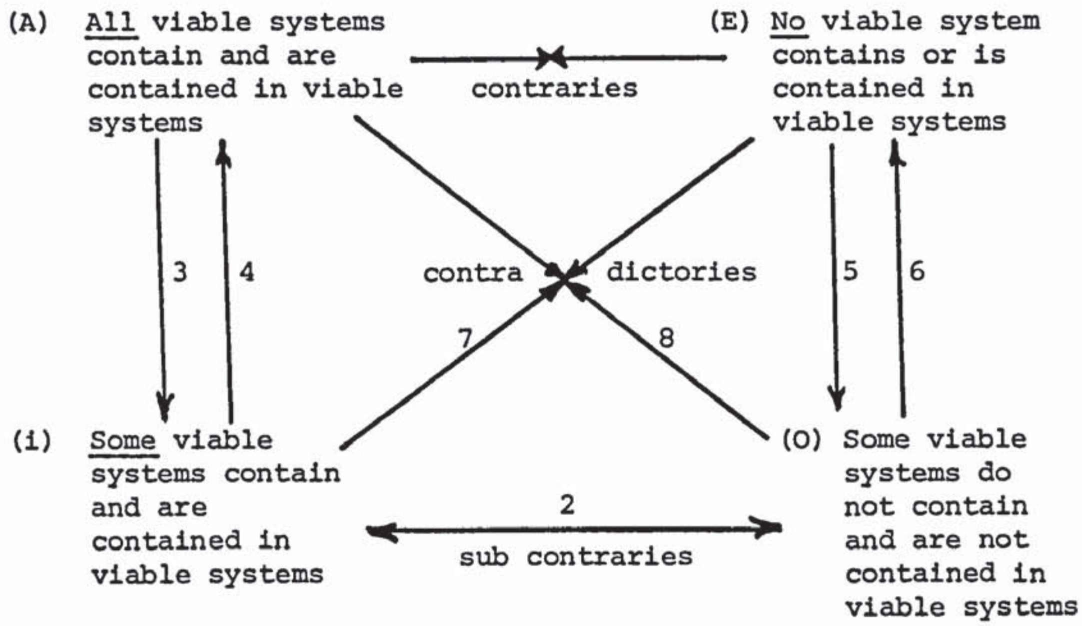


Figure B.3 The Square of Reasoning

A detailed discussion of this square of opposition may be found in Copi (1972, pp 151-158, 322-327). In general one can say that: A and E (1) cannot be true together,
I and O (2) cannot be false together,
If A is true then so is I (3)

and If E is true then so is O, (5)

The truth of I supports A (4)

and The truth of O supports E, (6)

The truth of I contradicts E (7)

and The truth of O contradicts A (8)

The contrary relationships of (7) and (8) are the relations of falsification advocated by Popper and the relations (4) and (6) are the relations embodied in the positivist principle of verification. It is now clear that although positivist and falsificationists choose, for whatever epistomological reasons, to emphasise different relationships they do in fact share the same deductive framework.

There are, of course, many differences between positivist and falsificationist thought which are not covered here and this inevitably means the accounts given here are necessarily crude and incomplete. However, some effort has been made to capture the essential issues so as to provide the reader with a rough guide.

B. 5. Kuhnianism

Kuhn's (1962) work is important and is mentioned here not only because of its contribution to 'the debate' in the philosphy of science but also because it is the source of what has become perhaps the most widely used academic buzzword "paradigm". Paradigms are examples which members of a scientific community share as the basis for working in co-operation with one another. Within a particular field of science there will be one or a number of paradigms which are in competition to become 'the establishment' to which the majority of scientists working in that field will give their allegiance. Paradigms begin with some general theory and, supplant their competitors by impressing scientists, a sort of 'bandwagon' effect.

A paradigm supplies, to participating scientists, a number of conventions. Firstly, it supplies sets of problems which will be the articulation of the paradigm. Secondly, it supplies methods for tackling the problems of the paradigm so as to allow humbler members to participate in research. Thirdly, a paradigm supplies criteria of success so that successful solutions are defined or characterised while failed predictions may not be regarded as significant. Finally, paradigms supply ways of interpreting what is observed so that as long as scientists see things the way the paradigm does there can be no disagreement about the 'observed facts' within the framework.

It is clear from the preceding discussions that the concepts of paradigm and Weltanshauung are closely related.

> "What were ducks in the scientist's world before the revolution (change of paradigm) are rabbits afterwards. The man who first saw the exterior of the box from

> above later sees its interior from below. Transformations like these, though usually more gradual and almost always irreversible, are common concomitants of scientific training. Looking at a bubble-chamber photograph, the student sees confused and broken lines, the physicist a record of familiar subnuclear events. Only after a number of such transformations of vision does the student become an inhabitant of the scientist's world, seeing what the scientist sees and responding as the scientist does".
>
> Kuhn (1962 p 111).

In providing ways of interpreting 'facts' the paradigm supplies a network of ideas, beliefs about other facts, which will channel the observations of any of the scientists perceptions i.e. 'new facts' will be seen in the light of the 'established facts'. Here one might think of 'enculturation' described by Collins (1974, 1975). Not only does a student learn to see things like his mentor, but to do them like the mentor and therefore to get the same experimental results i.e. he enters the culture of his mentor.

For a particular scientist, or manager, concerned with specific knowledge areas there will be a 'given' Weltanschauung which comes in according to the area of concern occupying attention. For instance, a manager will have one Weltanschauung, with particular 'core constraints' or construct systems for industrial relations; another for dealing with production problems, another for marketing etc. etc. and these, whilst forming discrete foci, may all be interrelated. This is consistent with the concept of Weltanschauung developed in Chapter 3 and applied in Chapter 5.

Kuhn's treatment of science is from the historian's point of view and he notes that both the previous accounts given above do not seem to account for science as it has been practiced by the 'scientific community'. Against falsificationism Kuhn states that:

> "once it has achieved the status of paradigm, a scientific theory is declared invalid only if an alternate candidate is available to take its place. No process yet disclosed by the historical study of scientific development at all resembles the methodological stereotype of falsification by direct comparison with nature." Kuhn (1962 p 77).

Kuhn's attack on positivism and its related theories is wide ranging and persuasive. It rejects the positivist view of the growth of knowledge which is summarised in Fig. B.1 above because it implies that successive theories are not in conflict with one another but that later theories subsume earlier ones to make the latter a special case of the former. By way of example he considers the change (Revolution) from Newtonian dynamics to relativistic dynamics.

> "Can Newtonian dynamics really be derived from relativistic dynamics? What would such a derivation look like? Imagine a set of statements, E_1, E_2, ... E_n, which together embody the laws of relativity theory .... To prove the adequacy of Newtonian dynamics as a special case, we must add to the E_1's additional statements, like $(v/c)^2$ 1, restricting the range of the parameters and variables. This enlarged set of statements is then manipulated to yield a new set, N_1, N_2, ..., which is identical in form with Newton's laws of motion, the law of gravity, and so on .... Though the N_1's are a special case of the laws of relativistic mechanics, they are not Newton's laws. Or at least they are not unless those laws are reinterpreted in a way that would have been impossible until after Einstein's work. The variables

and parameters that in the Einsteinian E_1's represented spatial position, time, mass, etc. still occur in the N_1's; and they still represent Einsteinian space, time, mass. But the physical referents of these Einsteinian concepts are by no means identical with those of the Newtonian concepts that bear the same name. (Newtonian mass is conserved, Einsteinian is convertible with energy. Only at low relative velocities may the two be measured in the same way, and even then they must not be conceived to be the same). Unless we change the definitions of the variables in the N_1's, the statements we have derived are not Newtonian." Kuhn(1962 pp 101-102)

Kuhn's view of science does seem to represent a useful step forward in the debate and would suggest that to be scientific one only has to attach oneself to a paradigm and work within the conventions of its 'normal science'. For this study, for instance, one might be seen as working within the Checkland, the Beer or even the general systems paradigm. However, the debate goes further because the falsificationists have argued that their view is not fundamentally in conflict with Kuhn's. Nevertheless, Kuhn's views remain powerful for many. For an application of this model to Management Science see Dando and Bennett, 1981.

It might be argued that paradigm change does not proceed according to any rational process, a feature shared by falsificationists. Also, such an interpretation does not seem to offer any hope for scientists who disagree, because it would be argued that they are using different concepts, that is, viewing phenomena through a different paradigm.

B.6. Sophisticated Falsificationism

The argument for this form of the falsificationist school is given by Lakatos (1970) in Criticism and the Growth of Knowledge. To this work the views of Kuhn and the falsificationists are effectively harmonised. No attempt will be made here to give a full account since it should serve the purpose of the general argument if the essential difference from the Kuhnian view is outlined.

The Lakatosian equivalent of the paradigm is the Research Programme. Lakatos accepts the social aspects of scientific activity so ably identified by Kuhn but argues that Kuhn is mistaken in maintaining that no process yet discovered "resembles the methodological stereotype of falsification by direct comparison with nature". It is accepted that paradigms are 'ways of looking at things' but:

> "One must never allow a research programme to become a Weltanschauung, or a sort of scientific rigour, setting itself up as an arbiter between explanation and non-explanation, as mathematical rigour sets itself up as an arbiter between proof and non-proof. Unfortunately this is the position which Kuhn tends to advocate; indeed, what he calls 'normal science' is nothing but a research programme that has achieved complete monopoly. But as a matter of fact, research programmes have achieved complete monopoly only rarely and then only for relatively short periods, in spite of the efforts of some Cartesians, Newtonians and Bohrians.
> The history of science has been and should be a history of competing research programmes (or, if you wish, 'paradigms' but it has not been and must not become a succession of periods of normal science: the sooner

competition starts, the better for progress. 'Theoretical pluralism' is better than 'theoretical monism': on this point Popper and Feyerbend are right and Kuhn is wrong". Lakatos (1970 p 155).

It should be noted that there is a slight difference of emphasis here. Lakatos uses "Weltanschauung" in a way which suggests that it is both unchanging and undifferentiated whereas the author's view is that a Weltanschauung is differentiated around core constructs, and that it can, logically, change a great deal, even if contingently it often changes very little.

A research programme is conceived as having two fundamentally different components as illustrated in Figure B.4.

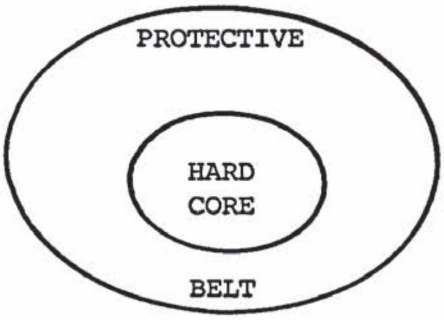


Figure B.4
The Research Programme

The hard core of the programme is not subjected to modus tollens and is thus regarded as irrefutable. The articulation of the programme generates a protective belt of auxiliary hypotheses to which modus tollens is applied according to the methodology of crude falsificationism. This protective belt is regarded as expendable to the programme and will characteristically change its composition through time.

The hard core will consist of the core constructs of the programme which will be embedded in its central hypothesis. The methodology of the hard core is the "Negative Heuristic" in which counter examples are deflected by generating suitable auxiliary hypotheses which attempt to change the "observations" that constitute the counter examples. The hard core is not invincible and will fail when the heuristic power (the ability to open up new lines of enquiry) of the programme is exhausted.

> "The idea of 'negative heuristic' of a scientific research programme rationalizes classical conventionalism to a considerable extent. We may rationally decide not to allow 'refutations' to transmit falsity to the hard core of the protecting belt of auxiliary hypotheses increases. But our approach differs from Poincare's justificationist conventionalism in the sense that, unlike Poincare's, we maintain that if and when the programme ceases to anticipate novel facts, its hard core might have to be abandoned; that is, our hard core, unlike Poincare's, may crumble under certain conditions".
>
> Lakatos (1970 p 134).

The 'positive heuristic' of the research programme generates and modifies the protective belt so that:

> "....the positive heuristic of the programme saves the scientist from becoming confused by the ocean of anomalies. The positive heuristic sets out a programme which lists a chain of ever more complicated models simulating reality: the scientist's attention is riveted on building his models following instructions which are laid down in the positive part of his programme. He ignores the actual counterexamples the available 'data' ".
>
> Lakatos (1970 p 135).

The heuristic power of the programme lies in its ability to generate a "problem shift" which arises from the dynamic nature of the protective belt. This will, in effect, generate work for scientists because the articulation of the programme will only be partial and there will usually be Kuhnian "puzzles" to solve. Since a programme will often have competitors its continued existence will be solely dependent upon it being able to maintain its heuristic power.

It should be clear by now that the developed falsificationist and Kuhnian views of science are closely compatible and represent a highly developed and plausible view. However, one should remember that all the theories described above treat the world as a closed system and so characterise science and scientists as exploring the regularities (invariances) in phenomena. Therefore the theories of science are seen as embodying the laws which generalise the regularities of nature in a descriptive way. Explanation and prediction are seen as symmetrical, arising from a deductive relationship between a law and the phenomena that it generalises.

An alternative view of science being advocated by the author is Transcendental Realism (Harre 1970, 1972, 1979; Bhaskar 1975). This is explained in some detail in Chapter 2.

APPENDIX C

The Systems Movement and Some Related Concepts

C.1 Introduction

The material of this appendix is complementary to the discussion of organismic modelling (OM) in Chapter 4. Many of the important concepts associated with OM are not dealt with in any detail in that Chapter and this is in the interests of ensuring that the discussion does not divert attention away from the main concern of the early chapters; namely to identify a suitable methodological framework for complex problem solving. The material of this appendix may also be of value in relation to some of the other chapters. The discussion here begins with a short look at the systems movement. This is followed by a discussion of some specific concepts including homeostasis, complexity and variety, control, functionalism, and meta language.

C.2 The Systems Movement

The concept of system is very old and goes back into the mists of time. It is explicit in writings of the 17th Century Rationalists such as Leibnitz and Spinoza. These systems and their authors were holistic, some would say naively so, in the sense that they claimed to give an account (explanation) of all that is, so that from an understanding of the ontology of the universe, inferences were made about man's material, intellectual, spiritual and ethical positions. Spinoza's whole universe was an infinite set of entities (of a single nature - substance) interacting through an infinite set of connections to produce an infinite set of states of affairs. Leibnitz's universe, by contrast, contained an infinite set of entities (monads or substances) whose most notable characteristic was that they had no causal interaction with one another whatsoever.

Although it manifests itself in a different way in the writings of modern systemic thinkers (see Chapter 2 for a more detailed discussion) holism is a hallmark of all systemic thinking. It has been recognised that man cannot hope to pronounce confidently on "all there is" so that modern holism manifests itself in a recognition of emergent properties and the need to consider "the wider system".

Ashby makes the need to retreat from naive holism clear:

> "Systems theory is essentially a demand that we treat systems as wholes, composed of related parts, between which interaction occurs to a major degree. No-one supports this demand more willingly than I do but ...

having won our battle for the admission of interaction, we must now learn moderation ... systems theory, having broken away successfully from the extreme 'classic' attempt to treat the whole as consisting of isolated parts, cannot go to the other extreme". Ashby, 1972.

One way in which systems thinkers have maintained some scope to pronounce on "all there is" is by pursuing the idea of principles of systems in general so that we can say something in principle about all systems including the ones not yet known to us. In modern times this idea was formally introduced by Von Bertalanffy and developed in later work:

" ... we can ask for principles applying to systems in general, irrespective of whether they are of a physical, biological or even sociological nature. If we pose this question and conveniently define the concept of system, we find that models, principles and laws exist which apply to generalised systems irrespective of their particular kind, elements and the "forces" involved". (Von Bertalanffy 1968 p.33).

Von Bertalanffy was not slow to find like minded people including the economist Kenneth Boulding:

"I seem to have come to much the same conclusion as you have reached through approaching it from the direction of economics and the social sciences rather than from biology - that there is a body of what I have been calling 'general empirical theory' or general system theory in your excellent terminology, which is of wide applicability in many different disciplines. I am sure that there are many people all over the world who have come to essentially the same position we have, but we are widely scattered and do not know each other, so difficult is it to cross the boundaries of the disciplines".

(K. Boulding quoted in Bertalanffy 1968 p. 14)

What emerges is a consequence of holism, namely the inter-disciplinary nature of the systems approach and one begins to see why this approach is right for this kind of research; for if organisational problems are essentially complex so that one must treat the relevant systems as 'open', then adequate thinking about these systems will necessarily cross the traditional academic boundaries which have evolved and proliferated in modern times.

Since World War II systems thinking and theory have evolved to uncover "principles of systems in general" to a degree which has led to the emergence of structure (reduction) on a functional rather than a physical basis. The areas of enquiry defined by this structuralisation are not totally unalike the traditional disciplines but are not defined by an answer to the question 'what kind of thing is <u>the</u> problem associated with, a chemical thing, an atomic thing, a metal thing, a hydraulic thing etc. etc.?' as the traditional disciplines tend to be. They are defined by the answer to questions such as 'what <u>kind</u> of problem is this?' or 'what <u>aspect</u> of of the <u>system</u> are we considering?' The theories and principles that emerge are therefore not the theories or principles of mechanics or hydraulics but the theories and principles of control, communication, entropy, organisation etc. etc. The only "thing" that these concepts and principles are specific to is the "concept thing" called "system".

This should not be viewed as a simple regrouping of existing "facts", for as we have seen (Chapter 2) knowledge has a transitive as well as an intransitive element, so that regrouping produces new knowledge as well as new gaps in our old knowledge.

The systems whose principles are generalised by systems thinking range above and below the level of the human individual and any cultural artifacts (Popper's World 3 (Popper 1976)) and some attempt was made, in the previous methodological chapters, to show that all these systems tend to share a common property namely "openness". Complexity is the key differentiating factor and provides the scale against which a system may be said to be above or below the level of the human individual. Boulding (1971) has classified systems in a hierarchy of complexity ranging from static frameworks to the transcendental. Ashby (1956) and Beer (1966) have made notable contributions to to our conception of complexity and Ashby's law of Requisite Variety has provided the basis of an area of cybernetic thinking.

Ackoff (1972) cites the emergence of semiotics, communication theory (Shannon 1948) and cybernetics (Wiener 1948) as important systemic developments since World War II. In a letter quoted by Cavallo (1979) Ackoff itemises the ideas of system, expansionism (holism) and objective teleology as the three age-shattering ideas to emerge since World War II to form the <u>Systems Age.</u> This idea of system is compatible with the idea of system as a set of interrelated parts, a whole, whose essential properties are not all analysable out with the parts.

Ackoff stresses the synthetic nature of systems thinking which seeks understanding of a thing "... in terms of its role or function in the larger system". This leads to what he calls " ... the doctrine of expansionism, ... /which/ ... depends on understanding larger and more inclusive wholes".

A recognition of the complexity of the world faced by man as well as the possibility to view it differently is central to the systems approach. The classic reductionist approach assumes away most of this complexity and strives for the impossible with a methodology that has only limited pragmatic success to recommend it, a success that is only manifest in relation to systems which, although open, have a relatively low level of complexity. Klir recognises the need to avoid unnecessary reduction:

> " ... developing methodological capabilities for solving systems problems in their natural formation, with no simplifying assumptions at all ... or, if unavoidable, with such simplifying assumptions which make the problem manageable, distort it as little as possible, and which are integrated as part of the solution with an indication of the incompleteness they imply. Within general systems research, the tools for solving the problem are of secondary importance and are chosen in such a way as to best fit the problem rather than the other way around. Moreover, the tools need not be only mathematical in nature but may consist of a combination of mathematical, computational, heuristic, experimental or any other desirable aspects".
>
> Klir, KL page 24 Cavallo 1979

This section has attempted to give a feel for the general character of the systems approach and is not an attempt to describe it systematically. Undoubtedly, a fuller treatment would have been possible but of doubtful value. The contributions of von Foerster, Churchman, Rapoport, Vickers, Wiener and others are of interest. However, the treatment given should provide sufficient setting within which to develop the models of Chapter 4. In the next section specific concepts will be investigated and again these will not cover the complete range of systems concepts but are those of specific relevance to the type of organisational model that are developed in Chapter 4.

C.3 Homeostasis

"Homeostasis" is the name of a process which takes place between two or more subsystems of a system* and represents the unavoidable tendency of interacting systems to "accommodate" one another. Following Beer (1966) consider the diagram C.1. in which two systems are interacting.

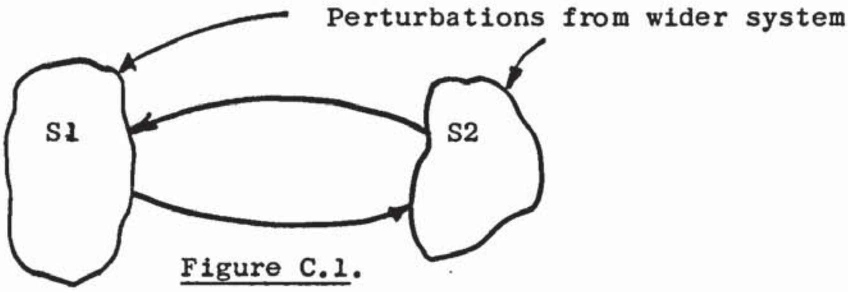


Figure C.1.

Interacting Systems

The inputs of one system are the outputs of the other and vice versa so that the state of each system determines the state of the other (wider system inputs remaining equal). Providing that the transformation functions of the systems remain constant, so that perturbations from the wider system are insignificant, the dynamic path of the interaction will necessarily follow a fixed pattern (even if we do not know what it will be) and the systems behave as interconnected deterministic machines. However, it is only in a special case that this relationship becomes homeostatic and the first condition for this arises when the dynamic path, the trajectory, of these systems is circular so that these systems reach an equilibrium as illustrated in Figure C.2.

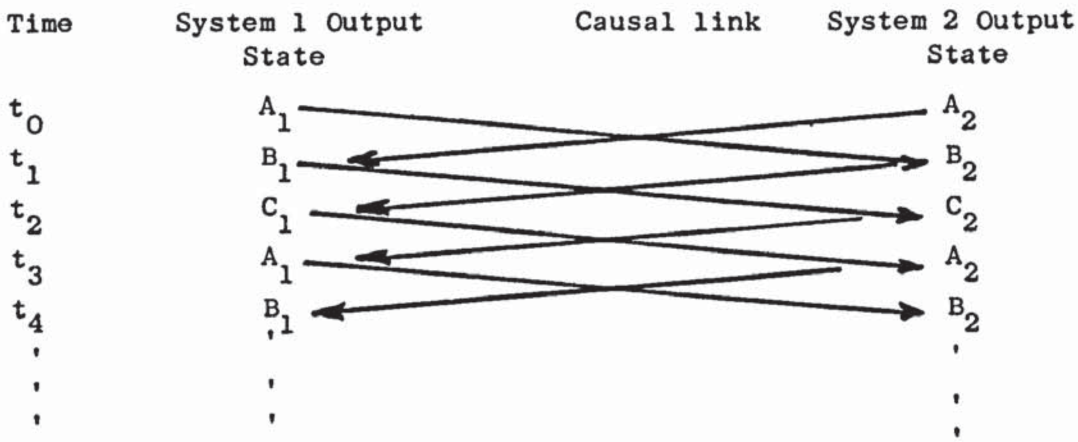


Figure C.2.

Interconnected, Deterministic Machines

* Where there are two systems in interaction there is a third system (Spinoza 1677 p 50), the system they are in, here this is called a meta system.

This example assumes that the state of any one system in a given time period is dependent upon the state of the other system in the previous time period so that the state of any system ranges between A and C and always returns to a given state in a regular time period.

Now if it is allowed that the possible set of states of any of these systems is $A_1 - A_n$ it follows that the range of states actually manifest will be determined by the range of states of the other system and where the relationship is homeostatic the range manifest will be some subset of A_1 to A_n i.e. A_1 to A_k.

The other condition for homeostasis is that this equilibrium should be able to resist the effect of disturbances, what has previously been called "perturbations" from the wider system. An equilibrium that can resist the slightest perceivable degree of perturbation is homeostatic but clearly in the management of social systems more <u>stable</u> equilibria are of interest in the sense that these dynamic states are what the intelligent elements in these systems are attempting to foster. When the tolerable range of disturbance becomes very large and the subset A_1 to A_k very small, the (meta) system can be said to be ultrastable (Ashby 1956).

This raises the question of how large must the range of tolerance be to qualify as ultrastable? All systems with a physical embodiment may perish at some stage given a large enough disturbance, i.e. homeostasis is destroyed. In this work the definition provided by Beer (1966) is roughly followed so that an ultrastable system is one where disturbances not evisaged by the system designers are successfully resisted. This may require some qualification since many social systems evolve as a product of how they have been in the past and how a series of owner/actors would have liked them to be. This requires that the defining set of individuals include such owners and actors as <u>have influenced</u> the shape of the system and these individuals may not have been conscious of performing a design role.

Having briefly discussed homeostasis we now move on to consider complexity and variety.

C.4 Complexity and Variety

It has been argued by Beer (1966) after(Ashby 1956) that complexity is the most notable feature of social systems and serves to make these systems probablistic to an observer. This high level of complexity is a function of the complex mechanisms inside and outside social systems and manifests itself in varying degrees of openness or uncertainty for particular observers depending upon the adequacy of their iconic models of the mechanisms concerned (see Chapter 2). Environments will necessarily be far more complex than their systems so it follows that an observer's iconic model of any environmental mechanism is less likely to be adequate than any model of the system's mechanism, particularly where the observer is an actor in the system. Actors will tend to have sentential rather than iconic models of the environment so that any understanding will usually be embodied in inductively based "proto laws". (Harré 1970).

In order to cope with complexity and control in social systems Beer has argued that it is necessary to measure complexity in terms of Variety, (following Ashby 1956) defined as the number of possible states of a system (Beer 1972). These ideas are developed and utilised in Beer (1966, 1972, 1979a and 1979b) and have been taken up by others including Davis et al (1979). This concept seems extremely attractive at a conceptual level but it is doubtful that attempts to compute variety can lead to a precise way of dealing with systemic problems as Beer seems to suggest. To begin with, the very high variety to be measured in a social system makes computation difficult to envisage while that of an environment is usually beyond comprehension. In order to appreciate the strengths and weaknesses of this concept it is necessary to consider it in more detail.

Ashby (1956) defined variety as the number of distinguishable elements and Beer's definition is tied to this. If the number of possible states of each element is taken to be two, then the variety is 2^n where n is the number of distinguishable elements. However (developing from Beer) for a given number of elements the possible number of states that an observer might envisage or expect in a time period t_0 to t_1 and the actual number of states manifest need not, and usually do not, equate.

$$V \text{ expected } (t_0 - t_1) \neq V \text{ actual } (t_0 - t_1)$$

This difference is a function of the imperfect knowledge of the observer, since an observer with perfect knowledge would anticipate, through the adequacy of his iconic models, which states woiuld be actualised between t_0 and t_1.

In a social system actors/observers will usually have beliefs about the states that will be manifest in the system and its environment, and this constitutes what has been termed here as "expected variety" (Ve). However, some expected states may not be manifest while some unexpected states are, and this is a function of the openness of the system for those actors/observers. These states, the manifest variety (Vm), constitute the variety that the actors in the system must cope with; managers must cope with the Vm of "their" system and systems must cope with the Vm of "their" environments.

For a given time period, therefore, Vm will be greater than V actual (Va) except where Va = Ve and actor/observers knowledge is perfect. Therefore:

$$Vm = Va + \left| Va - Ve \right|$$

Following from the concept of Variety there is Ashby's law of Requisite Variety which states that "only variety can absorb variety". This is a game theoretic concept and is well illustrated by the homeostatic relationship described in Figure C.1 where two systems absorb each other's variety and the variety of a wider system or environment but still maintain an equilibrium. This law is an expression of the fact that there must always be an equilibrium and where the relationship is homeostatic the equilibrium will be stable within a determined range of variation.

The discussion above helps to underline the centrality of individual Weltanschanuungen in the whole process and to warn against naive uses of notions such as variety. Without the idea of expectations and norms (W's) one is left with a fairly mechanistic view of the organisational system interaction process. The discussion has been all too brief but we now move on to "control".

C.5 Control

The concept of control is fundamental to the approach developed here and by Beer. It draws upon the concepts of homeostasis and variety discussed above and may be considered as a type of regulation or homeostasis with special distinguishing features.

If we return to the homeostatic system in Figure C.1 the two subsystems S_1 and S_2 regulated one another in the sense that the output of 1 determined the output of 2 and 2 of 1 etc. Taken as a whole system we might say that the system was self-regulating since it is the nature of the system, its elements and processes, which determine the behaviour of the system. The distinguishing feature of this sytem is that each subsystem influences the other equally, not only are the actual varieties balanced in the short term (required by the law of Requisite Variety for homeostasis) but also in the long term i.e. for the duration of the homeostasis. It will be argued, however, that control is synonymous with situations where the Va's are balanced in the short term but not the long.

This distinction aims to identify that feature of the concept which goes with the idea of being able to determine events. It should be noted that S_1 determined the output of S_2 but did not itself have a "choice" about what S_2 output it caused since S_2 had equal power to determine its output. For S_1 to control S_2 then S_1 must have a range of possible outputs (responses) to any S_2 input so that S_1 must be capable of setting a different homeostatic value. If the Va's of the subsystems are equal and both systems are prepared to actualise this variety in relation to each other then the whole system will remain self regulating and no subsystem will gain control. However, it may be that S_1 has a smaller Va than S_2 , but if S_1 is prepared and able to couple more Va than S_2, then S_1 will, over a range of activity, control S_2. This is because in reality individual systems are often multiply connected so that the Va of an individual system will be actualised amongst different relations. A human individual for instance will employ some knowledge, skill and energy in varying degrees between his family, work, recreation etc. all of which involve systemic relations with different techno-social systems. To clarify this distinction let the total Va that a system could couple to another system have the notation "Va,m." for the maximum actual variety. For the variety coupled in the current time period the notation "Va,a." will be used.

This mode of analysis is vital to understand the kind of organismic approach developed , which seeks to apply a common analysis to all homeostatic systems which may be "characterised" as seeking survival. The organism cannot, with its inherent variety, control the environment in the manner developed above, although it may where suitable amplifiers and filters exist to reduce the effective variety of the environment and increase the effective variety of the system; this is because environmental Va,m system Va,m. However, social and biological organisms, are often successful in controlling their own destiny because they have models of environmental variety, or at least the mechanisms in which it is embodied and can often select from amongst environmental Va,m which, but not any, subset (Va,a) to interact with i.e. which subset to actualise in relation to that system as opposed to systems in general. This is a vital point.

Where the environment produces variety that a system cannot avoid and which is not conducive to the survival of the system, the system must become adapted to a new homeostatic relationship and this will involve reorganising internal homeostatic relationships so as to accommodate the system inputs and outputs demanded by the environment (the controller) of that system. Where a system cannot do this it must "die" as in a case where the rate of change of environmental norms far exceeds the rate of change of systems norms. In Ashby's Terms systems must change their essential variables either in acceptable range or kind.

The final control relationship to be considered has already been mentioned and involves the use of amplifiers and filters. If the case of primitive man in relation to his physical environment considered it can be envisaged that a man might choose to interact with a subset of a general environment to create a shelter, perhaps using only his hands. However, what the man has created is a filter which he can interpose between himself and the general environment so that the worst extremes of the climate are mediated. If now a man develops tools and skills through which to apply them he now has amplifiers which greatly increase his effectiveness, not only to manufacture helpful filters, but also to meet more environmental Va,a 'head on'. Viewed in this way Popper's world 3 can be divided into two classes, one of which dramatically decreases the effective Va,m of any environment. From this point on the term "relevant environment" refers to the actual variety Va,a that a system is homeostatically coupled to and the term "general environment" refers to the wider set, the possible variety Va,m that the system might be coupled to, either directly or through filters and amplifiers.

To summarise. In terms of maximum actual variety environments are, by definition, inherently more complex than any system to which they relate, so that, ceteris paribus, environments control systems but the existence of filter and amplifiers may tend to negate or even reverse this control relationship. It has also been shown that systems often have discretion over which relevant system they interact with.

At this point the concept of control must be concluded so that functionalism can be examined.

C.6. Functionalism

Nagel (1961) following Merton (1957), has identified important features of functional analysis in biology and the social sciences, particularly sociology. Various uses of the term "function" are identified and the sense of "function" which refers to the role an entity plays in some system of which it is a part is discussed along with others.

In a more recent work by Prevost (1976) functionalism is discussed as part of the "analytical tradition in sociology" which is defined as:

> "the set of researches carried on with the explicit aim of building an explicative scientific theory of social organisation, its operations and changes".
>
> Prevost (1976).

This paper argues that Checkland's methodology has functionalism as its theoretical context and now has little to do with the theoretical framework of classical or "hard" science where it might be considered to have its historical origin. However, Naughton has rejected this view (1979) prefering to see Checkland in terms of "craft knowledge" as described in Chapter 2 above. "Function" is defined as "the contribution of an element to the organisation or to the overall action of the set of which it is a part". Prevost cites the following four assumptions as prerequisites for the legitimate use of functional statements in biology which in turn is the origin of functional statements in sociology and anthropology.

> " - First, the system must be assumed to be goal directed;
> - Secondly, the end-states must be clearly described and the range of tolerable variation stated;
> - Thirdly, the mechanisms whereby an item fulfils a function must be portrayed in detail. This condition is essential to the use of functional statements because it is through statements about the mechanisms that the relation and the end-state which it maintains is explained in causal terms.
> - Fourthly, the description of these mechanisms must include reference to processes whereby changes in the end-state produce compensating changes in an item. These are known as negative feedback mechanisms and they are essential in maintaining the stability of biological organisms".
>
> Prevost (1976)

The idea of goal directedness is central to functional analysis and can only be understood in these terms. Without the notion of outcome or result from an element's interaction in a greater system a cam shaft could not be understood as the functional valve lifter and a train could not be understood as a mode of transport.

Such functional descriptions are neutral in respect of the actual, real mechanisms or entities referred to so that any mechanism capable of catching mice is a mousetrap and this functional description is indispensible in identifying this set of mechanisms:

> "Every mousetrap can be identified with some mechanism, and being a mousetrap can therefore be identified with being a member of some (indefinite) set of possible mechanisms. But enumerating the set is not a way of dispensing with the notion of a mousetrap; that notion is required to say what all the members of the set have in common, and in particular, what credentials would be required to certify a putative new member as belonging to the set".
>
> Foder (1968) p.p. 116-117

The inherent goal directedness and the ability to name classes of mechanisms independent of structure reflects, to a large degree, the implicit holism of functionalism:

> "The term functionalism has been used to describe the analysis of social and cultural life from the standpoint of wholes or systems. This point of view has been manifest in all the social sciences "from psychology through sociology, political science, economics, and anthropology to geography, jurisprudence and linguistics". Although there are several connotations of the word functionalism, its most important aspect is the emphasis upon systems of relationships and the integration of parts and subsystems into a whole. General systems theory and the functionalistic point of view (including dynamic equilibrium concepts from economics) offer a theoretical framework for the study of organisations".
>
> Johnson et al (1963) p. 11

The reference to a camshaft as a valve lifter stresses this entity's relationship with a larger system as well as identifying the goal or outcome of its interaction with a larger system.

The role of "goal" can generate some problems at a fundamental level. For example it may not be clear what a particular system is a system for. A central part of Checkland's methodology is the recognition that different perspectives will exist amongst common problem owners which makes the problem, and the system with which it is associated in some sense, unique to each owner. Each owner may identify different, and in some cases, multiple purposes of the system. The goal that a mechanism, entity or system "serves" will depend upon the observer.

In this process human beings may be considered as unique since as systems they are members of their functional systems and the system of observers, i.e. they can observe themselves. With these systems other observers have a problem since they must identify the goal(s) served by the activities of human beings in "relevant" systems but also the goals particular individuals may have intended to serve. Without this it is impossible for an analyst to define and alleviate the "problems" of others. At the most abstract this situation is subject to the problem of other minds and its ramifications (Vesey 1964) but this problem cannot be usefully explored in this study.

In complex open systems the outcome of any action, the product of any active mechanism will be equally complex so that some outcomes may be manifest which were not intended or which are not considered desirable. In the former case functions are "latent" as opposed to "manifest"; in the latter case the concept of "dysfunction" may be used to categorise outcomes as undesirable.

The concept of equifinality (Emery 1969) is often employed in systems thinking to characterise the possibility that an indefinite number of paths may lead to the same outcome. This leads neatly to the idea that different structural/physical arrangements have the same product as a result of their interaction with a wider system. Mechanisms with the same outcome are functionally equivalent and for a given mechanism in a given system the possibility of functional alternative always exists, i.e. artificial hearts are functionally equivalent to "real" hearts. For different (in a structural sense) elements may be functionally equivalent so that they perform the same function with their own system but different functions in each other's systems. Cash in a commercial system may be considered as functionally equivalent to blood in the human body but this equivalence does not allow one to be substituted for the other. Thus it is clear that function equivalence falls into two categories, in the first, elements perform the same function in the same system, but not others; in the second, elements perform similar functions in different systems.

Functionalism as manifest in systems thinking often lacks the clear identification of mechanism in the sense quoted from Mulkey (1971) by Prevost but this does not necessarily render the analysis devoid of explanation as Prevost suggests:

> "The conceptual models used are neither explanatory nor predictive. Faced with the complexity of soft problems, and the difficulty of quantification, the methodology

also uses a non-testable conceptual model which is descriptive and/or explorative. ... The conceptual model of Checkland's methodology is explicitly validated according to accepted concepts in the problem area studied".

Prevost (1976) p. 72

It is true that Checkland's models are not explanatory and this point has been made in Chapter 3. However, the type of model developed in Chapter 4 after Beer can be explanatory when the functional description modelled is a level of reality 'below' that which is to be explained. (Bhaskar 1975).

At this stage it is necessary to look at the concept of meta language. This will be dealt with in the next section.

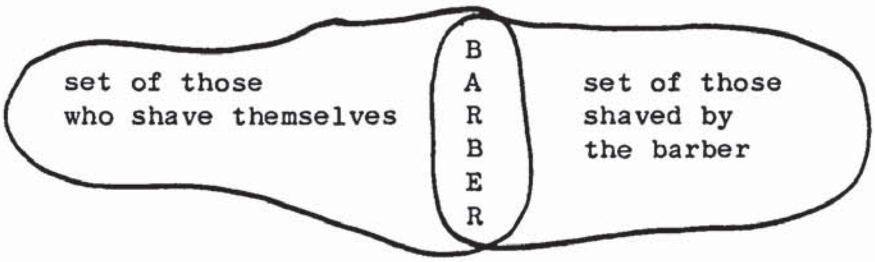
C.7 Meta Language

The concept of meta language is central to the type of organismic model developed below and Beer has based the structure of Platform for Change (1975) on this idea. All languages are used to express a system of thought or concepts (the system of syntactics should not be confused with the web of belief it represents). The basic proposition is that all such systems yield propositions which are 'undecidable' and which require a language 'logically above and beyond' to make clear, i.e. a meta language. Beer gives the following example:

> "The Barber in this town shaves everyone who does not shave himself." Beer (1975) p. 7

This proposition appears to be contradictory but can be made sensible in the meta language provided by set theory. The set of those who shave themselves and the set of those who are shaved by the barber is not mutually exclusive: they overlap, and it is in this overlap that barbers who shave themselves exist:

Adapted from Beer 1975 p. 9



The property which makes a language "meta" is relational and does not depend upon the properties of language which, for instance, make English different from French. In fact, meta language arises as a function of a logical property associated with a particular network or framework of concepts which has a wider range of coherence in relation to some other network, i.e. a Weltanschauung. A consequence of this is that a meta language and the nominal language to which it relates may be expressed in the same spoken language such as English.

The language of a controller is held to be meta with respect to the system controlled and this is related to the concept of recursion discussed in the next section. It is interesting to note that since differences in meta language is dependent upon W's the source of the distinction must lie in the Weltanschauungen themselves. That is to say that where meta and sub relations exist there are met and sub W's. These differences play an important part in defining system wholes and levels which form what has been described as recursion. Recursion will therefore be discussed in the next section.

C.8 Recursion

A central concept in systems thinking is the idea that the world consists of sets of systems arranged in some kind of hierarchy. Boulding, (1971) for instance, shows systems to be arranged in a hierarchy of complexity as in Figure C.3.

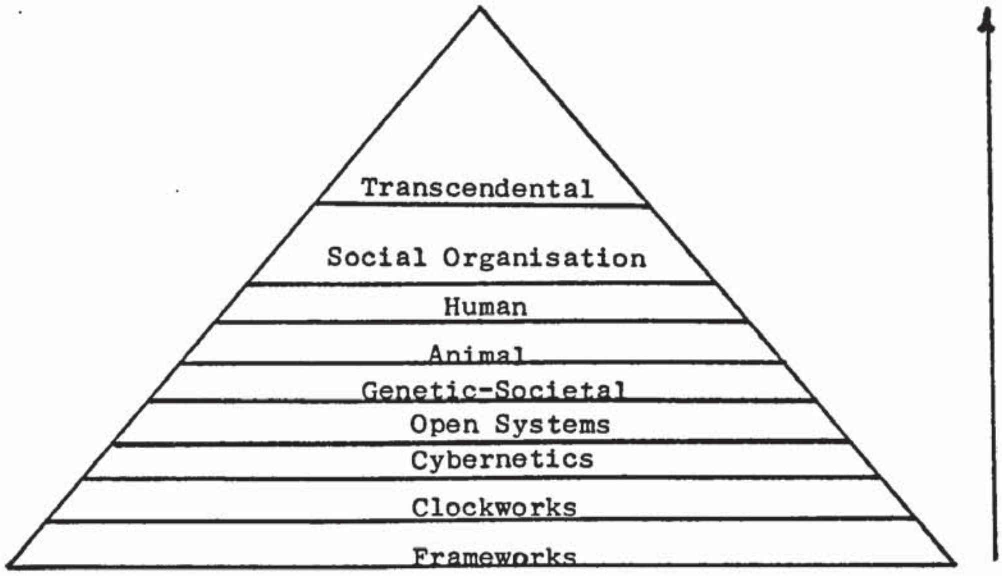


Figure C.3.

A Hierarchy of Complexity

The world arranged in a hierarchy is a fairly common conception. The realist view of science discussed in Chapter 2 has 'hierarchy' as a central concept so that science proceeds when it uncovers another layer of reality.

Although hierarchy is central to recursion it is not the complete concept (necessary but not sufficient). To complete the idea the concept of functional equivalence is necessary. A system described at a lower level of recursion is described in terms of its parts and functional equivalence means that the functional properties of the whole are found in the parts. An important implication of this is that any model which described a recursive system has the potential to explain the operation of that system by describing a lower level of recursion which will contain the causal mechanisms responsible for the phenomena produced by the system.

Recursion is an important feature of the model of a viable system outlined in Chapter 4. Beer states the principle as follows:

"If a viable system contains a viable system, then the organisational structure must be recursive".
Beer (1972) p. 287

The logical implication of the theorem is that the chinese boxes that represent the nesting of viable systems involves an infinite regress, for if any viable system does not contain viable systems and is not contained in a viable system then the structure is not recursive.

Beer's idea is captured more concisely in the following definition:

(1) (Def) Every viable system contains, and is contained in viable systems. This definition is also adopted by Beer in Heart of Enterprise (1979) and leads to the logical implication contained in the following principle:

(2) There exists an infinite series of viable systems Since the capabilities of human beings are limited the following principle can be stated:

(3) Any analysis will involve only a finite series of viable systems. This in turn implies that:

(4) In the limits of analysis viable systems have to be treated as black boxes. One principle remains and this also stems from functional equivalence:

(5) Any viable system contains, as the next level of recursion, at least two viable systems.

To justify this principle(s) consider the case where a system contains, at the next level of recursion, only one system. If the properties of the part and the whole are the same then there are no grounds on which to differentiate between the part and the whole (this follows from the identity of indiscernibles discussed in Chapter 2). They become functionally equivalent but also indistinguishable in the language of this model. Where there are two or more parts, levels of recursion are distinguishable because, although functionally equivalent, the number of viable systems considered at each level are not identical. A whole with only one part is indistinguishable from its part so that one part recursion levels cannot be sustained. This argument should not, however, be taken as maintaining that two individuals cannot be compound elements in the performance of a function, for it is quite common to find that the chain of command contains many people. If the tasks performed are functionally equivalent the chain becomes a communication channel.

This completes the discussion of concepts which are complementary to the account of viable system modelling in Chapter 4.

APPENDIX D

The Author's First Year Report

COMPANY RESPONSE TO CUSTOMERS

ONE YEAR ON : impressions and proposals

K.J. MOLLOY

19.11.76.

INTRODUCTION AND SUMMARY

This paper is intended to be a discussion document for the first year annual review. The first two sections are included, primarily, for the benefit of those members of the supervisory team who are less familiar with the sponsoring organisation and the years activities. In the third section company activities are grouped into categories on the basis of objectives. Proposals for study in the remaining time are included in the fourth section. These include work on Market segmentation, Buyer values and behaviour, the Area Engineers, Pricing Policy and Delivery Performance. An underlying objective is to focus upon perceptual gaps within the company. Also, possible comparative studies with another organisation is suggested.

THE SPONSORING ORGANISATION

George Ellison Limited is a privately owned, medium sized, manufacturing company, specialising in medium voltage electrical distribution switchgear. The founder, Mr. George Ellison 1873 - 1955, opened a switchgear factory in Paris in 1898. After 8 years production, Ellison sold his French interests in preparation to opening new manufacturing facilities in Warstone Lane, Birmingham in 1907. By 1915 Ellison was employing 300 people on two sites with branch offices in London, Manchester, Newcastle, Sheffield and Glasgow. The present premises in Wellhead Lane, Perry Barr, were opened in 1916.

Research, commenced in 1921, at Mr. Ellison's instructions, lead to the development of a very hard synthetic resin and paper laminate with remarkably good electrical and mechanical properties. The new insulating material was the basis of a separate company in 1929 and became Tufnol Limited in 1944. Between 1946 and 1954 a hydraulics division was formed - later to be a limited company - to supply hydraulic presses to Tufnol Limited. Also, George Ellison S.A. (Pty) Limited was formed to market switchgear and Tufnol in South Africa.

In 1966 the companies were re-grouped under George Ellison Holdings Limited and Evered & Company (Equipment) Limited, a hospital bed and ward equipment manufacturer, was acquired as a subsidiary of the switchgear company. In 1968 the Hospital equipment activity was absorbed on the George Ellison Limited site in Wellhead Lane. The object would seem to have been to stop the losses which had been made on switchgear manufacture for some 5 or 6 years previously by spreading fixed costs over two activities thus raising productivity, output and profitability from the switchgear factory. However, George Ellison Limited continued to lose money.

The company in its present form dates from 1973 when three members of the pre-1973 senior management acquired the failing company with the backing of Barclays Bank. The object of the new owners was to transform the switchgear company into a viable organisation with an assured future.

Survival was the immediate concern. The company began to disentangle itself from the Holdings group. Many group overhead activities such as publicity were dispensed with. Towards the end of 1973 the work force fell by approximately 13%, mostly due to a redundancy program. (Graph I) Invoice factors were employed so as to improve the cash flow situation. The other major strand of the survival strategy has been the introduction of a requirements planning system, based on an I.B.M. Bureau computer package, and aimed at minimising stock in stores and work in progress.

The strategy of the new owners has, in part, been successful. The company has survived, breaking even in the first full year of trading (Oct. '73 to Sept. '74) and making a small profit in the second. However, it is far from clear that the future is in any sense assured.

COMPANY PROBLEMS SINCE OCTOBER 1975

This section is intended to give supervisors, who are not familiar with George Ellison Limited, a flavour of the last year's management problems. What follows is a general and not necessarily comprehensive description of the company's activities with an insight into the main problems which have demanded management attention. Comments are made with the benefit of hindsight and represent my own view rather than any official view within the company.

I. ORDER INPUT

When I joined the company in October 1975, the main area of concern was the order input situation. The general opinion among managers was that the company could only survive a limited period of short time working. Order input had declined steadily from £234,800 in June 1975 to £122,300 in September 1975 and a continuation of this trend made lay-offs seem inevitable. In the event, October (first month of the third financial year) and November showed a significant improvement with orders at £261,000 and £459,800 respectively. November's figure has proved to be the absolute high for the 1975/76 financial year, which has been characterised by a steady decline in order input to finish with September 1976 at £220,000, (see Graph 2). This is alarmingly low particularly when one makes an allowance for inflation.

II. PRICING POLICY

For most of the year and for some time before the prices realised for Ellison products have been held down, both nominally and through discounting. The thinking behind this policy would seem to have been that lower quoted 'real' prices would result in a larger volume of successful tenders. Clearly, revenue per order would fall, but this would be made up by the increased physical volume of orders and thus gross revenue would be maximised. Senior management have now rejected this policy. Some would argue that the steady decline in order input during 1976 provides strong evidence to suggest that demand in this market is not particularly price elastic. Pricing policy is now aimed at restoring the relationship between Ellison prices and those for all manufactured products, which existed towards the beginning of 1975, (see Graph 3). But is this approach sound?

It is true that a large proportion of the business in switchgear is tied to large capital projects and that switchgear represents a relatively small proportion of the total expenditure on such projects. Clearly, even quite substantial reductions in switchgear prices could only have a marginal effect on the number and timing of such projects, particularly in the short term. However, some elasticity must be introduced by the large number of smaller projects associated with the replacement or extension of plant in home industry. The timing of these projects must be more price sensitive since switchgear represents a larger proportion of the total expenditure.

Given a fairly inelastic demand picture the real importance of pricing policy is in relation to Ellison's competitors rather than her customers. Assuming other differentiating features, such as brand loyalty, to be equal, relative price levels between competitors will determine the order of customer preference among manufacturers and this in relation to capacity will determine the proportions of the available market cleared by each manufacturer. Manufacturers whose factories are filling up will eventually quote longer delivery dates than higher priced producers and business will be channeled to the less price competitive manufacturers.

It may not be a serious disadvantage to be among the more expensive producers, so long as there is enough business left over from more competitive manufacturers, to fill ones factory. However, in a contracting market (such as the present one) there may not be enough business to fill all the factories in the market. Ellison's falling order input may not be empirical evidence of inelastic demand but of a contracting market. Indeed, viewed this way, one might argue that pegged prices have made Ellison products competitive for the first time in many years. Decline in the numbers employed in the electrical engineering industry (Graph 1) would seem to indicate that business has fallen more sharply for other members of the industry. Price increases should therefore be restrained to a level that will maintain Ellison's competitive position in relation to competitors. The pegging of prices may have been taken too far but the company should avoid going to the other extreme.

In the above remarks, I have assumed that differentiating features other than price remain equal but this cannot be the case in practice. For instance, there is a good deal of evidence to suggest that industrial buyers exhibit a marked degree of brand loyalty in the face of upward price adjustments. However, it may be a fallacy to assume that Ellison customers will tolerate very large price increases. A preference for Ellison gear must reduce a customer's price sensitivity but it cannot remove it altogether. The danger is that very large increases could go beyond customers sensitivity level. It may turn out that regular customers are more sensitive to the rate of change of price level rather than the absolute level of price.

Most customers will accept increases in line with inflation and no doubt competitors will regularly increase their prices to compensate for inflation. However, future Ellison price increases will be aimed at recovering inflation and returning to the 1975 position vis-a-vis the industry. Inflation should guide the basic rate of price increases but the question is how quickly should the company attempt to move to the old position. A restoration in one step would give approximately 15% to 20% increase overnight which must stand a good chance of alarming customers. The next most reasonable option seems to be to add in the extra in a series of steps. If one decides to increase for inflation on a monthly basis it is very tempting to add the extra at 'x' percent per month. However, 2% extra per month is just the same as 6% every three months to customers who only order every three months. Similarly, 20% extra over 6 months will be equally shocking to customers who order less frequently than once very 6 months, whether the increase in a single jump or at 3.3% per month. Most of Ellison's turnover goes to customers who order relatively infrequently and it seems hard to credit that 20% on top of the going rate of inflation will not test even the firmest customer loyalty. This, I would suggest, means that 1975 price levels can only be restored over a longer period. After all, the decline in prices has been gradual and it may be necessary for increases above the rate of inflation to be equally gradual if traditional customer loyalty is not to be strained.

Assuming that some customer's loyalty will tolerate substantial price increases the effects should not be over estimated. During last financial year approximately 32% of Ellison turnover went abroad, 29% direct. This 32% of the market can have very little loyalty to Ellison which is not price sensitive. In addition, the company can only have close links with a proportion of its home market. The possibility of differential price increases should be considered.

In summary the following points apply. Firstly, price increases should be restrained to a level which will maintain a competitive position in relation to customers. Secondly, increases above the nominal rate of inflation should be phased so as not to alarm customers. Thirdly, differential pricing policies should be considered to allow for different levels of price sensitivity.

III. PRODUCT DEVELOPMENT

In recent years Ellison have been weak in the 660v to 15 kV range of the market. Although technical developments below 660v brought a decline in the use of 'oil break' switchgear in favour of 'air break' during the 1950's, oil break remains strong above 660v. Ellison's product above 660v was known as "A.P.I." (Air Potted - Impulse tested) and in recent years demand for A.P.I. has declined. Some consideration was given to scrapping the product, but about a year ago the following facts emerged. Firstly, the market above 660v was larger than realised. Secondly, A.P.I. was not attractive to much of the market because it did not offer certain integral safety features. Thirdly, a new design "A.P.E.", which did offer the required specification, could be based upon A.P.I. Fourthly, the redesign exercise would provide an opportunity to reduce the production cost of the basic design, since 1950's designs tend to be over-engineered by today's standards.

It was decided to go ahead with A.P.E. with a strategy previously employed on a less sophisticated product. A suitably large order would ensure that any new production capacity would be put to use without delay. Also, such an order would quickly generate cash which would cover the cost of new tools and equipment. At the time there was an enquiry from a customer for £250K of A.P.I. for which Ellison successfully tendered. The customer was persuaded to accept A.P.E. and delivery dates for the first 11 panels were agreed before the completion of the re-design exercise. In the event things have not gone to plan. Firstly, the enquiry was tendered approximately £20,000 below the competition, so the ability of the order to generate sufficient cash must be in doubt. Secondly, time scales for the completion and implementation of the new design were underestimated. Thirdly, there have been some technical problems with the new design. These problems have resulted in the necessity for a new commencement of delivery date and for a time it looked as if a second adjustment would be necessary. In addition to these problems the lack of time has produced poor detailed planning in production. Components manufactured but not ready for installation in a panel were not organised systematically. The lack of time to prepare and plan this project in detail has cost dearly in terms of the general level of organisation associated with A.P.E. Worst of all, delays tend to be in finishing rather than starting with the result that the number of components, assembles and instruments having to be held in stock for extended periods is consdierable. This has aggrevated an already pressing cash flow situation.

IV. PRODUCT DIVERSIFICATION

During the year the now Chairman of the company and the Commercial Manager payed a visit to the Japanese factory of Mitsubishi as part of a series of exchanges aimed at exploring the possibility of George Ellison Limited acting as U.K. outlet for Mitsubishi switchgear products. This arrangement offered advantages to both sides due to a high degree of synergy and Ellison is now the sole U.K. agent for Mitsubishi gear.

Mitsubishi are a very large and diverse company and have experience of the British market through products other than switchgear. However, the switchgear market is industrial and seems to show more resistance to Japanese products than many of the consumers markets such as cars. Increasing publicity relating to unfair competition in consumer markets has made Mitsubishi reluctant to attempt direct entry to the U.K. switchgear market, especially since a previous attempt has failed. A link with Ellison offered an opportunity to gain acceptance through the name of one of the industries oldest members.

For Ellison the advantages are several. Firstly, the Mitsubishi product range is now the Ellison product range, thus providing a much needed extension to the range of products offered. Several years of rationalisation of the product range have dangerously narrowed the product base. The most notable mistake being the dropping of motor control gear. Secondly, this product extension is achieved with the minimum of capital outlay. No extra plant or machinery is required to provide the Ellison mask because labels with the Ellison name and Mitsubishi logo are attached before the gear leaves Japan. Ellison will have to buy and hold some stock, but this is a very small capital outlay compared with the cost of launching Ellison made extensions to the product range. Thirdly, Ellison can capitalise upon the Mitsubishi R. and D. effort. This area has been neglected by Ellisons in recent years with the result that technological developments, such as vacuum switchgear, may require a great deal of

Ellison's future business to be factored. Certainly, the company as it now exists and as it will be for some time to come will not have the resources to lead the market in new developments.

The synergy mentioned above means that both companies should do better under the new arrangements than if they launched the same products independently. Mitsubishi's superior production techniques and facilities should provide high quality products at competitive prices. Ellison's knowledge, influence and prestige should ensure acceptance and maximise sales, at least with Ellison customers.

The arrangement was finalised in time for the Electrex Exhibition (3rd to 7th May 1976) and a range of Mitsubishi products were displayed on the Ellison stand. However, the decision was not easily made. There is always the danger that association with Mitsubishi could damage the Ellison image. Indeed, this fear resulted in Mitsubishi products receiving 'low key' treatment on the stand. No sales campaign has since been launched, but the company must push the products if not the Mitsubishi name. The creation of a components section within the company should ensure efficient processing of customer orders for Mitsubishi products but what about the market? Much of the potential will be lost if Ellison customers, present and potential, are not informed that the company now offers these additional products. Up to the end of October 1976 Mitsubishi sales were only £9,000. Apart from the loss of sales, low turnover may encourage Mitsubishi to seek partnerships elsewhere.

V. PRODUCTION ARREARS

Production at George Ellison Limited is planned on a two month cycle. In month one the components and assemblies are manufactured in preparation for switchboard manufacture in month two. In any one month, production of components for next months switchboards and switchboards from last months components is in progress. However, because shortages of components inevitably arise manufacture of all programmed switchboards is usually not complete. Suppliers of 'made out' components do not always deliver on time. Also, delivery times for some raw materials are longer than those quoted to some Ellison customers, added to which, the system for recording stock and organising component manufacture is less than perfect.

Any production arrears will be carried over into the next months production because work already in the system will usually proceed (shortages permitting) ahead of newly programmed work. In this way arrears build up cumulatively. Table 1 shows the monthly arrears from September 1975. These figures represent the value of production programmed for completion, but not completed at the end of each month. They do not represent the value of orders which are late deliveries to customers because some switchboards are not included in the appropriate program due to Sales/ Drawing Office hold-ups. Although these values represent the expected sales value and not the actual cost of outstanding work, a considerable amount of capital must be tied up in unfinished work which must add to cash flow problems and discredit the company's delivery reputation. In both February and August 1976 the value of arrears rose to over 50% of the average, monthly, budgeted production load of £171,837 for last financial year.

The situation is in fact more serious than shown particularly in terms of the efforts upon customer late deliveries. The £76,000 shown for September 1975 was 'written off' on the 1st October. The program for October contained £75,000 of arrears plus new work to bring load to capacity/budget. In spite of this, arrears at the end of October were £45,000 and grew to £100,000 by February 1976. The improvement in April arose because of poor order input and some product lines were re-programmed in May. By August arrears were estimated to be around £100,000 and the factory was re-programmed again in September, which still showed £20,000 arrears by the end of the month.

Why do arrears build up? There seems to be a number of factors. Firstly, as mentioned above, arrears in any one month are inevitable. Stock control and production scheduling system can have marked effects upon this area. In addition, the components section of the company may be required to produce quantities of a very large range of components and assemblies (Ellison has approx. 4,500 'made in' component and 1,500 assemblies on the books). The machinery employed is old, overdue for replacement, and lacks the flexability of newer machines. Breakdowns are inevitable and production falls behind schedule.

Secondly, the widening scope of Ellison's activities is placing increasing strain upon the component capacity of the factory. Often the system is hard pressed to produce the requirements for Ellison's main range of products. Lower 'real prices' for products will have placed extra emphasis upon increased physical output which will tend to magnify any imbalance between switchboard and component capacity. During the last year the company has formally introduced Completely Knocked Down (C.K.D.) switchboards. Capacity has been increased for other products such as laminated busbars. Both these products require considerable steelwork while C.K.D. makes large demands upon all component sections. A large order for C.K.D. when added to 33/69 switchboards could find component sections loaded well beyond capacity. The launching of A.P.E. switchgear, for which sales of over 500 units is forecast for the coming year, will further accentuate the capacity imbalance. Capacity will have to be increased, particularly in Frame & Weld where steelwork is made or more items will have to be 'made out'.

Thirdly, conflicting objectives seem to prevent corrective action in good time. Senior managers place the highest priority on achieving the output set in the annual budget so as to achieve the corporate objectives of the company. While no-one is happy with continued arrears, re-programming is reluctantly accepted. To do so, carries the implication that output must fall (further) behind budget. During the 1975/76 financial year the factory load was re-programmed three times and still arrears rose to around £100,000 on two occasions. Arrears represent started but unfinished switchboards which monopolise valuable working capital. It would be better not to load work into the factory, than to put it in and not have it finished when planned. The planning manager should be given the authority and responsibility to make regular adjustments to his program in order to keep arrears at a more reasonable level. A more realistic approach to the planning function will almost certainly pay dividends in terms of increased production efficiency since an over-pressured system cannot run smoothly.

VI. THE YEAR IN SUMMARY

The problems of immediate concern have been outlined above. Order input has continued to show cause for concern although this may to some extent be inevitable when a few large orders can make such a difference.to the order book. However, complacancy should not be encouraged. The achievements of the 1974-75 financial year have not been built on particularly in the export market where there is no systematic sales campaign. Added to this is the company's cash flow problems which have grown appreciably throughout the year, at least partly because of the factors I have discussed above. The company's attempts to expand operations, both in the form of extentions to the product range and increased productive capacity with attendent increases in the numbers employed (see Graph 1) have aggravated a shortage of working capital.

THE I.H.D. PROJECT : FIRST YEAR

This section describes activities and problems with which I have been involved during the first year of the project. Items not previously reported to supervisors have been given more attention.

I. ACTIVITIES AGREED BY THE SUPERVISORY TEAM

The overriding objective of the 1st years work has been to gain sufficient knowledge of the sponsoring organisation and project area to be able to submit proposals for a second years work which will lead to a successful thesis. The aims of the initial work were three-fold: to settle in and gain a working knowledge of George Ellison Limited; to determine provisional terms of reference which would provide sufficient scope and freedom to allow the project possibilities to be explored; and to select a suitable course of formal study within the University.

The first initial objective was achieved through an induction program, involving a stay of one week in each main section of the company. This part of the project occupied approx. one-quarter of the year. The second objective was achieved by the following terms of reference :

Company Response to Customers: A study of the process whereby a medium-sized company reacts to customer requirements - the study will embrace the complete process from receipt of enquiry through to issue of manufacturing instructions and completion of the order and will point to improvements in company performance in these areas and effect on personnel.

The third objective was satisfied by involvement in selected parts of the first term of the University's M.Sc. Systems Analysis course. This was followed by a communications course, a marketing course, and a marketing workshop.

The next stage was to embark on a series of studies aimed at a more detailed knowledge of the company's activities. Several flow diagrams were constructed with the aim of showing the order processing system. Although, several attempts at a representation of the whole order processing system have been unsuccessful I feel I can make the following remarks.

(a) <u>The Order processing system</u>

The most striking feature is the complexity of the system, particularly on the order processing side. Many practices have evolved and overtime amendments to the system have resulted in elaboration. The present system is a result of a long process of development and modification, but unfortunately amendments have not been made in a co-ordinated way. The sales department have made changes to suit themselves while other departments have done likewise. Where the interface between different departments involves personal contact between responsible members, amendments may be made to each other's convenience. However, it can happen that 'up systems' departments, such as sales, implement amendments which make the job of 'down system' departments, such as despatch, more difficult.

This complexity is reflected in the number of sub-systems. The main system is known as the "S.O. system". This takes the bulk of Ellison's order value. Any order which requires time in the drawing office must go through this system. The number two system is known as the 'M system'. Its main feature is that it allows quick despatch with invoices and advice notes being generated upon receipt of the order. Both the above systems have their own paperwork. In addition to the above there are two hybrid systems, which handle List 26 and warehouse Lambar. Both start in the S.O. system and finish in the 'M system'. Warehouse Lambar was implemented to allow quick delivery of 'off the shelf' Lambar (laminated busbar). However, no appreciable stock is held anymore, but those who operate the system find that they can get quick despatch with the reminance of this system than with the S.O. system. Advice and invoice numbers are obtained from the 'M system' and eventually the paperwork is completed in the 'M system'. In common with warehouse Lambar, List 26 starts in the S.O. system. The paperwork is diverted to a particular individual who gives the order a number with a 'C' or 'A' prefix. Once again the 'M system' paperwork is employed. In both cases these systems depend upon particular individuals for their operation.

The next most impressive feature of the order processing system is the informality of its operation. Clearly, any system, irrespective of how well it is designed, will break down very quickly without the informal co-operation of the operating members. Working to rule is an example where this co-operation is withdrawn, but at George Ellison Limited working to rule would mean working as normal. The willingness of the system operators to co-operate with each other and cover for mistakes and misunderstandings elsewhere in the system, must be recognised as a positive asset to the company. However, over the years, this informal co-operation must have acted as a source of many unofficial customs and practices. The apparent absence of an officially responsible person or department to approve or disallow amendments with overall system performance in mind has allowed too much freedom to system operators. Most operators can give reasons why they do this or that, but few show a good appreciation of the overall system. Ideally, a diagram showing the overall system should be available to all operators, who should be able to make reference to it when considering amendments to be submitted for approval. In addition, operators should have a responsibility to ensure that their section of the system map is up to date. As with many other areas of company activity the order processing system reflects a lack of control.

(b) Switchboard Conversion rates and time-lags

Discussions with members of the sales department had indicated that the conversion rate between quotations and orders was approximately 33% for List 527 and 33/69 switchboards. This view was endorsed by senior managers who probably got their information from members of the sales team. At a Supervisors meeting it was decided to collect data to construct a price distribution diagram of quotations and orders and this gave an opportunity to test the 33% hypothesis. The results (see 'Conversion Rates for Switchboards' 19.2.76.) showed the picture to be much more complex than assumed within the company. Conversion rates varied with price with much higher success rates at lower prices.

The conversion rate enquiry rested heavily upon the assumption that, typically, an order matured 3 months after its quotation. As with the 33% hypothesis this assumption was widely held by members of the sales department. The 3 month hypothesis was tested (see 'Time-lags between Quotations and Orders' 25.3.76. and 'More on Time-lags' 12.7.76.) and found wanting. The basic view was that the average would be three months with larger orders taking longer than small ones. A graph of price against time-lag produced a scatter diagram and segments of the order input such as home market only produced equally weak correlations.

Clearly, the results of the time-lag enquiry threw considerable doubt upon the results of the conversion rate exercise because it failified one of its basic assumptions. The following argument did seem to offer some hope.

1. Quotations over time t_1 are typical of quotations over t_1, t_2, t_3, etc.
2. Orders over time t_1 are typical of orders over t_1, t_2, t_3, etc.

Therefore:

3. Conversion rates calculated with different time-lags will give similar results.

However, this argument did not stand up to empirical test. Rates calculated with time-lags 0 and 3 months showed considerable variations. This is hardly surprising given the small number of sporadic orders which dominate such a large proportion of the Ellison business.

The importance of conversion rates for George Ellison Limited lies mainly in the fact that they have, at different times, been used to control the business by adjusting nominal price levels. For some time it has been official company policy to set price levels according to what the market will stand (note above remarks on prices), and variations in conversion rates should reflect changes in the relationship between George Ellison's prices and market prices. The argument goes as follows :-

1. There is an inversely proportional relationship between changes in price level and changes in order input.
2. Conversion rates measure order input in relation to Enquiry input.

Therefore :

3. There is a proportional relationship between movements in conversion rates and movements in the appropriate price level.

If there are appropriate prices to clear a given quantity of the market, then other things being equal these must be reflected in conversion rates.

How effective then are conversion rates for setting market prices at George Ellison Limited? The ratios used are calculated monthly with no time-lag. The methodology employed must therefore be subject to the same reservations as applied to my own effort. The monthly figure can have no value whatsoever. Indeed, ratios for any one month often produce absurd results because the level of orders $>$ the level of quotations in some cases. In addition to this figure a cumulative ratio is calculated.

At the beginning of the financial year this has the same limitations as the monthly figure. As the year progresses the ratio must be more accurate, but suffers because the time-base contains too much old data. The most accurate figure is that for the whole year, but exactly how accurate one cannot say.

Is there an accurate method for calculating ratios? Quotations over a fixed time (say 1 month) and orders on an open accumulator seems to offer the only solution. Order input could be monitored with each order being allocated to its appropriate quotation month. The ratio for a particular month would grow with time and only after 6 - 8 months could one be confident about the ratio for that month. Clearly, this does throw some doubt upon the values of ratios in price fixing. This may be the case but an accurate ratio may be very useful in evaluating past price policies.

II: THE 1976/77 SALES FORECAST

On the 5th August 1976 the Sales Manager, Mr. Blakemore, invited me to help with the sales forecast for the year October 1976 to September 1977. It was suggested that I should co-operate with the marketing manager, Mr. Brawn, to produce a forecast of : (a) the number of pieces expected to be sold, and (b) the money value expected to be realised for these quantities allowing for inflation.

The piece forecast was based on a collection of historical data with adjustments for market conditions. The historical data included : the 1974/75 actual quantity employed in the previous years forecast; an estimate of the 1975/76 actual quantity based upon 10 months production; plus the 1975/74 forecast quantity. Comparisons between the 1975/76 actual and forecast quantities were intended to provide a general guide to the soundness of assumptions made in last years forecast, with the intention of including any sound ones in this years forecast.

The historical data provided some problems. The ideal data would be the number of pieces ordered by customers in the appropriate period. However, this information is not available in the sales department. Records are kept of the value of work ordered for each product group but not the quantities. The figures used in the forecast were those programmed for production in the appropriate period. Clearly, distortions are possible. Customers may order well in advance of requirements, while more technically complex orders may be delayed for some time in the Drawing Office before being programmed for production. This is the second year that this data has been required, but as yet no step has been taken to record this information for the coming year.

The data used plus the forecast is shown in Appendix I. Comparisons between the 1975/76 actual and forecast quantities showed considerable deviations for some product groups. Some allowance must be made for the fact that the actual is 10 months actual production load annualised and not order input. However we decided to test the assumptions relating to product groups 33/69. The assumptions were as follows :-

1. Panels with 800 amp breakers have 800 amp,double tiered.
2. Panels with 1600 amp breakers have $\frac{2}{3}$ 1600 amp, double tiered.
3. Panels with 2500 amp breakers have 2500 amp, all single tiered.
4. Panels with 3150 amp breakers have 3500 amp, all single tiered.

The above assumptions were explicit, but the following assumption was implicit!

5. Breakers and Fuse Switches do not appear in the same panel.

The method of testing was to examine the whole population of switchboards programmed for production over the previous year and to construct a table showing the various combinations of breaker (Table 2). Of the five assumptions only No. 4 was not falified by the evidence and thus was taken into account when determining the 1976/77 quantities. After several discussions between Mr. Blakemore, Mr. Brawn, and myself,the forecast quantities for each product group were fixed, with the exception of List 527, which was determined before my involvement, and Mitsubishi which was taken from the commercial manager's forecast. Average standard values were employed to reach a standard forecast value for the quantities predicted. The standard value represents the value according to the 1972 price list, and is known within the company as C.510 value. The C.510 price deviation for last year was adjusted upwards by 10% for each product group to allow for inflation. The expected C.510 deviation multiplied by the standard forecast value gave the nett forecast value for each product group.

The resultant forecast of £5,504,000 represents the highest attainable forecast and we felt a number of qualifications (see Appendix I) were necessary if it were to be achieved.

III. A USEFUL SPIN-OFF FROM THE FORECAST

Once a quarter the costing department produces a Standard Products prime cost Analysis Report which is based upon standard models for the main product groups. With any system employing standard models there is always room to question the relevance of the models to actual output. The results of the work undertaken to test the forecast assumptions also provided a useful comparison with the List 33/69 model. Most of the combinations of breaker which were predominant, did not appear in the model. The Marketing Manager was therefore able to recommend the addition of the following panels to the costing department :

(a) 1 x 800 amp Breaker

(b) 2 x 800 " "

(c) 1 x 1600 " "

(d) 1 x 2500 " "

(e) 2 x 2500 " "

(f) 1 x 3500 " "

(g) 1 x 1600 amp Breaker + 1 x 600 amp Fuse switch

1 x 300 amp Fuse switch

IV. CONCLUDING COMMENT

A good deal of my work indicates that mistaken views are widely held within the company. This may be a function of the size of the company. A good deal of informal contact takes place across the organisation and thus a misconceived view can easily become a consensus view. Traditionally, the company has made extensive use of judgement and influence, particularly in selling. A number of features of the present day situation indicate that much of this tradition remains. Many people are reluctant to make full use of opportunities to test assumptions against basic data, possibly many see no value in it when one can consult the resident authority on this or that. Very often basic information is not available as in the case of order input quantities. Area Engineers who should be the eyes and ears of the company, operate in a very autonomous manner. Apart from the need to meet financial budgets they seem constrained in few ways. Until recently, their geographical areas were not clearly defined. Reporting back on anything but regular customers seems to be reluctantly undertaken. The Sales Manager had to send two memos to the Area Sales force before replies to his request for information relevant to the order input forecast began to come in. The absence of such data, plus a general feeling that "we know our business" when in many respects we do not, must be responsible for many misunderstandings.

AN ATTEMPT TO CATEGORISE COMPANY RESPONSE TO CUSTOMERS

Much of the first years work has lacked direction. This is inevitable in a project where the terms of reference are so vaguely defined at the outset. However, it is necessary that a more analytical framework be defined if future work is to progress towards a successful thesis. The diagram on pages 31 – 34 represents my attempt to analyse company responses in terms of the objectives of the actions involved. The idea is that the diagram should form a hierarchy of responses in which the description at any level forms an accurate, if more general description of the activities below. Three main areas of response are defined : 1. attempts to define customers, customer behaviour and customer perceived needs; 2. attempts to satisfy customer's perceived needs; and, 3. attempts to influence customer behaviour and perceived needs. At this general level the model should be applicable to any manufacturing organisation. The subsequent levels of the hierarchy are defined with George Ellison Ltd. in mind. Model building and maintenance plus market research are seen as examples of category 1, the various services offered and supplied are seen as category 2 activities, and publicity plus direct selling are seen as category 3 activities.

The model is based upon two main assumptions :

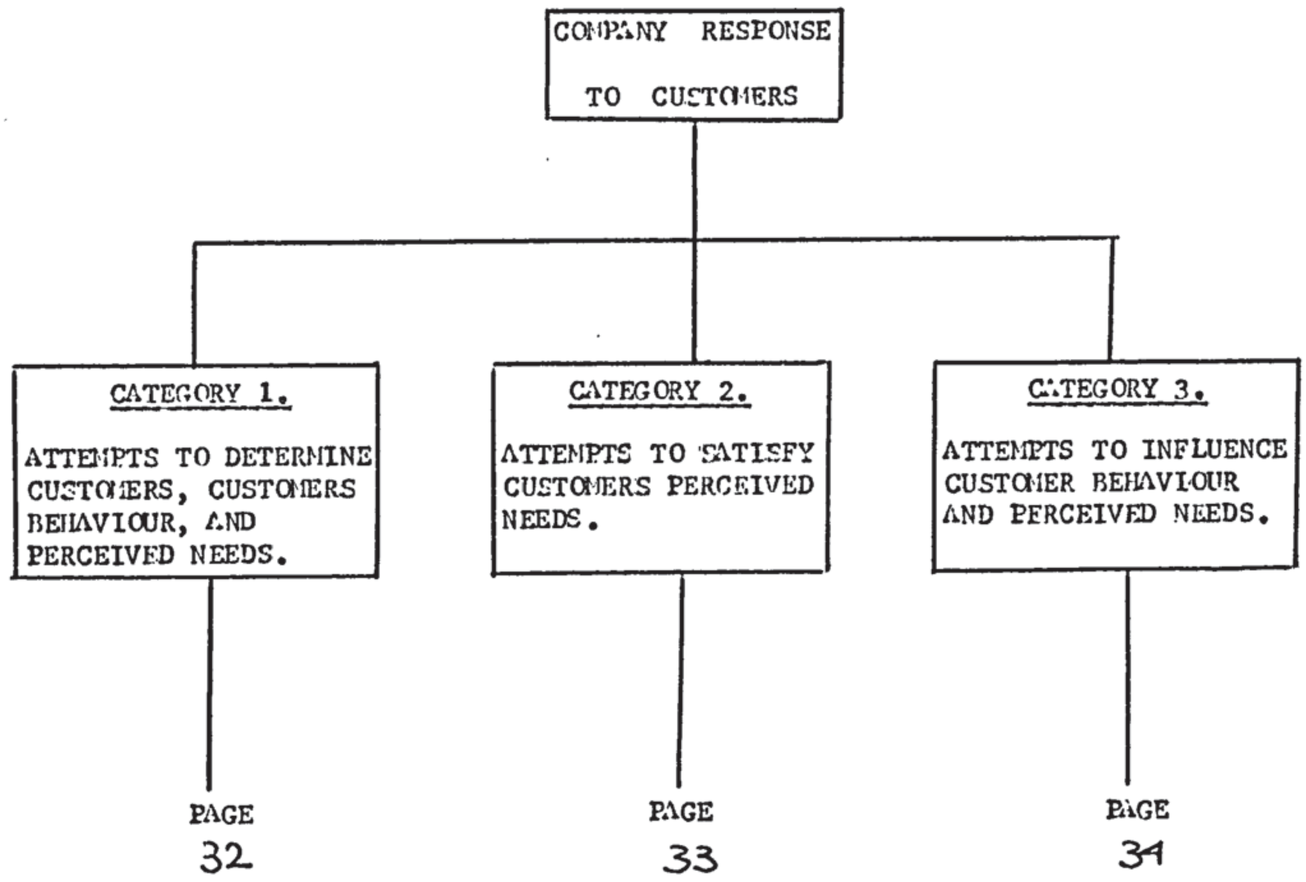
1. Customers behave rationally, i.e. they attempt to satisfy their needs, as they perceive them, with the minimum expenditure of resources.

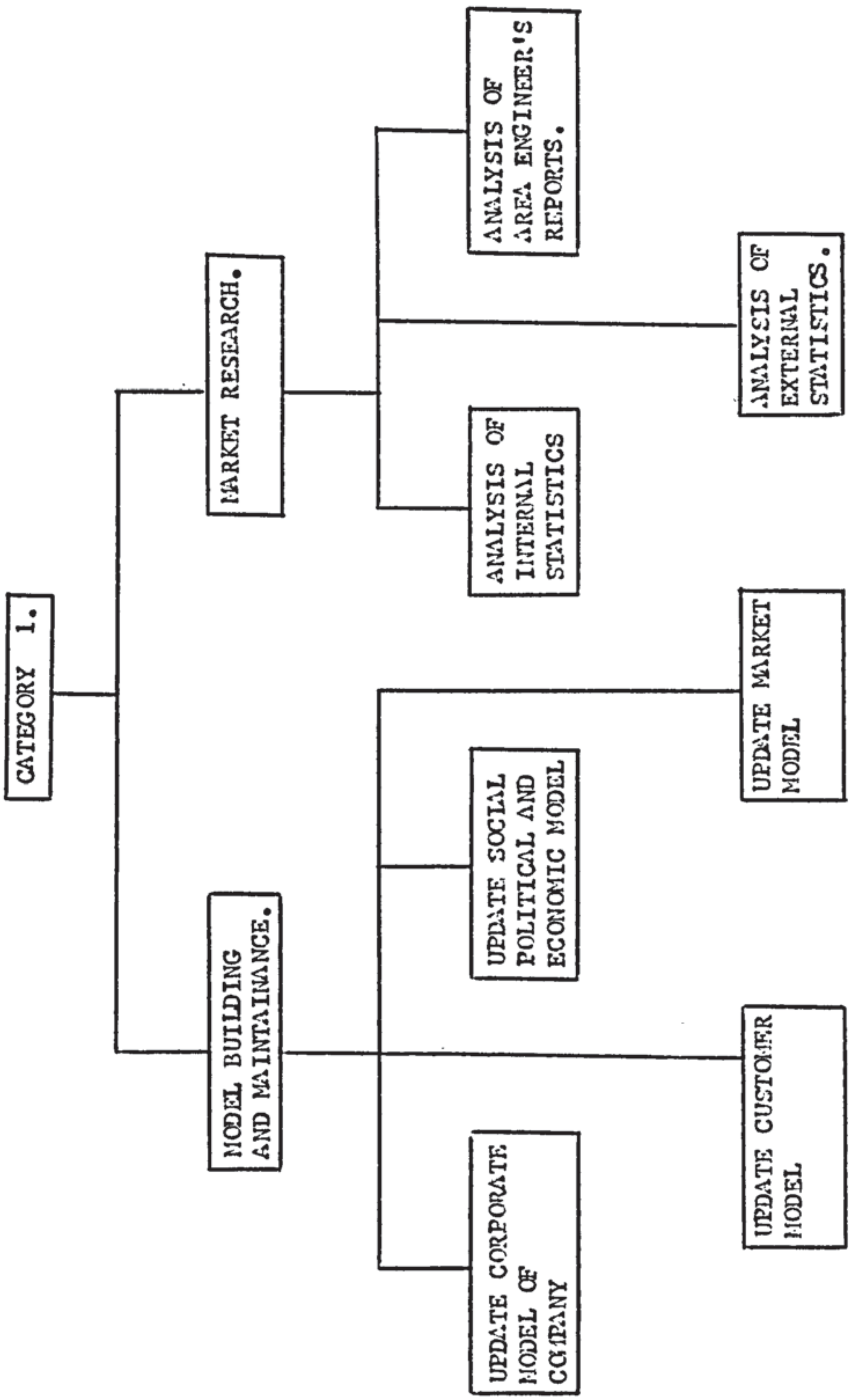
2. Companies behave rationally, i.e. they attempt to satisfy customers perceived needs, as the company understands them, with the maximum advantage to themselves. Clearly the only customer needs relevant to the company are : (a) those which the customer cannot satisfy without interaction in the market; and (b) those which the customer can satisfy with a smaller expenditure of resources by interaction in the market. '(a)' relates to deprivation through lack of endowment and other contingencies which generate short falls against needs, while '(b)' relates to differencies in efficiency and productivity arising from specialisation.

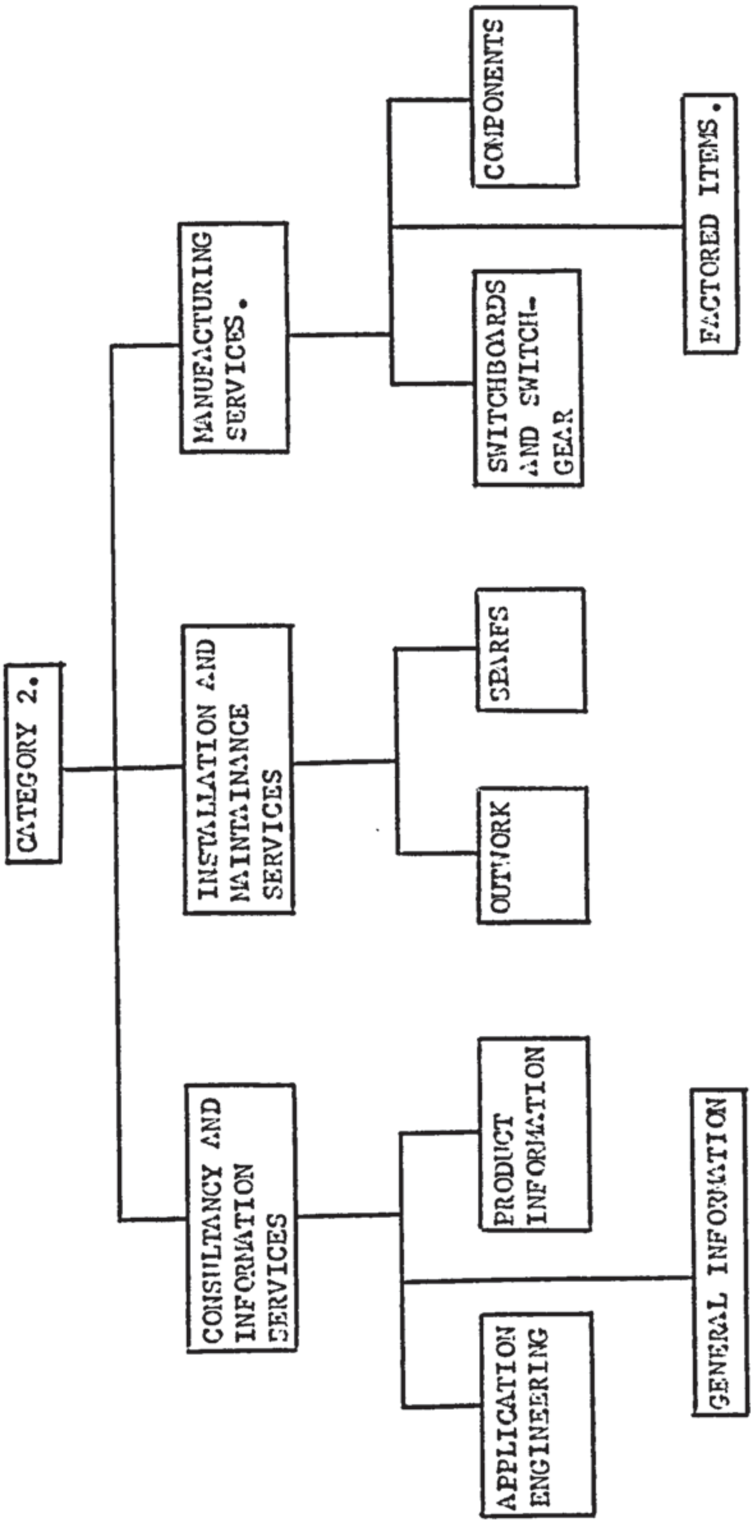
It is interesting to note that assumption 2. does not necessarily imply that companies always attempt to help customers satisfy their perceived needs. There may be a tendancy for companies offer customers those services which the company thinks it would want if it were the customer, the "If I were them ....." approach. The company may have all sorts of specialist knowledge, which it feels makes it a good judge of motor cars, switchgear or whatever and in the long run any company has an important role to play, through category 3 activities, in educating customer's perceived needs.

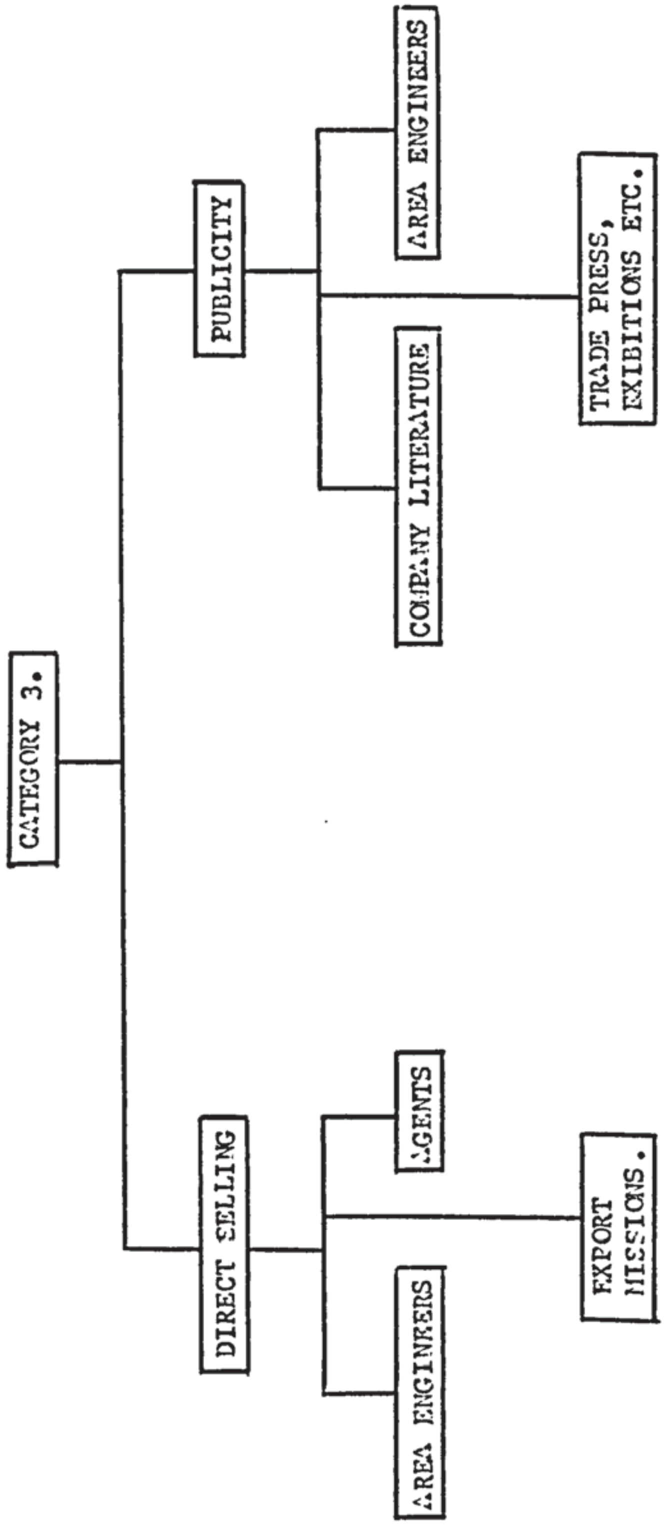
Not all category 3 activities have long term education as the objective, since in the short term a company will want to sell its products whether they satisfy customer perceived needs or not. Clearly, a successful company will either give its customers what they want, at least to a higher degree than its competitors, or be able to influence the customers to the view that they want what the company can give. A company could be satisfied with its performance under category 2, but be failing under the criteria used by the customer. Poor performance under category 1 could negate efforts under category 2, but in the longer term any gap between customer perceived needs and the company's assessment of them must be reflected in the company's order book.

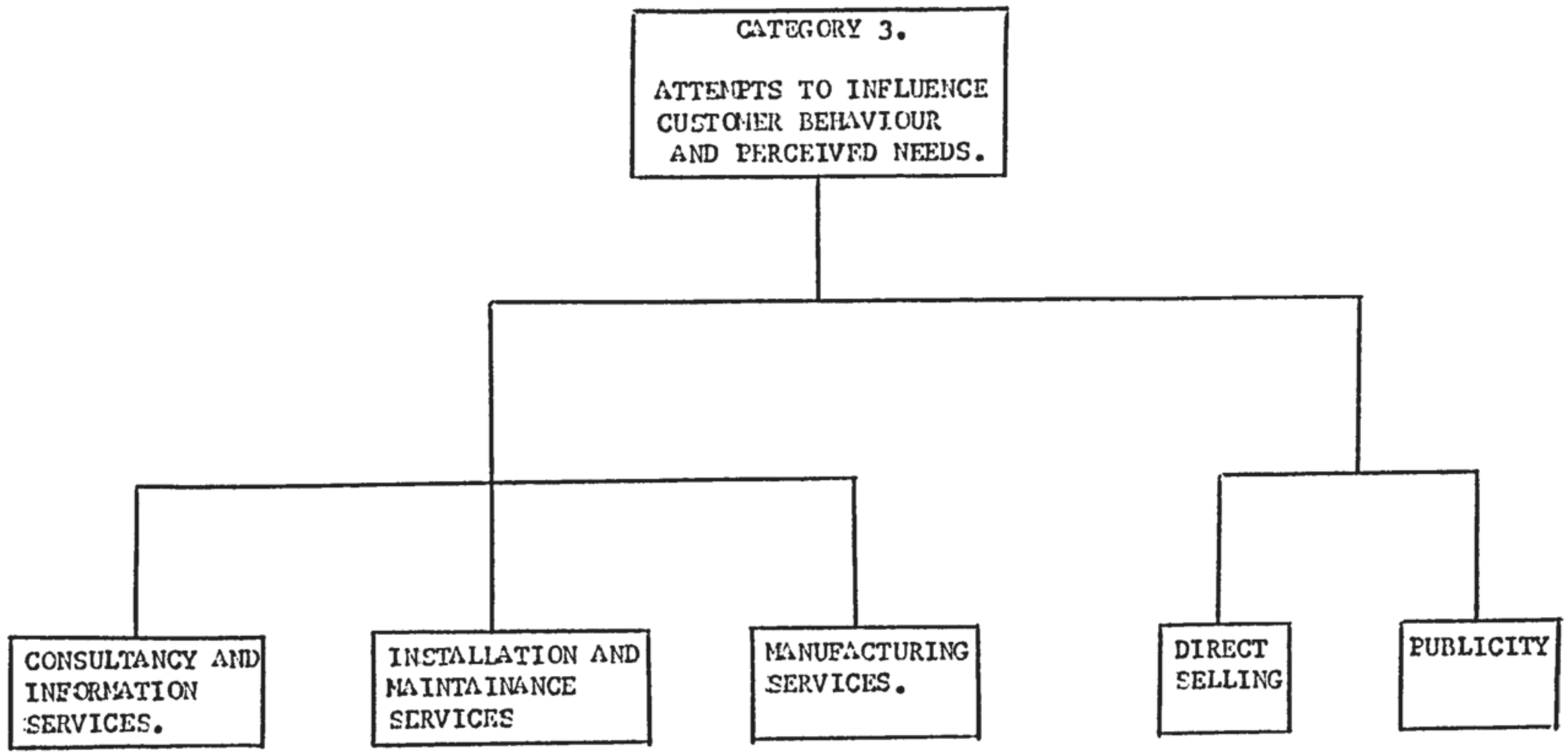
An interesting feature of company responses is that activities may qualify for different categories. Category 2 activities may qualify for category 3 (page35) which may in turn qualify for category 1 (page36). It follows, therefore, that both category 2 and 3 activities may be seen under category 1 (page 36). This is because a given activity may have more than one role. Manufacturing services may be primarily attempts to satisfy customer needs but they also influence customer behaviour, through the credit, or otherwise, they reflect upon the company. Different senses of 'determine' allow category 2 and 3 activities to be considered under category 1. However, there is no symmetry. Category 1 may not go under categories 2 or 3 nor can category 3 go under 2.

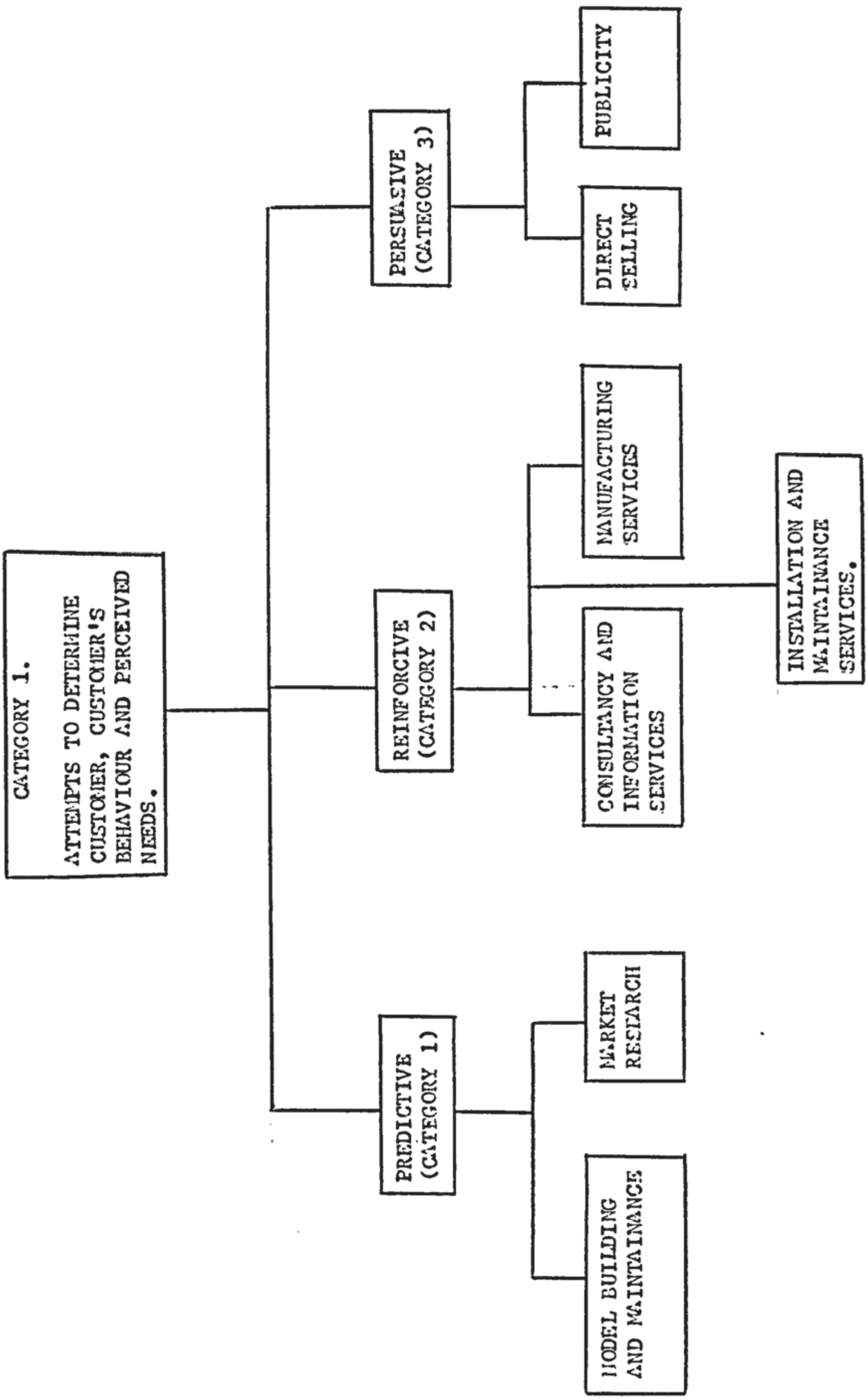

COMPANY RESPONSE TO CUSTOMERS
CATEGORY 1.
ATTEMPTS TO DETERMINE CUSTOMERS, CUSTOMERS BEHAVIOUR, AND PERCEIVED NEEDS.
CATEGORY 2.
ATTEMPTS TO SATISFY CUSTOMERS PERCEIVED NEEDS.
CATEGORY 3.
ATTEMPTS TO INFLUENCE CUSTOMER BEHAVIOUR AND PERCEIVED NEEDS.
PAGE 32
PAGE 33
PAGE 34


CATEGORY 1.
MARKET RESEARCH.
MODEL BUILDING AND MAINTAINANCE.
ANALYSIS OF AREA ENGINEER'S REPORTS.
ANALYSIS OF EXTERNAL STATISTICS.
ANALYSIS OF INTERNAL STATISTICS
UPDATE MARKET MODEL
UPDATE SOCIAL POLITICAL AND ECONOMIC MODEL
UPDATE CUSTOMER MODEL
UPDATE CORPORATE MODEL OF COMPANY


CATEGORY 2.
MANUFACTURING SERVICES.
INSTALLATION AND MAINTAINANCE SERVICES
CONSULTANCY AND INFORMATION SERVICES
COMPONENTS
FACTORED ITEMS.
SWITCHBOARDS AND SWITCH-GEAR
SPARES
OUTWORK
PRODUCT INFORMATION
GENERAL INFORMATION
APPLICATION ENGINEERING


CATEGORY 3.
DIRECT SELLING
PUBLICITY
AREA ENGINEERS
AGENTS
EXPORT MISSIONS.
COMPANY LITERATURE
AREA ENGINEERS
TRADE PRESS, EXIBITIONS ETC.


CATEGORY 3.
ATTEMPTS TO INFLUENCE CUSTOMER BEHAVIOUR AND PERCEIVED NEEDS.
CONSULTANCY AND INFORMATION SERVICES.
INSTALLATION AND MAINTAINANCE SERVICES
MANUFACTURING SERVICES.
DIRECT SELLING
PUBLICITY


CATEGORY 1.
ATTEMPTS TO DETERMINE CUSTOMER, CUSTOMER'S BEHAVIOUR AND PERCEIVED NEEDS.
PREDICTIVE (CATEGORY 1)
REINFORCIVE (CATEGORY 2)
PERSUASIVE (CATEGORY 3)
MODEL BUILDING AND MAINTAINANCE
MARKET RESEARCH
CONSULTANCY AND INFORMATION SERVICES
INSTALLATION AND MAINTAINANCE SERVICES.
MANUFACTURING SERVICES
DIRECT SELLING
PUBLICITY

PROPOSALS FOR THE SECOND YEAR

(A) GENERAL

It will be impossible to look at everything detailed in the hierarchy of responses in the time available. Much of my first years work has indicated that members of the organisation hold views which are at odds with the actual situation. I have indicated that it is possible for customer perceived needs and the company's assessment of them to be at odds and I propose to investigate this further. Therefore, most of the selections I have made are aimed at highlighting these perceptual blind spots. For instance, the company may be giving poorer delivery service than it realises. Late delivery measured against last promised date may yield a very different result from late delivery measured against first delivery date with suitable allowances for customer requests for late delivery. Dates may be re-negotiated but this should not be taken to mean that the customer is satisfied with the new date. Further, the company may be incorrectly guaging the importance of delivery to customers. Delivery may have a different importance to various sections of the market and the same may be true of price.

Such misconceptions may not be peculiar to George Ellison Limited but indicative of companies of its type and size. If possible, I would like to collect data in comparable organisations. It should be possible to define properties of George Ellison Limited which will, within reasonable limits, serve as criteria of similarity, i.e. number of employees, type of product, turnover, etc. The work could concentrate on exercises like that carried out on conversion rates at Ellisons but be aimed at testing the following hypotheses :

(a) Customer perceived needs $\neq$ company assessment of customer needs.

and/or ;

(b) Company variables $\neq$ company assessment of variables.

(B) WORK PROPOSED AT GEORGE ELLISON LIMITED

I. Market Segmentation and Channels of Distribution

Work has been started in this area during the first year (see Order Segmentation). However, the work was not aimed at evaluating company perceptions. I propose to circulate a questionnaire with Ellisons which should provide a basis for comparison. Further work on quotation patterns should highlight any shifts between segments due to the activities of George Ellison Limited. I hope to employ a survey analysis package at the University computing centre to analyse the data. This should provide detailed results with a saving in time. The results will be set against any available data from trade associations, etc. relating to segmentation in the general market.

There is a certain amount of literature available on channel theory and it may be useful to regard each market segment as a different channel of distribution. If different segments show different characteristics, they may require different approaches in terms of response.

II. Buyer Values and Behaviour

Work in this section should follow from the segmentation study. The object will be to determine the relative value to the market, or sections of it, of various differentiating factors such as Price, Size, Appearance, Delivery Performance, After-sales service., etc. I intend to employ a survey technique with the same questionnaire being circulated to customers and members of the company. This should provide the basis for a comparison between customer values and company assessments of them. The results from this and the previous sections work should be valuable to the company for clarifying the conceptual behaviour. If delivery performance rates closely with price it may be possible to determine the degree to which better delivery can compensate for higher prices.

III. The Area Engineers

The Engineers are of particular interest because they appear in all three categories of company responses. Their role in providing technical advice and application engineering is an important part of Ellison's attempts to satisfy customers needs. The role of consultant and salesman are closely linked which may encourage Engineers to identify closely with the customer with the result that they may give better advice to the customer than they do to the company. In the case of Ellison's Engineers, there is a good deal of evidence to suggest that responsibilities under category 1 have been neglected (see notes on 1976/77 forecast). Very poor reporting back on tender progress has also been in evidence, although recent alterations has shown some improvements.

The Engineers may not fully recognise their role as salesmen, at least in the persuasive sense. The inclusion of Mitsubishi gear will call for a more aggressive stance from the sales force if high volume sales are to materialise. At present, one engineer covers the whole country, but it may be necessary to make Area men equally responsible for Mitsubishi.

Traditionally the role of the Area Engineer has been that of consultant and influencer. Liaisons between company Engineers and professional Engineers within manufacturing industry have been a source of patronage for Ellison. Professional Engineers dominated many manufacturing industries and their buying decisions, unlike much of modern industry where the accountant's presence is more apparent. The role of the Area Engineer seems to have been extended in category 3, while increasing competition has made activities in category 1 more important.

I hope to examine the literature relating to company representatives with a view to determining what an Area Engineer's role(s) should be. This will be compared against the activities of Engineers as far as possible. I mentioned under I. that there may be shifts in segments between quotations and orders. If such shifts exist the activities or lack of activities may be instrumental.

IV. Pricing Policy

The hierarchy shows that the main role of pricing policy is as part of the company's attempt to satisfy customer needs. Apart from giving a customer a price he can accept pricing policy will also influence a customer's future attitude to the company. A view now current at Ellison is that substantial numbers of George Ellison customers are particularly attached to Ellison products and are not, therefore, particularly price sensitive. This may be true of a section of the home market where the where the old Engineer class of manager still has strong influence, but cannot be true of the whole market. During the 1975/76 financial year 32% of Ellison output went abroad, 29% direct. Since Ellison's impact in this area has only been apparent in the last few years, there can be no such brand loyalty among these customers. The danger is that policies based upon this assumption may fail to give an acceptable price and have a negative influence upon customers future behaviour.

Company policy, if not practice, has been to charge the market price, but exactly how does one determine the market price? The April '76 price list for components (List 144) was calculated on a 'cost plus' basis with adjustments for inconsistances. This may have involved the company in opportunity losses since if market prices are higher then the 'cost plus' price, revenue will have been lost. From the 1st November 1976 List 144 prices were increased by 15%, taking no account of movements in costs.

Once again 'pricing policy' is an area in which literature is available. I would like to examine the mechanism of pricing at George Ellison Limited. The practices of other organisations may also provide valuable examples for Ellisons.

V. Delivery Performance

I have already dealt with the effects of production arrears upon delivery. Until recently, the contribution to late deliveries made by the failure of the sales department to issue jobs on time, was considerable.

Often a new delivery date would have been negotiated, but this does not imply either that he is happy with the new date, or that there will be no detrimental effect upon future prosperity to order Ellison.

I propose to monitor customer despatches with a view to determining the actual number and value of late deliveries. The data will be analysed into % re-negotiated, % customer late delivery request, etc. It would also be interesting to determine what both customers and members of the company think Ellison's delivery performance is, relative to competitors. It should be possible to include relevant questions in the section II survey.

TABLE 1 : PRODUCTION ARREARS FOR 1975/76

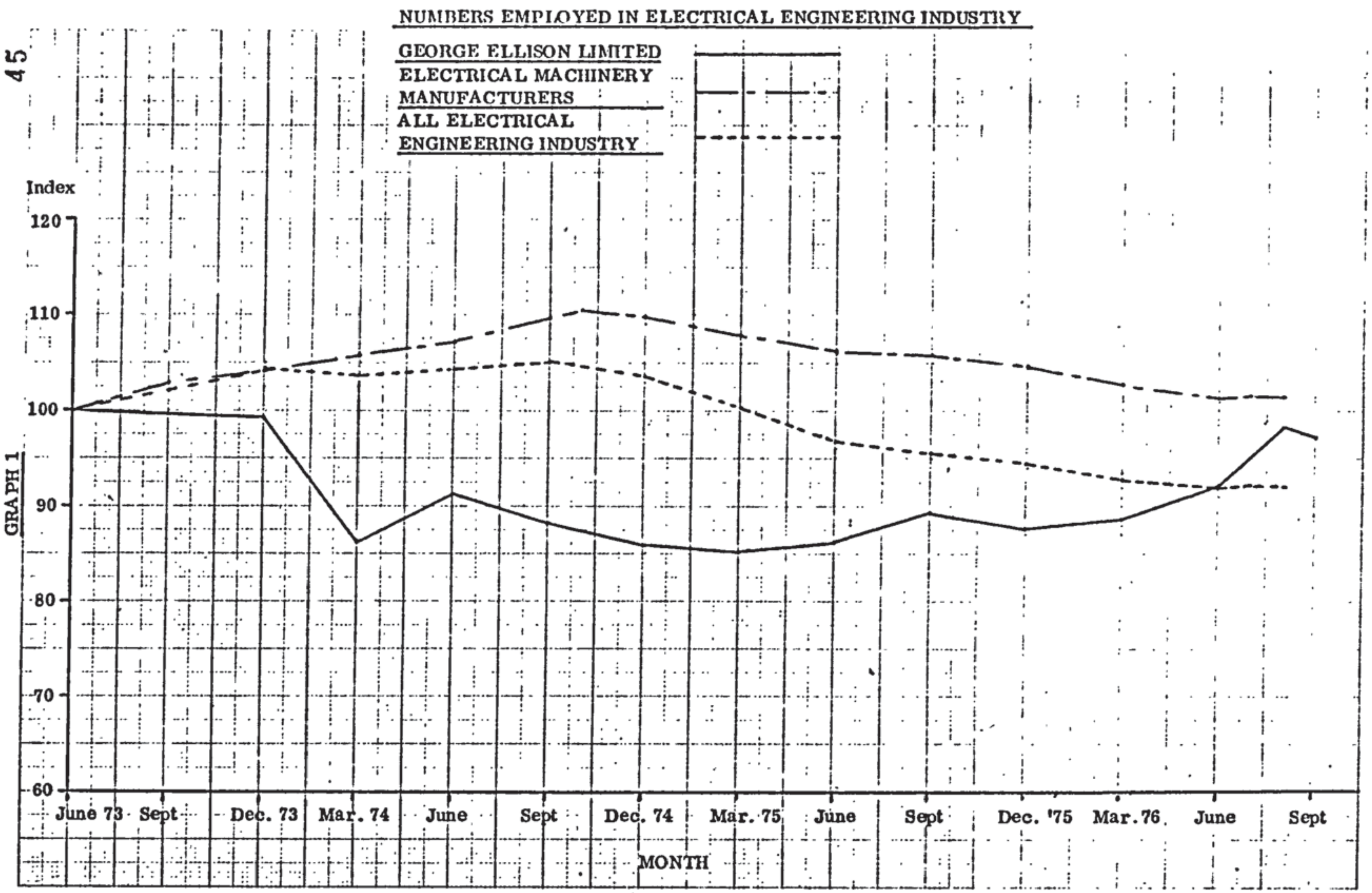
Month	Oct.75	Nov.75	Dec.75	Jan.76	Feb.76	Mar.76	Apr.76	May 76	June 76	July 76	Aug.76	Sept.76
Production Arrears (£K)	42.0	51.7	40.2	80.9	100.9	80.9	52.0	47.3	67.1	95.0	100*	20.0

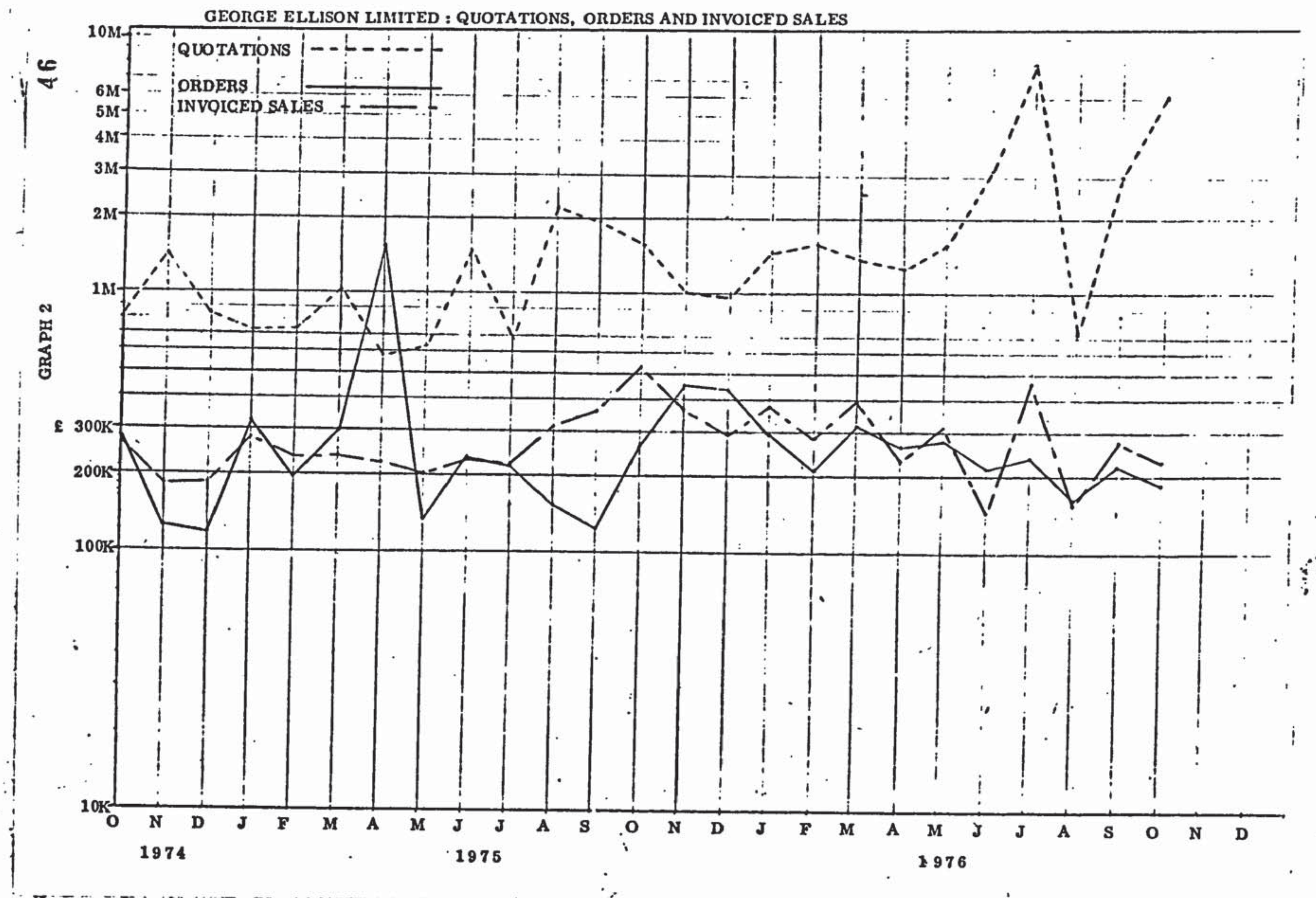
* Estimate

TABLE 2 : COMBINATIONS OF BREAKERS IN 12 MONTHS PRODUCTION

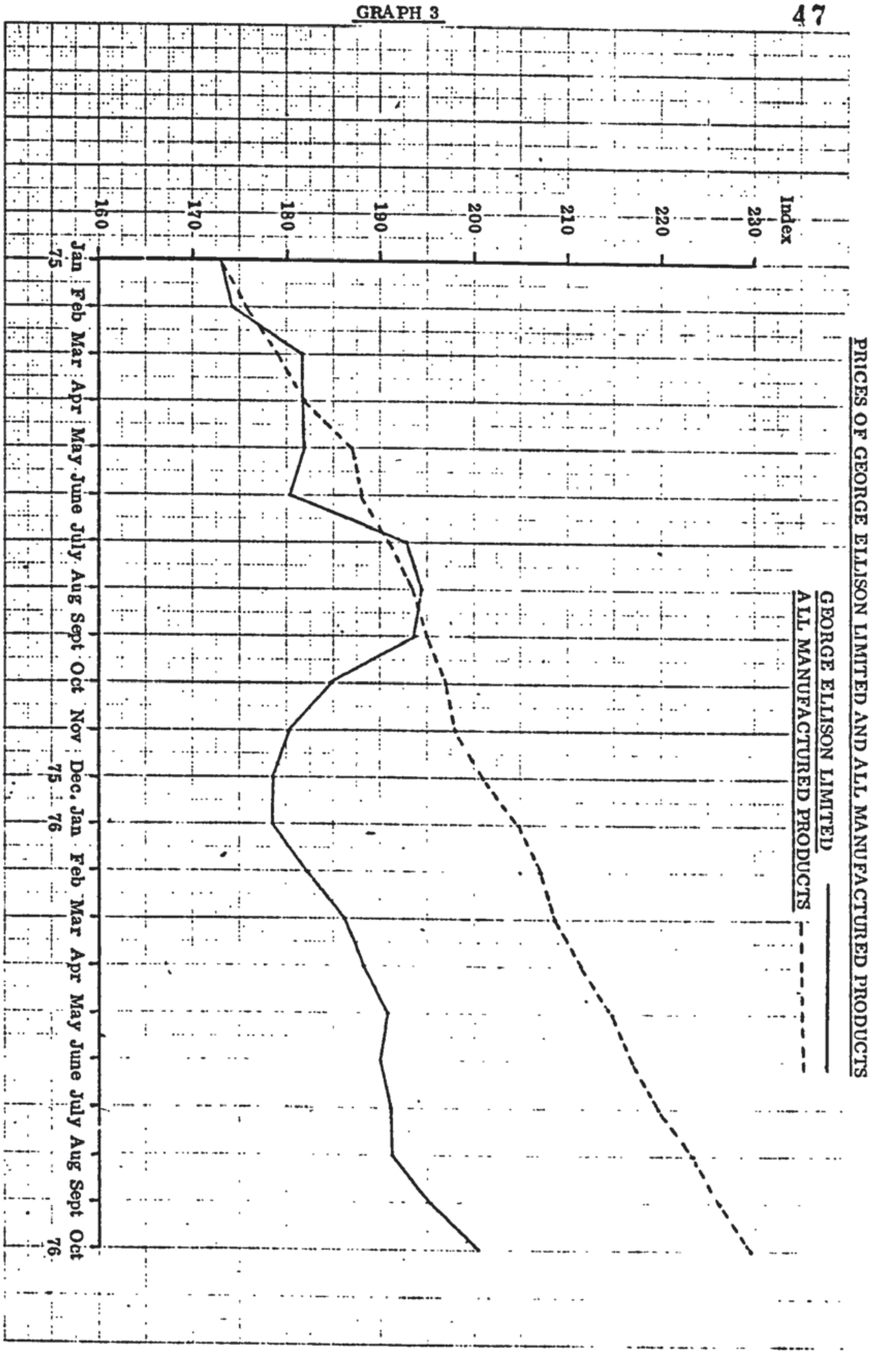
Breaker Size	Single	800A	1600A	2500A	3150A	With Fuse Switch
800 amp	23	63	17	3	0	9
1600 amp	172	17	42	2	0	25
2500 amp	20	3	2	7	0	6
3150 amp	18	0	0	0	0	0

GRAPH 1


NUMBERS EMPLOYED IN ELECTRICAL ENGINEERING INDUSTRY
GEORGE ELLISON LIMITED
ELECTRICAL MACHINERY MANUFACTURERS
ALL ELECTRICAL ENGINEERING INDUSTRY
Index
120
110
100
90
80
70
60
June 73
Sept
Dec. 73
Mar. 74
June
Sept
Dec. 74
Mar. 75
June
Sept
Dec. '75
Mar.76
June
Sept
MONTH


GEORGE ELLISON LIMITED : QUOTATIONS, ORDERS AND INVOICED SALES
QUOTATIONS
ORDERS
INVOICED SALES
GRAPH 2
£
10M
6M
5M
4M
3M
2M
1M
300K
200K
100K
10K
O N D J F M A M J J A S O N D J F M A M J J A S O N D
1974
1975
1976

GRAPH 3



PRICES OF GEORGE ELLISON LIMITED AND ALL MANUFACTURED PRODUCTS
GEORGE ELLISON LIMITED
ALL MANUFACTURED PRODUCTS
Index
160
170
180
190
200
210
220
230
Jan 75 Feb Mar Apr May June July Aug Sept Oct Nov Dec. 75 Jan 76 Feb Mar Apr May June July Aug Sept Oct 76

11/8/76 — 1976/7 — ORDER INPUT FORECAST

PRODUCT	1974/5 Actual Quantity	1975/6 Forecast Quantity	1975/6 Annualised Quantity (1)	1975/6 % Vat From Forecast	1976/7 Forecast Quantity	1976/7 Forecast Std Value £k	1976/7 Forecast Nett Value £k	1976/7 C510 deviation	1975/6 Actual C510 deviation
427 Panels		583	140	-76	500	600	870	+45	+30
166 Panels	67	40	40	0	30	22	37	+68	+51
400A	28	17	19	+12	14				
800A	30	18	17	-6	13				
1600A	9	5	4	-20	3				
33 Panels		578	466	-19	500	835	1,170	+40	+27
800A)	526	232	215	-7	240				
1600A)		497	396	-20	420				
2500A	31	68	52	-24	55				
3150A	5	15	23	+53	25				
69 Panels		760	697	-8	700	470	660	+40	+29
150A		1,082	1,066	-1	1,070				
200A		635	570	-11	570				
3/400A		1,408	1,317	-6	1,320				
600A		244	302	+24	300				
800A		90	124	+38	125				
70 Panels		40	74	+85	80	160	230	+44	+31
KVAr		8,000	17,000	+114	18,500				
35 Housings		57	38	-33	45	16	23	+44	+30
M. C. C. B. Panels		86	1	-99	100	(2)98	140	+43	
Total Switchboards						2,201	3,130	+42	+29

Notes
(1) 10 months actual figures annualised on the basis of working days.
(2) New Produc5 with assumed C510 base
(3) One large order for Khalid with us supplying components only.

Assumptions
1. Sales campaign anticipated for new products. i.e. APE, Dist. Pillars, MCCB boards, and Mitsubishi equipment.
2. Inflation will fall to 10% by September 1977.
3. The 500 APE panels will consist of 400 OCB's and 100 oil switches

1976/7 ORDER IN PUT FORECAST CONTINUED

PRODUCT	1774/5 Actual Quantity	1975/6 Forecast Quantity	1975/6 Annualised Quantity (1)	1975/6 % Vat. From Forecast	1976/7 Forecast Quantity	1976/7 Forecast Std. Value £k.	1976/7 Forecast Nett Value £k	1976/7 Forecast C510 deviation	1975/6 Actual C510 deviation
13/14 8/1600A	323	392	442	+13	500	261	345	+32	+20
2500A	37	69	106	+54	125				
3150A	28	38	33	-13	35				
44 .150A		2,064	647	-69	650	64	103	+61	+48
200A		815	528	-35	530				
3/400A		1,611	554	-66	560				
600A		330	187	-43	190				
800A		80	54	-32	50				
26 30A	750	1,323	1,106	-16	1,000	40	74	+85	+68
70A	170	298	356	+19	375				
903 Feet	6,257	7,800	9,555	+23	7,000	80	117	+46	+31
11 P. Button	2,303	1,200	2,223	+85	2,100	22	65	+195	+165
Shunt L/S	426	200	390	+95	350				
Series L/S	183	125	158	+26	140				
144	(£k) 150	(£k) 246	(£k)123	-50	(£k)150	(2) 115	150	+30	+16
Dist. Pillar		400	5	-99	200	(2) 70	100	+44	+31
MCCB C.U		28,000	0	-100	(3)	(2) 210	300	+43	0
Total Components						862	1,254	+45	+35
Spares	(£k) 206	(£k) 266	(£k)201	- 24	(£k)200	106	200	+88	+71
Gross Products						3,169	4,584	+45	+32
Mitsubishi							370		
Other Factored							550		
Grand Total							5,504		

4. Increased effort is anticipated on loose equipment sales

5. The Mitsubishi forecast has been taken from Mr. Baker's report.

D. M. Brawn
K. J. Molloy

COMMENTS ON FORECAST 1976/7 - 26.8.76.

L.166

Almost entirely replacement units. declining products

L.33

Forecast 7% increase in the number of panels. This was based on an improvement of approximately 5-6% on the home market, and an improvement in our export performance. However, Ted Baker has told us that Khalid will be building some panels on this years Doha contract (if we are awarded it). We had assumed all these panels would be ordered from Ellison. To compensate for this loss we believe extra effort should be made to obtain orders from Abu Dhabi, Dubai and Sharjah. We also do not get our share of orders from Nigeria.

L.69

Forecast the same number of panels as this year. Fuse switches are being replaced by MCCB's, but the slight recovery in the economy and the strengthening of our sale force will counteract this to give a level demand. For the export market the comments for L.33 apply.

L.70

Mainly sold on the home market. This year has shown a vast increase over last year mainly due to increased sensitivity to cost factors. We expect this growth to continue next year, but at a slower rate.

L.35

With the slight upturn in the economy and the strengthening of our sales force we expect to sell more Packaged Sub-Stations and hence more Transformer Housings.

2/contd.........

MCCB BOARDS.

U.K. production of MCCB's in 1973 was £4.1 million, in 1975 this was £8.5 million and our forecast for 1976 is £10.9 million. With this rate of growth an order for MCCB boards of £100,000 should not be unobtainable (especially with our Mitsubishi Agency). However, this will certainly not be achieved unless we let potential customers know that we can offer MCCB boards.

In the first 10 months of this financial year we have submitted export quotes for £459,000 for MCCB Boards to the following countries:-

Saudi Arabia
Syria
Qatar
Dubai
Iran
Iraq

With a more active follow-up that at present we ought to be able to obtain £40,000 of business overseas.

L.13/14

With the structural changes within the company relating to components and the resultant strengthening of the sales team a 15% increase in the home market order input volume seems reasonable.

In the first 10 months of this financial year Hon Kong accounted for 60% of export orders. We expect Vikings to order more next year, and there appear to be good opportunities from our new Venezuelan contract to justify a 20% volume increase in export orders next year. The other countries to which we export are Singapore and Hong Kong. However, if Khalid are going to build part of any orders we receive from Doha, part of the lost business in L.33 can be added to L.13/14.

3/contd............

L.44

Home comments are the same as for L.69, Export comments are the same as for L.13/14.

L.26

Over the last few years demand for L.26 products has been falling. 75% of orders are from lift manufacturers, who are having a rough time at the moment and do not appear to have very bright prospects due to the trend towards one-level factories and the vast over capacity of office buildings in the major cities. We therefore expect this fall in demand to continue next year. There are no export prospects.

L.903

This year the volume of Lambar ordered has increased by 50% over last year. However, this has been due to the exceptional circumstances of our special relationship with Lucas through Fred Pearson, and the Government Grant for investment that Lucas received. We do not expect this to be repeated next year, so we are forecasting a fall in volume, but we are still forecasting 12% more than last years actual.

L.11

16% of order input is received from Canada. The balance is made up of 47% Original Equipment Mfrs., 22% Manufacturing Industry and 15% Consultants and Contractors. Since we do no selling activity in Canada we do not expect this to increase (and we do not think that the level of orders warrants any selling activity). The home market has been steadily falling and we expect this to continue next year.

4/contd.........

L144

Home comments the same as L.13/14.

Export should improve due to Viking, plus an extra increase due to the Khalid operation as mentioned above.

DISTRIBUTION PILLARS

Not much activity on the home market. However, in the first 10 months of this financial year we have quoted £1.6 million exports to the following countries:-

Malaysia
Indonesia
Dubai
Hong Kong
Saudi Arabia
Sharjah
Iraq
Qatar

As for MCCB Boards, with a more active follow up than at present we ought to be able to obtain £100,000 of orders from £1.6 million quotes.

MCCB CONSUMER UNITS

Feedback from Khalid to A.J.Y. Payne and E.N.F. Baker has indicated that there will be an order from Qatar this year, with us supplying the components.

SPARES

In volume terms spares have been falling in recent years. We expect this to continue next year, but inflation to offset this to give the same value of order input.

WHAT DO WE NEED TO DO?

We must make the whole U.K. market aware that we offer Integrally Earthed 11 kV gear, Packaged Sub-Stations, M.C.C.B switchboards and loose Components. By this we mean a publicity campaign, plus follow up by Area Engineers.

5/contd..........

On the export market we require more sustained activity in the field. It is not sufficient to quote and wait in England for the orders to be received. We require a high quality export man to liaise with and monitor our Agents and to push our switchboards and components on a world wide basis.

D.M. Brawn

K.J. Molloy.

APPENDIX E

The Outwork Department Project

4.2.77

SOME NOTES ON THE OUTWORK DEPARTMENT.

GENERAL

In the past G. Ellison Limited has sucessfully differentiated its products/services from those of its competitors by a willingness to meet customers' exact requirements, through a strong emphasis upon application engineering. The Company has offered a complete service often acting as consultant as well as manufacture, Outwork services have played a similar role, enabling the Company to offer its customers a fuller service. Specialist skills built up through specialisation have been sold to customers as a byproduct of the companies main activity.

The main function of outwork services may be to enable the Company to offer a full range of related services, but there is an important secondary role. A well organised service, which satisfies the customer, will go a long way to engender a good opinion of G. Ellison Limited with the customer. One might argue that this is no less true of manufacturing services. However, the large amount of 'face to face' contact involved in outwork services makes a vital difference. Unlike manufacturing services, outwork is carried out on the customers permises. Fitters not only carry out work but often have direct contact with customer employees. The Outwork Manager may have to visit the customers installation and liaise with representatives of the customer who may have influence in future purchasing decisions. As with the area engineers, a good customer opinion at the personal level may be projected to the organisation he represents. Undoubtedly, this must increase the list attributes required by the ideal Outwork Manager to include some aspects of sales-manship.

Contd.......

George Ellison is neglecting an opportunity to 'fly the flag' by not paying attention to the dress of Ellison fitters while on customers premises. All vans used by fitters are clearly marked with the Ellison name etc., but what about the clothing of the fitters? Apart from reminding customers of the company, the Ellison name on overalls and donkey jackets will help to foster the impression of a professional approach. Such a vital interface between customer and company should not be neglected.

MANAGING OUTWORK

This job involves considerable amounts of paperwork which must receive regular attention. Forms must be filled to cover petty cash transactions, the fitters hours must be recorded for both wages purposes and to charge to customers, the invoicing proceedure must be attended to and this, plus the activities involved in organising jobs makes the outwork office a busy one. Checks must be made to ensure that all materials are available to do a particular job. Negotiations with customers are necessary to ensure that the supply, at his installation, can be interrupted where necessary. Special tools and facilities such as cranes and generators must be hired in some cases and separate arrangements must be made to get bulky items to site where necessary, accommodation must be booked for fitters working too far away to come home the same day and the various idiosyncrasies of the fitters must be considered when deciding who to send on a particular job.

THE PROGRAMMING PROBLEM.

In the past, a major source of overload for the outwork office has come from the difficulties of planning work. Little problem aries from customer requests for maintainance etc., because

Contd.....

the required date will usually be made clear by the customer, well in advance. The major problems arise with outwork associated with Ellison manufacture. If a switchboard requires off-loading, erecting etc. by Ellison fitters, when manufacture is complete, the Outwork Manager have little warning of when this might be and this makes planning the work load difficult. What seems to be needed is a system to advise the Outwork Manager (a) when switchboards requiring outwork are approaching despatch, and (b) when instruments etc. which must be fitted to existing switchboards are ready for despatch. In the past instruments have sometimes been sent to customers installations to await installation by Ellison fitters, and the Outwork Manager has not known about it. Equally instruments have occasionally been in stores, unknown to the outwork Dept., awaiting action by the outwork Department.

Requirement (b) has already been dealt with. The shop floor progress office has agreed to consult the Outwork Manager, in cases where the paperwork indicates outwork, before despatching instruments and other shortage items, to customers. This will serve two purposes. Firstly, the Outwork Manager will be made aware that the services of his Dept. will be required allowing him to programme the work at the earliest possible date.

Secondly, the Outwork Manager can decide whether or not the goods will be despatched to site with Ellison fitters. Goods sent direct to await installation may be damaged before they can be fitted.

Contd......

Requirement (a) still needs action. Three alternatives seem possible:

No. 1. This uses the order progress board recently set up by J. Thompson and G. Garner. Switchboard orders shown on the progress board require updating on the board when they pass into the test Dept. The operator of the board would inform the outwork Dept. every time this took place. This might be done with a suitable card giving the outwork details. The Outwork Manager would now know that fitters would be required in another week or two. This system required that the sales Dept. indicates clearly those orders requiring outwork.

No. 2 This involves redirecting a copy of the customer acknowledgement - which the Contract Engineers send to every customer - to the outwork dept for orders where outwork is required. This already gives the expected week of completion. The Outwork Manager could file these by week numbers this would give a number of 'targets' to investigate a week or two in advance. The progress board could be referenced determine of these jobs were into the test dept. any orders late into the manufacturing programme or otherwise delayed could be refiled under a following expected week of completion. The remaining order can now be provisionally programmed by the Outwork Manager.

No.3 This involves informing the outwork dept. every time an order requiring outwork services is booked out of manufacture. This task could be performed by the shop

Contd.....

floor progress office as with the despatch of instruments and would typically give the Outwork Manager approx. 1 - 2 weeks warning. Mr. Cox and Mr. Brindley have indicated their willingness to co-operate in this respect. Rather than indicate on a panel by panel basis, they would warn the outwork dept. as each board is complete.

The late delivery system for instruments plus No. 1 and No.3 above cannot work effectively unless the sales Dept. indicate clearly on paperwork that outwork will be required. This should extend to the inclusion of the outwork S.O.B. number.

CONCLUSION

No. 1 and No. 3 described above involve least work for the Outwork Manager. My own reference would be for No.3 on the grounds that the new proceedure would become part of the main order processing system and those individuals who would have to operate it have already agreed in principle to co-operate. Any system based upon the progress board would depend upon it being kept up to date. The board aims to reflect the state of the system but a reliable planning proceedure for outwork must be part of the main system. No.2 has the attraction that it only depends upon the efforts of the Outwork Manager for its effectiveness. It may be worth redirecting a copy of the customer acknowledgement to the outwork Dept. as a back up to system 3. Should reporting back from the progress office stop for any reason, the basic input for system 2 will be at hand.

Contd.....

Whichever system is implemented, two things must happen:

1) Shop floor paperwork must indicate clearly if outwork services are required and give the outwork S.O.B. number.

2) The present practise of sending to the outwork Department, a copy of the advise note for every despatch must stop. It wastes paper and contributes little to the effective operation of the department.

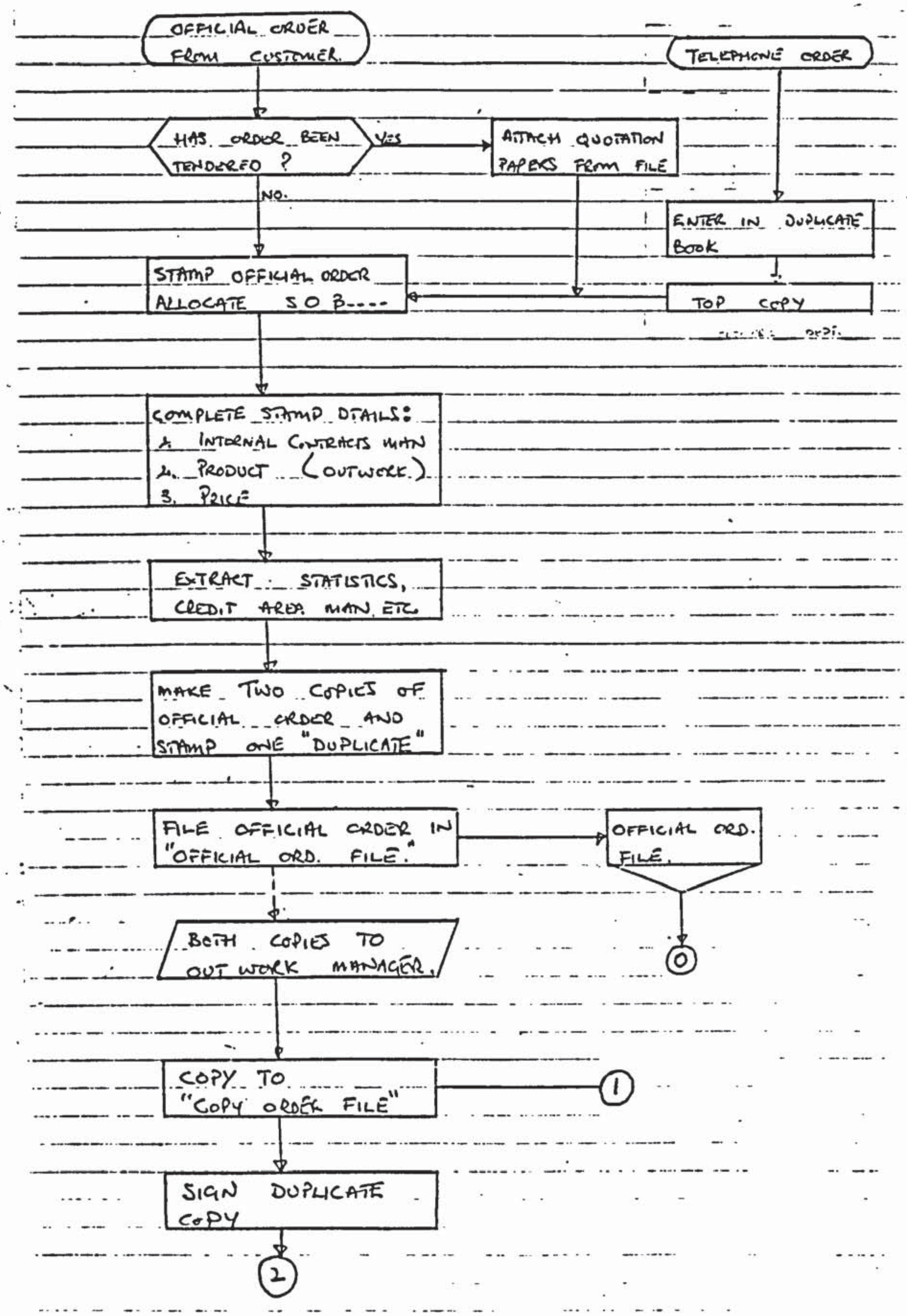
K.J. MOLLOY.

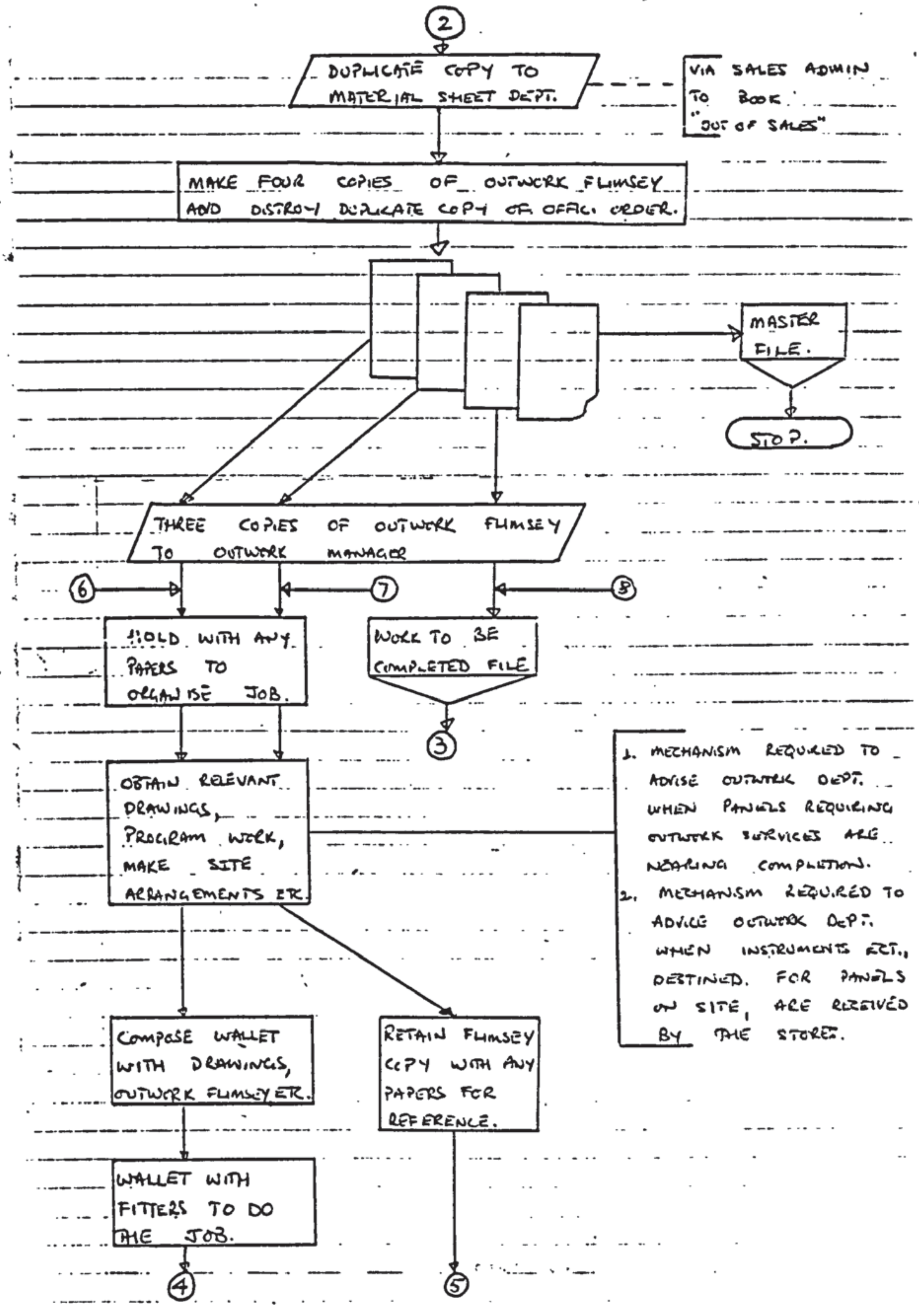
THE OUTWORK ORDER

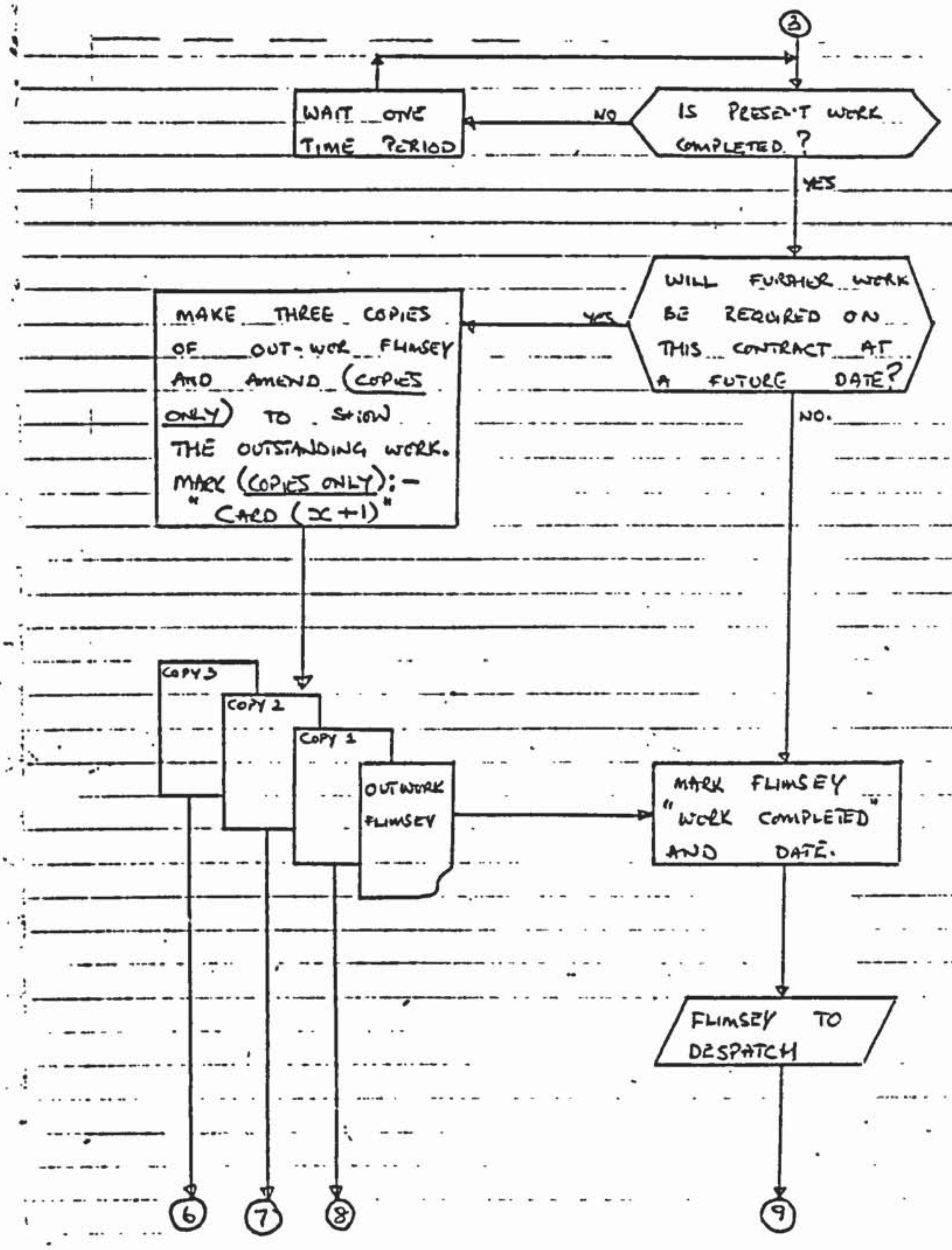
PROCESSING SYSTEM

K. J. MALLOY.

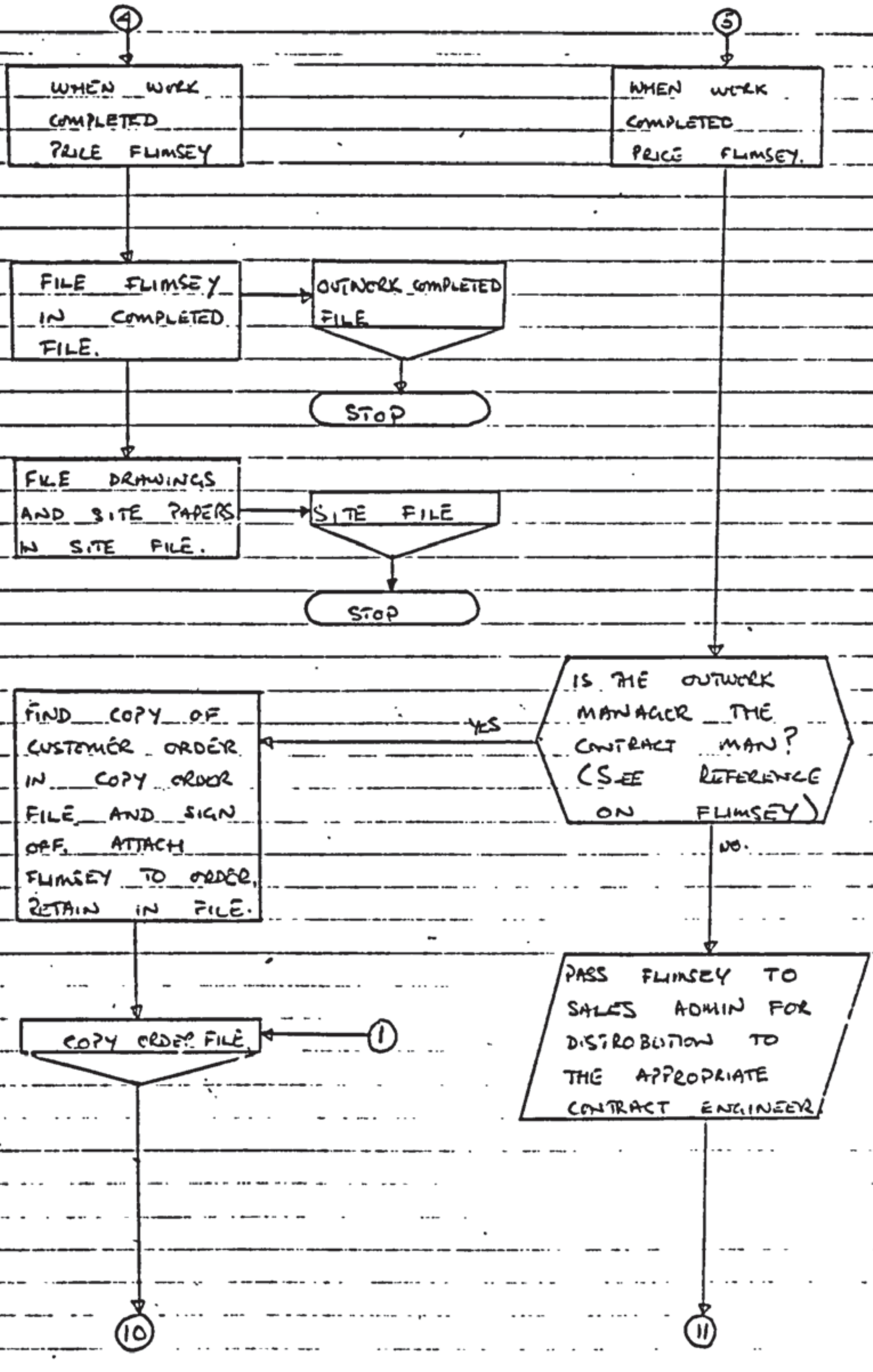
24.1.77.

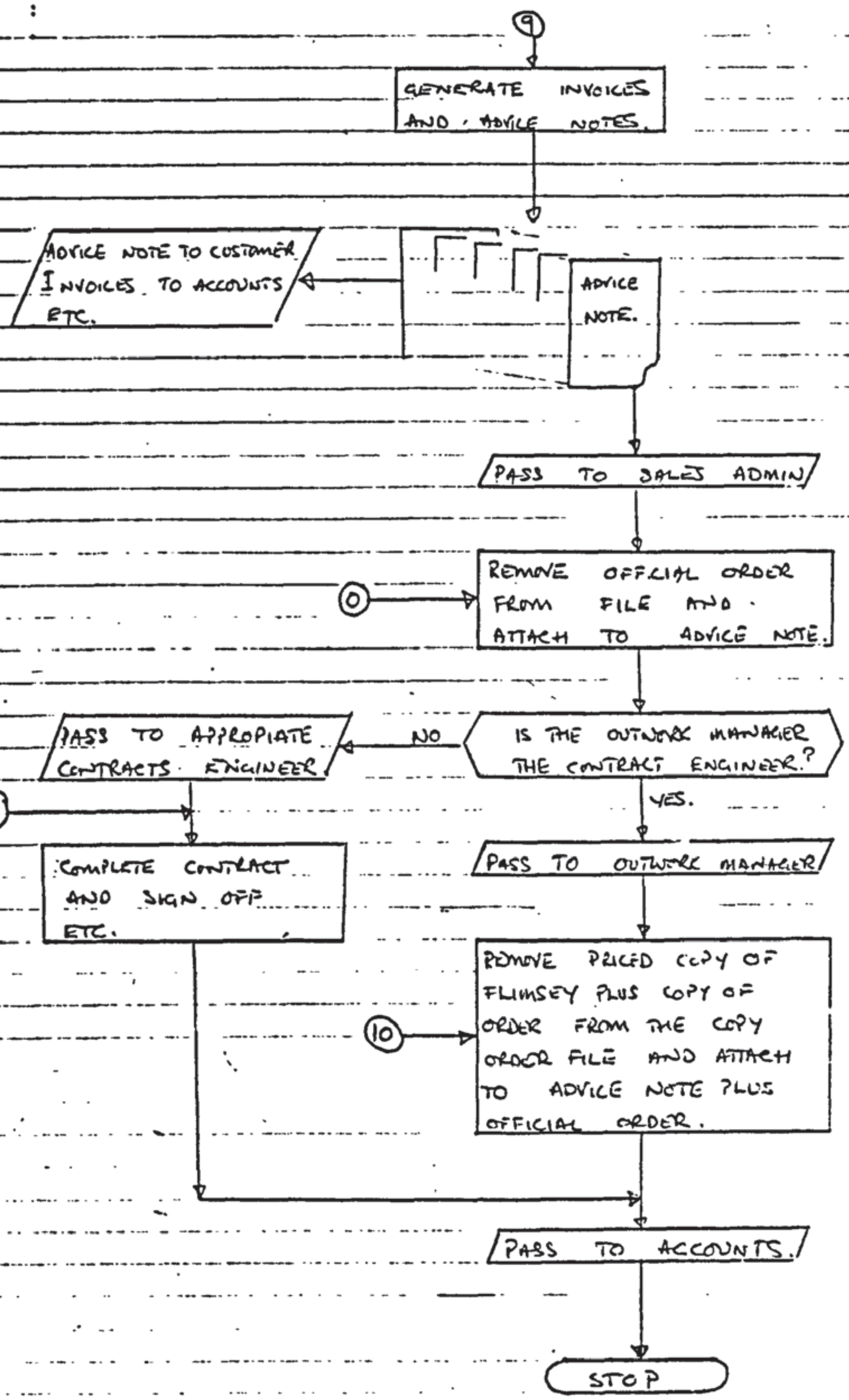

OFFICIAL ORDER FROM CUSTOMER
TELEPHONE ORDER
HAS ORDER BEEN TENDERED ?
YES
NO.
ATTACH QUOTATION PAPERS FROM FILE
ENTER IN DUPLICATE BOOK
STAMP OFFICIAL ORDER ALLOCATE S O B----
TOP COPY
COMPLETE STAMP DTAILS:
1. INTERNAL CONTRACTS MAN
2. PRODUCT (OUTWORK)
3. PRICE
EXTRACT STATISTICS, CREDIT AREA MAN, ETC
MAKE TWO COPIES OF OFFICIAL ORDER AND STAMP ONE "DUPLICATE"
FILE OFFICIAL ORDER IN "OFFICIAL ORD. FILE."
OFFICIAL ORD. FILE.
0
BOTH COPIES TO OUT WORK MANAGER.
COPY TO "COPY ORDER FILE"
1
SIGN DUPLICATE COPY
2


2
DUPLICATE COPY TO MATERIAL SHEET DEPT.
VIA SALES ADMIN TO BOOK "OUT OF SALES"
MAKE FOUR COPIES OF OUTWORK FLIMSEY AND DISTROY DUPLICATE COPY OF OFFIC. ORDER.
MASTER FILE.
STOP.
THREE COPIES OF OUTWORK FLIMSEY TO OUTWORK MANAGER
6
7
8
HOLD WITH ANY PAPERS TO ORGANISE JOB.
WORK TO BE COMPLETED FILE
3
OBTAIN RELEVANT DRAWINGS, PROGRAM WORK, MAKE SITE ARRANGEMENTS ETC.
1. MECHANISM REQUIRED TO ADVISE OUTWORK DEPT. WHEN PANELS REQUIRING OUTWORK SERVICES ARE NEARING COMPLETION.
2. MECHANISM REQUIRED TO ADVICE OUTWORK DEPT. WHEN INSTRUMENTS ETC., DESTINED FOR PANELS ON SITE, ARE RECEIVED BY THE STORES.
COMPOSE WALLET WITH DRAWINGS, OUTWORK FLIMSEY ETC.
RETAIN FLIMSEY COPY WITH ANY PAPERS FOR REFERENCE.
WALLET WITH FITTERS TO DO THE JOB.
4
5



3
IS PRESENT WORK COMPLETED ?
NO
WAIT ONE TIME PERIOD
YES
WILL FURTHER WORK BE REQUIRED ON THIS CONTRACT AT A FUTURE DATE?
YES
MAKE THREE COPIES OF OUT-WORK FLIMSEY AND AMEND (COPIES ONLY) TO SHOW THE OUTSTANDING WORK. MARK (COPIES ONLY): - "CARD (x+1)"
NO.
COPY 3
COPY 2
COPY 1
OUTWORK FLIMSEY
MARK FLIMSEY "WORK COMPLETED" AND DATE.
FLIMSEY TO DESPATCH
6
7
8
9


4
WHEN WORK COMPLETED PRICE FLIMSEY
FILE FLIMSEY IN COMPLETED FILE.
OUTWORK COMPLETED FILE
STOP
FILE DRAWINGS AND SITE PAPERS IN SITE FILE.
SITE FILE
STOP
5
WHEN WORK COMPLETED PRICE FLIMSEY.
IS THE OUTWORK MANAGER THE CONTRACT MAN? (SEE REFERENCE ON FLIMSEY)
YES
FIND COPY OF CUSTOMER ORDER IN COPY ORDER FILE AND SIGN OFF. ATTACH FLIMSEY TO ORDER. RETAIN IN FILE.
COPY ORDER FILE
1
10
NO.
PASS FLIMSEY TO SALES ADMIN FOR DISTRIBUTION TO THE APPROPRIATE CONTRACT ENGINEER
11


9
GENERATE INVOICES AND ADVICE NOTES.
ADVICE NOTE TO CUSTOMER INVOICES TO ACCOUNTS ETC.
ADVICE NOTE.
PASS TO SALES ADMIN
0
REMOVE OFFICIAL ORDER FROM FILE AND ATTACH TO ADVICE NOTE.
IS THE OUTWORK MANAGER THE CONTRACT ENGINEER?
NO
YES.
PASS TO APPROPIATE CONTRACTS ENGINEER
11
COMPLETE CONTRACT AND SIGN OFF ETC.
PASS TO OUTWORK MANAGER
10
REMOVE PRICED COPY OF FLIMSEY PLUS COPY OF ORDER FROM THE COPY ORDER FILE AND ATTACH TO ADVICE NOTE PLUS OFFICIAL ORDER.
PASS TO ACCOUNTS.
STOP

FROM: E.N.F. BAKER. TO: MR. J.F. BLAKEMORE

REF. ENFB/RM.

SUBJECT: OUTWORK REPORT. 21st February 1977.

As requested, my comments on the report on outwork are:-

1. Comments on fitters appearance etc. on site are reasonable and when finance is available it may be worthwhile in considering the recommendations.

2. The report is slightly ambiguous with reference to the fitting of relays etc. to a switchboard after despatch and the indications are that arrangements are in hand for Works progress to advise the Outwork department when this equipment is ready for despatch, enabling the outwork department to co-ordinate the despatch of this equipment to coincide with their visit to site, so that the necessary work can be carried out. I trust that those concerned realise that there is a standard clause in our tenders which quote the services of a fitter as a chargeable service, to fit relays that arrive after the board is despatched. This service is not covered by the charges quoted to off-load or erect a switchboard, therefore unless instructions are received from the customer to carry out this additional work, we will be extending our service for nil return whilst also evolving an internal system to deal with it.

3. On the subject of outwork planning, it would be preferable to evolve a system such that it relied on as few people as possible, every link introduces yet another possibility for error.

It is my opinion that the existing system whereby the Sales Dept. allocate an S.O. number on every job requiring this service, and passes it down to the Planning Dept, is retained. Currently the Planning Dept. (M.S.) issue an outwork flimsy to the Outwork Dept. and this is filed, but as this is filed in a common folder, it does not give any indication of the commitments over any particular period of time. Should this instruction be passed to the Outwork Department on a card, similar to the cards being used on the Progress Board. The Outwork Manager should provide a partitioned box, each partition identified with a Week No. and each card simply held under the Week No. specified. This would then provide an immediate visual display of the tentative forward comitments on switchboards. Any other contracts taken directly by the Outwork Manager could be included in this system, giving the total scene, to enable the Outwork Manager to plan the activity.

It is reasonable to assume that the Manufacturing Programme produced by Mr. Roberts will reasonably accurately portray the progress of all contracts, particularly now that the decision to re-program at the end of each month has been taken. Therefore, if the Outwork Manager is included on the circulation list and receives a regular copy of this programme, he can very simply check his cards against the programme and create a firm Outwork Programme (with customer's input) without relying on any further involvement of anyone else in the system.

This system would rely on no further effort from anyone than is currently expected. The creation of the card instruction, would simply replace the existing 'Outwork flimsey'.

Signed............ E. Baker.

FROM: K.J. MOLLOY TO: MR. J.F. BLAKEMORE

FURTHER COMMENTS ON OUTWORK: A reply to Mr. E.N.F. Baker's Comments (21st February 1977).

25th February 1977.

Sincere thanks for the opportunity to reply to Mr. Baker's comments on my outwork report. I find it encouraging that another member of the Management team has taken the trouble to examine my report and comment in such detail. My reaction is as follows:

(A) LATE DELIVERY OF INSTRUMENTS

I did not realise that there is a standard clause in our tenders which quote the services of a fitter as an extra chargeable service. Mr. Ken Howard did not realise this and Mr. David Parsons has only become aware as a result of Mr. Baker's comments to me. However, one must realise that instruments and relays in this category will only account for a proportion of items delivered late to site. It seems clear that this proportion must vary with time depending upon: the efficiency of the Ellison productive unit, the state of our relations with suppliers, etc. One imagines that present cash difficulties must be reflected not only in high levels of shortages within the factory, but also in the number of items missing from despatched switchboards. Presumably, many customers enforce their contract to the letter and refuse delivery of panels with additional material missing, but with the present need for maximum invoicing levels, customers will be persuaded, where possible, to accept panels whatever the shortages. In such cases the onus is clearly on us to supply the necessary labour and I believe that it is preferable, in the interests of better customer - company relations, for material deliveries and fitter's site visits to be co-ordinated where possible.

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In cases covered by the exclusion clause in question, I still believe that the basic arrangement with the progress office offers the best option. It is hardly fair to describe the arrangement as a system since it is merely a cross or lateral link in the existing system. Its real value lies in its enabling function, since it places the Customer Services Manager in a position to approach the customer and offer the services of his department in one form or another. Mr. A. Robinson informs me that often the required level of skill to fit a particular instrument is relatively low and in circumstances where the department is heavily loaded with work, the customer could be advised that his own electrician could install. The customer will be left feeling he has had a service and the cost to us will only have been a telephone call. Where the customer requires an Ellison fitter, how much better for us to offer our service, even if we must request an additional order to make a further charge. Leaving the ball in the customer's court may cover us legally, but it also represents a reduced level of service to the customer, and it can do the Companies reputation no harm whatever for the customer to get the impression that we care about the state of our equipment in his installation. Mr. Baker's comment is valuable, since the Customer Services Manager is now aware of these different categories and will consult the appropriate contracts man to assertain the conditions attaching to a particular case. However, we should remember that we are not playing barrack room lawyer with the legal profession, but dealing with customers whose patronage we wish to encourage.

I for my part sincerely hope that everyone concerned does not regard the inclusion of such a clause in our contracts as a satisfactory solution to the problem of long delivery instruments. This problem has grown over recent years as a result of take over and subsequent rationalisation with the instrument industry. If this tendancy towards a monopolistic supply situation continues, as seems likely, the board of this Company should carefully consider what strategy it intends to follow to counter the inevitable further deteriation in our level of service to our customers. In the short term there seems to be little we can do beyond

Contd.....

ensuring the highest possible level of follow up from our customer service department as outlined above. In the longer term we might consider action to safeguard our supplies and two approaches seem possible. Firstly, we might consider the vertical integration approach and take over or aquire a stake in some small ailing instruments manufacturer, (assuming that Mr. Winestock has not aquired them all). Secondly, we might consider a gradual more into this area on the Perry Barr site. Clearly, certain widely used instruments will always be mass produced and supplied "off the shelf" by large manufacturers. However, I find it difficult to accept that the technology involved in instruments and relays is completely beyond our grasp. A major barrier to entry into this area is the tooling costs associated with the technology in wide use today, but the movement toward more electronics in this area should remove these difficulties. Why not extend our switchboard modular approach to instruments and relays? Digital readouts and the wide range of electronic compounts now available must offer great scope for the future. One of the above suggestions may or may not offer a realistic solution, but this problem requires serious attention.

(B) OUTWORK PLANNING

I would stress that I do not advocate that the present system where by the Sales Dept. allocate an S.O. number to every outwork job and pass it to the material sheet dept., be discontinued and I would question the correctness of defining the material sheet section as part of the planning dept. It is difficult to see its functional role in planning and in practical terms is not responsible to the planning manager, but to Mr. Payne.

It is incorrect to suggest that the material sheet dept. issue only one 'outwork flimsy' to the outwork dept. In fact, three are issued with a forth to central filing, (see 'The outwork order processing system' 24.1.77.). There is no simple way to replace these flimsies because they play a vital role in the

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invoicing proceedure and this alone makes Mr. Baker's prefered system unworkable. One flimsy triggers advice notes etc., one gives price details complete with mileage charges, expenses, fitters time etc., to accounts and the third forms a permanent outwork record of the job.

In terms of logical structure, Mr. Baker's prefered system resembles my suggested alternative No.2 system, (see 'some notes on the outwork Dept.' 4.2.77. page 4). Both Mr. Baker and I recognise that this type of system involves the least number of people, although I doubt that Mr. Baker's version involves less than my own for the following reason: who will fill out the proposed card? Someone must! my version involves no extra people at this stage since the contracts engineers already generate customer acknowledgements, which provide all the required information. Redirecting a copy involves them in no extra work. The card, however, would! Mr. Williams fills out the card used on the progress board, so must he then fill out two cards for outwork S.O.B's? If as seems possible Mr. Baker envisages the material sheet dept. generating the card, as well as issuing it, they must, as explained above, generate both card and flimsies.

I note with some interest that a decision has been taken to reprogramme at the end of each month - a policy which I fully endorse (see 'One Year On: impressions and proposals' 19.11.76. page 13 to 16). However, if Mr. Robert's programme is employed, this monthly cycle must set the updating cycle for outwork planning. It is difficult to say exactly what would be an optimum warning time, but I have taken it to be between one and two weeks. Whatever it actually is, updating from the programme would give warnings of between a few days and three weeks plus, depending upon the spread of completions in 'last months' production. My prefered system does not have this limitation, since the progress office will report completions <u>relavent</u> to outwork on a <u>continuous</u> basis. A link with the progress office has the further advantage that completions will be screened so that the Customer Service Manager is only presented with information relevant to his operation. This fine tuning extends to suppressing reports on

Contd.......

individual panels to allow reports on a switchboard basis - a refinement not available on any other option. I cannot accept that a link with progress can introduce any significant additional error, since it is this very office which reports completions for updating Mr. Robert's programme and the existing progress board. My prefered 'system' involves fewer links at this stage as compared with Mr. Baker's preference.

Mr. Baker's over-riding grounds for prefering this type of system are that "This system would rely on no further effort from anyone than is currently expected". The whole point of reviewing the existing system is that it relies on far too much effort from the Customer Services Manager. Few people at his functional level can be as heavily loaded. The criterion which leads Mr. Baker to prefer his type of system leads me to prefer another.

I would stress that shop floor paper work must indicate clearly if outwork services are required and give the outwork S.O.B. number. This will leave shop floor and outwork paperwork fully cross-referenced, (for another look at cross-referencing problems see 'Customer Requirements Summary Sheets' 30.1.77).

APPENDIX F

Reporting Changes for the Author

From: B. E. Hinkins 24th November 1977

To: Mr. A. J. Y. Payne
Mr. D. I. Watts
Mr. S. Davies
Mr. I. Smart
Mr. E. N. F. Baker
Mr. I. W. Trench
Mr. R. Wood
Mr. K. Kitchen
Mr. D. I. Watts
Mr. F. W. Webster
Mr. W. T. Chapman
Mr. N. Cotterill
Mr. F. Pearson
Mr. A. Roberts
Mr. D. Parsons
Mr. B. Reynolds
Mr. J. L. Hosker

SUBJECT: DATA PROCESSING SYSTEMS

With immediate effect Mr. George Garner and Mr. Kevin Molloy will report directly to Mr. Barry Reynolds.

Mr. Reynolds is now rapidly approaching the time when he will begin to affect the operation of the business with the new computer we are installing.

It is perhaps appropriate for me to remind you all that whatever is introduced will be ineffective unless we all, and this includes myself, work to the disciplines imposed.

B. E. HINKINS

MEMO

From: B.E.W. Hinkins To: As listed

6th January, 1978.

Kevin Molloy is now approaching the end of his 3 year project which is due to be completed by September of this year. In order that the total project on which he was engaged can be brought to a satisfactory conclusion he will require to spend an increasing amount of his time on the project and less time on some of the day to day tasks on which he has been utilized.

With immediate effect he will report to Mr. K. Kitchen.

Circulation

A.J.Y. Payne
D.I. Watts
E.N.F. Baker
I.F. Smart
F.W. Webster
N. C. Cotterill
W. T. Chapman
F. Pearson
R. Wood
D. Parsons
L. Hosker
A. Roberts
B. Reynolds
S. Davies
I. Trench
F. Dean

For Information

P.F. Swain
K. Molloy

APPENDIX G

Activities Inherited from the Marketing Manager

Activities Inherited from the Marketing Manager

The core activity left by the Marketing Manager was the monthly computation of sales statistics for records and distribution to managers. For a considerable time the author prepared these reports although the raw data was collected by Sales Office Administration as had been the custom previously. It was agreed in principle that the compilation of these reports should also be carried out by Sales Administration but that the author would be responsible for their accuracy and interpretation.

Despite this fact this work remained a recurring problem. The Sales Office was inevitably short of labour, which simply reflected a company wide problem. Sickness, holidays, etc. found the system without "slack" so that it was never possible to shed this task completely. The responsibility required that even where compilation was not carried out by the author the checking and following up of queries often took a considerable time so that on average the whole task took a considerable time so that on average the whole task took between 3 and 4 days a month.

These reports were not simply restricted to sales but also covered tenders and orders on a current month and cumulative year basis. These were additionally broken down into Nett (representing revenue charged or to be charged) and standard representing revenue in constant price terms). In their original form these statistics also included an analysis of sales by geographical areas. Due to the pressure on labour the sales office procedure for the collection of data on sales by area was discontinued by default as was the collection of invoice sales. The attitude of the sales office personnel was that invoiced sales were an accounting function and should be carried out by the Accounts Department.

The Accounts Department were able to supply this data but there were some difficulties. Firstly, accounts were not used to collecting this data categorised by product group and when they began to do this people were not as concerned as one might have hoped to ensure that this was done accuractely. Secondly, the amount of standard value allocated for a given nett value was object subject to the same inaccuracy. Where these errors were gross it was possible to follow up and eradicate them but the large volume concerned makes one suspect that many small errors must have gone unnoticed.

Another significant area of involvement was sales forecasting. Work on the 1976/77 forecast with the Marketing Manager made the author familiar with all the available data sources. In Mr. Brawn's absence the Sales Manager asked the author to prepare the basic versions of the 1977/78 forecast based upon such statistical evidence as was available. This was done and the estimates by area that were reluctantly provided by the area engineers (external sales force) were used to modify the forecast. This basic document was used to "negotiate" with the Managing Director whose initial concern was that the Sales Department should be able to justify the figures put forward. The next stage was to pass the forecast to the Accounts Department who made an estimate of the company's financial performance - against this forecast. In the event the forecast increased. This was done, by the Managing Director, in an indirect way, by constantly rejecting the forecast and asking Sales to "re-examine their assumptions" until they saw their way to the "required" figure.

By the time that the 1978/79 forecast was under consideration a new M.D. was in this chair, the Sales Manager had been made Sales Director and had subsequently left the company to rejoin his old employer (GEC) and the old Sales Director, Mr. Payne, was back at the head of sales as Commercial Director. The author was asked to provide the basic statistical input as in previous years. The process was similar but with the new M.D., Mr. Hinkins, acting as adjudicator. The forecasting/budgeting was carried out over approximately three months but the final budget was almost exactly that which Mr. Hinkins declared would probably be needed at the beginning of the forecasting process. This judgement seems to have been based upon the number of employees and a feeling about the turnover per employee achieved by some of the other significant members of the industry. The extended technical analysis seems to have been needed as some kind of rationalisation for a decision which seems, to the author, to have been inevitable. Such technical justification would, of course, be required to "sell" a budget/ forecast to the board of directors.

A significant improvement to emerge from the 1978/79 round of forecasting/budgeting was the generation of departmental budgets which not only set up expenditure targets but made managers responsible for achieving them. Questions could always be raised about how realistic these targets and the forecasts to which they relate are, but it is not intended to make forecasting and budgeting a central theme in this thesis.

The Marketing Manager had also been responsible for routine data collection from Area Sales Engineers as well as general publicity. He and several predecessors had attempted to formalise this system with little success which may be accounted for by the following factors. Firstly, Area Engineers did not generally report to the Marketing Manager on issues other than market prospects etc. and the Marketing Managing could not exercise any disciplinary power over the engineers. Secondly, those with disciplinary power did not insist upon a significant level of formalisation in the general methods of operation used by the engineers. The autonomy of the engineers had become a tradition both within this company and several others in the industry. Thirdly, those with authority were often like the engineers themselves in having little time for formal reporting of systematic operation and they shared considerable scepticism about what could be achieved by analysing figures. Selling was considered much more of an art than a science and the idea that it could be "reduced" to a science was distasteful to them (a sentiment one is inclined to share).

In working on the 1976/77 forecast Mr. Brawn and the author became convinced that there were indeed, severe limitations to what could be achieved, by way of prediction, from figures taken in the aggregate, especially when one attempted to forecast (induce) a year's input from a set of year by year historical data; and this was just as true for predictions against individual product groups. The difficulty was due to the mix of order size in any one product group.

The order input for G.E. consisted of a relatively large number of small orders which in general provided a base of activity not sufficient to maintain the Company in a viable condition. On top of this were orders ranging from £15,000 or £20,000 to £50,000 (even £1,000,000 in an extreme case). The receipt of such input makes straight forward statistical prediction near impossible. It was therefore realised that there could be no substitute for an engineer "knowing his patch" and reporting back prospects (with confidence factors) and likely date of order to the Marketing Manager.

Under the direction of Mr. Blakemore a primitive version of such a system was set up by Mr. Brawn and ran satisfactorily for several months. The product of this system was a future picture of likely order input with max. and min. limits by month, for about three months ahead. This system worked well both in terms of the level of co-operation received from engineers and the validity of the predictions produced. These predictions were not more than the aggregate of peoples opinions about the future but for G.E's products these were the "right" people. The system was theoretically well based and Mr. Blakemore lent his full authority to make it happen.

The author had it in mind that this sytem could be improved and extended using Baysian forecasting techniques which inorporate subjective probabilities and a high degree of adaption. Such a system could assess the forecasting reliability of the engineers as well as compensate for any inherent tendency for them to be optimistic. The forecasts would improve and the performance data could be fed back to the engineers to give them a basis on which to learn to be better forecasters. In the event this system could not be maintained after the 77 crash and although the reports continued to arrive for some time the author could not find time to maintain the system.

During this period it became apparent that the marketing information area was important and underdeveloped in G.E. The forecasting system would have been particularly valuable if fully developed but several other areas of development seemed possible and desirable. An example of this was the use of analysed data to update the standard costing model. It was clear that information about sales, orders and enquiries, if sufficiently comprehensive, could form the basis of model evolution in other areas of the Company. A possibility would be to update the costing model regularly so that the cost profile for a particular product group remained realistic. This update did not even happen once a year.

Production planning could also benefit from knowing what the item mix was likely to be within a product group so that the factory could be loaded on a physical basis and not just a financial one. This lays stress upon knowing product demand by physical requirement and not just financial requirements. "Piece " data was not readily available and became more difficult to obtain.

APPENDIX H

Customer Requirements Summary Sheets

Customer Requirements Summary Sheets

The difficulty of generating "piece data" was chiefly responsible for the author's suggestion that requirements summary sheets be introduced, see exhibit 1 for full details. The central idea behind this suggestion is that data should be collected from as near to its "sources" as is possible.

Just as the area engineers were the right people with respect to market forecasting, so that sales engineers were the right people with respect to detailing customer enquiries, orders and sales in financial and physical terms. They deal directly with the customer and in effect control the G.E. side of the transaction.

Another concern prompting this suggestion was the lack of effective cross referencing between the various record systems. In particular it had proved impossible, in some cases, to determine the order number and other related details of a successful quotation. The sales office staff maintained that if a set of papers were missing from the quotations filing system then that quote had become an order, but it often proved impossible to identify the order unless some member of the Sales Department specifically remembered it. In such a case, not only were the order details missing but so were the tender documents and the absence of these papers need not necessarily imply that the quotation had become an order. Other possibilities range from someone having removed them for reference through to them having been lost.

After some consideration it was realised that the right system here would not only "plug" the existing information system gaps but might also provide an embryo model of a developed system, possibly based upon computer technology, where data would be manipulated electronically. The important point here is that the information systems operated by the sales engineers for the purpose of controlling any individual contract would be integrated with the marketing and sales analysis system with which the author had become principally concerned.

This would itself remove a major obstacle to any second order information system such as the marketing system because there would effectively be no isolation between systems. To explain further; sales statistics were, at the time of the project, encoded on "stats slips" by the contract engineers in the Sales Office (one for each job) and "read off" by Sales Administration, the other papers in the file often being too technical for them to follow. However, the customer's requirements might change at some later date without the statistical data being amended. The contract engineers had to have their own records in order and up to date, for their own purposes, but they cared little about the statistical records, feeling that too much administration time had already diverted them away from "more productive" activities.

If records were kept electronically the record structures could be standardised between engineers and statistical records amended automatically. This, however, remained a dream so that the immediate objective was to introduce the requirements summary sheets as a first step to structuring a more elaborate information system and at the same time aleviate the need to waste large amounts of time when senior management requested important information not routinely available.

This proposal was first put forward in January 1977 but the financial crash in March 1977, followed by the department of Mr. Brawn and subsequently Mr. Blakemore, ensured that the suggestion had little chance of adoption.

CUSTOMER REQUIREMENTS SUMMARY SHEETS.

INTRODUCTION

30th January 1977

Although considerable amounts of information are kept at G. Ellison Ltd, much of its potential value is lost due to the lack of cross referencing. In particular, it has been very difficult if not impossible, to determine the S.O. number(s) of an order, given the quotation number. While this does not handicap the day to day running of the sales office, it does frustrate attempts to assess and control the business, by making it impossible to calculate an accurate conversion rate (see "Conversion Rates for Switchboards" 14.2.76 and 'Time-lags between "Quotations and Orders" 25.3.76)

Further, deficiencies in the available data have become apparent in the last round of sales forcasting on order input. Up to date information on quantities of items ordered was not available anywhere in the organisation and the Sales Department were unable to supply any information on the subject. The production planning department was able to supply information on quantities loaded for production, but this does not include orders recently received and does not extend back over many years. Recent developments make it unlikely that 'piece' information will be readily available from the planning department this financial year. I therefore propose an amendment to the order processing system to plug these information gaps.

THE PROPOSAL

The proposal is to introduce a customer requirements summary sheet. This would replace the present 'stats slip' which is filled in by the tendering engineer before a quotation is issued to the customer. The new document would require the Engineer to supply 'piece' information in addition to the value information supplied at present. This should only require marginally more time, since the Engineer is the man who knows most about the job. I enclose a possible layout for the summary sheet. The preprinted layout should make the form quick to use and indicate clearly the information required. Others may be able to suggest improvements in both the layout and the items included. The customers name should in all cases be as per the official enquiry/order and where the source is other than that shown on the official document, this can be indicated in the comments section.

Cont. ....

The method of operation would be as follows. The Tendering Engineer would fill out the summary sheet at the same point that the present 'stats slip' is completed. The top copy should provide two copies by carbon paper or backing with different coloured paper for each copy. The three copies should be attached to the paperwork so that sales administration can extract statistics in the normal way, after which, the top copy should be sent to D. Brawn for filing, by quotation numbers, in a suitable loose leaf folder. The remaining copies should remain with the quotation documentation for filing in the sales department.

In the event of an order, the quotation documentation should be sent to the contracts engineer in the normal way. The existance of the summary sheet should help the engineer to familiarise himself with the job, a process which can occupy a good deal of time. The engineer can now fill in the order details, i.e. S.O. Number, date etc. If the customer has only taken up part of the quotation, the appropriate section(s) can be deleted. Similarly, additions can easily be made to bring the duplicate copies into line with customer requirements. The second copy should now be sent to D. Brawn for filing by S.O. number(s). Before filing, the original should be removed from the quotation file to insert the S.O. No. and customer details. Both files are now cross referenced. The order file gives quote numbers and customer for every order and the quotation file gives order number(s) and customers for any successful quotation.

The third copy should be amended if necessary when the order is signed off for invoicing. This would give invoice statistics and could also be sent to D. Brawn for filing in the order file.
The full history of every job is now available for quick referencing.

A similar system could be introduced to cover the components section of the business.

KJM/RM
1.2.77.

CUSTOMER REQUIREMENTS SUMMARY SHEET.

QUOTATION N°.......... DATE....... S.O. N°......... DATE......

CUSTOMER: CUSTOMER:

PRODUCT	CONTENTS	QUANTITY	CSIO LIST PRICE	NETT PRICE	% TERMS
427	1200A BKR				
	400A BKR				
166	400A BKR				
	800A "				
	1600A "				
33. C	PANELS				
	800A BKR				
	1600A "				
	2500A "				
	3150A "				
33. N-C	PANELS				
	800A BKR				
	1600A "				
	2500A "				
	3150A "				
69 C	PANELS				
	150A FSW.				
	200A "				
	300A "				
	400A "				
	600A "				
	800A "				
69 N-C	PANELS				
	150A FSW.				
	200A "				
	300A "				
	400A "				
	600A "				
	800A "				
70	PANELS				
	KVAR				
35	PANELS				
MCCB	PANELS				
MISC	PANELS				

PRODUCT	CONTENTS	QUANTITY	CSIO LIST PRICE	NETT PRICE	% TERMS
44	150A FSW.				
	200A "				
	300A "				
	400A "				
	600A "				
	800A "				
11	SHUNT LS.				
	SERIES LS				
	P. BUTTONS				
26	30A BKR				
	70A BKR				
903 PLUG IN	LENGTH. FT.				
	FITTINGS N°.				
	BOXES.				
	FEEDER. FT.				
DIST.	FRAMES				
PILL	KIOSK.				
CON	MCB				
UNITS	MCCB.				
G.G. S.BD	PANELS				
G.G. S.G.R.	UNITS				
G6	UNITS				
TX.	MVA				
O/W	MAN. HRS.				
MISC					
TOTAL REQUIREMENT					

COMMENTS:

ROTADEX

Rotadex Systems Limited

Registered Office and Works:
5 Fortnum Close Kitts Green Birmingham B33 0JL Tel 021-783 7411/4

Manufacturers of card indexing and filing equipment
Business forms and colour printers

Our Ref HSS/JH Your Ref

George Ellison Limited,
P.O. Box 280,
Perry Barr,
Birmingham B42 2TD

London Showroom:
360 Euston Road, London NW1 3BL
Tel: 01-388 0960

Date 20th December, 1976

Dear Sirs,

We thank you for your kind enquiry given to our Mr. A. Davis and have pleasure in quoting for your requirements as follows:-

3000	3 part Customer Requisition Summary sheets size A4, all parts printed identical in black one side only to copy. Part 1 cut from white Plus Fabric 70gsm, part 2 cut from green Plus Tint 70gsm, part 3 cut from blue Plus Tint 70gsm; tipped at head.	£68.75
alternatively,		
	As above but interleaved one time carbon sets	£97.50
alternatively,		
	As above but on Idem NCR paper.	£92.25
3000	3 part Sales Quotation forms size 9½" x 8". All parts printed in black alike, part 1 cut from white 70gsm Plus Fabric, part 2 green 70gsm Plus Tint, part 3 blue 70gsm Plus Tint. Tipped at head	£63.00
alternatively,		
	As above but interleaved one time carbon sets	£92.00
alternatively,		
	As above but on NCR paper.	£87.00

Prices exclusive of V.A.T.

We trust we shall be favoured with a valued order in due course.

Yours faithfully,
Rotadex Systems Limited,

H.S. Spooner,
Group Sales Director.

Registered in England 527785

Directors: G.H. BARNETT, B.Com., F.R.Econ.S., M.Inst.M. E.L. BARNETT (Secretary)
H.S. SPOONER, M.Inst.M. D.E. KARSEY, M.I.Ex.

MEMBER

APPENDIX I

The Implementation of Graphics

The Implementation of Graphics

Not long after the 1977 crash the Chairman, Mr. P.F. Swain, explained his views about the need to have some kind of simple trend indicator to show the turnover performance of quotations, orders and sales. He explained that his principle concern about Mr. Brawn had been his lack of co-operation in this respect and that he felt long lists of figures were of little help to most managers who would not be able to "see the wood for the trees".

The result of these discussions was that the author agreed to set up a system to provide this type of information on the understanding that someone else would quickly become responsible for maintaining it. The product of this system, the reports, had the following characteristics:

1. The results were shown graphically so that trends were easily discernible.

2. Data was presented for all the significant product groups.

3. Data was given by quotations, sales and order.

4. Data points were at weekly intervals although some data was only available monthly. This problem became more acute when the Accounts Department became the sole source of sales information. Monthly figures were divided by the number of working weeks to get a weekly figure.

5. The reported data was a derivative of the original in which the plotted curve had a restricted rate of change. This was achieved by an exponential smoothing technique with a smoothing factor of 0.1. This was felt desirable on the basis that it was more likely to reflect underlying movements.

6. Its final characteristic was that it was relatively time expansive to oerate not least because it often exposed errors in the "raw" data which might not otherwise have been detected. This would normally require some investigation on the author's part.

Needless to say, in the post crash atmosphere this task was difficult to unload and even when it was agreed that Sales Administration would take responsibility the author remained as consultant and ajudicator when anomalies arose. These graphs remained a constant requirement of the Chairman, who would ask to inspect them on a fairly regular basis. Despite this, these graphs became increasingly behind as time progressed because people at the operational end found it difficult to give it a sufficiently high priority. Many said they found it increasingly difficult to perform their basic tasks without having to cope with extra work.

In September 1977 Mr. B. Hinkins joined the Company as Managing Director, replacing Mr. P.F. Swain who moved to the position of Chairman with special responsibility for long term planning. Mr. Hinkins shared Mr. Swain's feelings about the impractical nature of the long lists of figures covering every product group which were, at this time, circulated to a fairly restricted set of senior managers. The author was asked to investigate the possibility of showing this data for a restricted set of aggregated product groups and for limited categories. For instance standard values were omitted as were enquiries.

A decision was taken to produce "Z" curves for the restricted categories. These graphs showed month, cumulative financial year to date and twelve months moving average on the same page. A full year's plot produced a "Z" like appearance, hence the name. These curves were not produced instead of the old monthly figures but as well as. They were circulated to a large executive committee (in excess of twenty) made up of almost every middle manager in the Company.

The concern expressed by the author about the absence of piece information first expressed in "Customer Requirements Summary Sheets" was shared to a degree by the new Managing Director, whose concern was to have piece information about the manufacturing rate for "Breakers" and "Fuse Switches". The provision of this data fell far short of the system envisaged by the author but it was possible to collect this data from the appropriate manufacturing section. This was done on a monthly basis, reported on graphs and circulated to the executive along with the "Z" curves described above.

It occurred to the author that there were some important lessons to learn from these exercises in graphics. Firstly, the display of data in graphical form did seem to make the information clearer so that such a technique must be recognised as a variety reducer or filter. Secondly, not everyone shared this opinion and some managers declared the curves to be useless and meaningless to them. This was difficult to understand at first but eventually the author realised that the key to understanding lay in the distinction between information and data (???). Information is "a difference that makes a difference" but most of the differences these managers observed were identified by someone else for someone else's purposes. They, for their purposes, would require different data in order to receive information, i.e. something helpful that made a difference to them. Furthermore, this particular mode of display was also defined by someone else and while it remains true that some were ignorant of the technical details of "Z" curves, most felt little interest, beyond the need to placate the M.D., in familiarising themselves with what was represented and how. The author concluded that any effective management information system had to allow the individual managers to define the content, frequency and format of the reports they receive so that the data involved has the best chance of being information for them.

APPENDIX J

Proposals for Computerised Sales Analysis

NOTES ON A PROPOSAL FOR A COMPUTERISED QUOTATIONS, ORDERS AND INVOICED SALES ANALYSIS SYSTEM.

K. J. Molloy

31.5.77

Summary

1. The package offered in the Data Science International Ltd., February 76 proposal does not meet G.E. requirements.

2. Any system adopted by G.E. should:
(a) allow at least a weekly update;
(b) record 'piece' and 'value' information as well as information relating to the customer;
(c) incorporate the Area Sales Engineers' reporting procedure;
(d) move the sampling point away from Sales Administration and accounts to the Sales Engineers

3. Implementation of '2' may allow system links with other areas of company activity, such as standard costing and production planning

4. In considering data processing at G.E. two extremes must be avoided:
(a) packages like that offered by Data Science International Ltd., should not be accepted simply because they are there;
(b) debate within the company should not go on indefinitely.

The Data Science International Proposal

The proposal offers the following:

(a) A listing of Quotations, Orders and Invoices for the current period.

(b) Quotations, Orders and Invoices aggregated by product - standard and nett;

(c) Quotations, Orders and Invoices aggregated by best 50 customers - standard and nett;

(d) All listings divided into Home, Indirect Export, Direct Export and Total, with % price deviation shown;

(e) Ad hoc reports by Industry type, Rep/Agent, etc.;

(f) For Quotations, Orders and Invoices, comparisons between this and last years, plus comparisons between this year to date and last year to date;

(g) Conversion Ratio (current months orders/current months Quotations X 100%) listed on Quotations report.

This proposal was submitted on 23rd February 1976 and represents a considerable improvement on the system as it then existed. Not only would it have been possible to generate the same type of information with a saving in managerial time, but the ad hoc processing runs available would have provided highly valuable analytical information on sales by Industry type, Area Engineer, etc.

However, the situation at G. E. has changed since then and so have the requirements. Indeed, part of these changes have provided the impetus required to push this concept towards implementation, and in this may lie great danger. If this system is implemented without modification, much of the potential value of employing computer techniques in the Sales/Invoicing area will be lost, involving the company in considerable opportunity losses. Amendments at a later stage may prove both difficult and costly.

A major change in information requirements is represented by the system for producing product group information in a graphical form, which the writer is in the process of setting up. To have a computerised sales ledger and not get the machine to do the tedious calculations involved in producing smoothed trend plots, must be a case of having a dog and barking oneselt. Incorporating this facility into the basic programme will have two major implications. Firstly, processing runs will have to take place on a weekly basis and not monthly as may have been envisaged by many users of the existing monthly sales statistics. Printout format will have to be amended to show a trend value for standard, nett and C510 Deviation, but this can easily be incorporated into the basic programme.

This would involve a cost increase of approx. £20/week on the February 76 figures to provide the information weekly. Secondly, the work involved in maintaining graphs will be greatly reduced. The demands upon G. E. Personnel will be minimised and the calculations will be carried out with accuracy.

The data science proposal makes no mention of order book value. This calculation is presently carried out as part of the monthly sales statistics, but could easily be incorporated into the Sales ledger package.

The above amendments represent minimum modifications required to the Sales package proposed to bring it into line with present practises and requirements. However, the opportunity now exists to implement a much more ambitious package which will considerably enhance the company's analytical ability in the marketing/sales areas with the possibility of spin-off benefits for other areas of company activity.

A Modified Proposal

For some time I have been trying to persuade the company to introduce a modified form of data recording (See 'Customer Requirements Summary Sheets 30.1.77) aimed at providing cross-referenced information which goes beyond the 'value' orientated information and forms the basis of all present analysis. Although these initial proposals make much play of the usefulness of 'piece' information, it should be stressed that the method of recording, using what in effect is a coding sheet, makes possible detailed analysis on such things as market segmentation and conversion ratios between Quotations and Orders. With this system the month on month method for calculating conversion ratios presently employed could be evaluated against a logically sound method. The main point of my proposal is that the computer system should not only be modified so as to provide periodic analysis of the type described above, but that it should interface with the G.E. system in a similar way to that envisaged for customer requirements, summary sheets and further, the Area Engineers' reporting procedure should also be incorporated.

The system interface

Quotations present no problem because a suitable coding form (see example provided with C.R S.S 30.1.77 proposal) can be filled in by the Sales Engineer instead of the present stats-slip. Should the company adopt an 'in house' facility at any time, it may be possible to drop the coding form and submit data direct to the system.

Invoices have, in effect, been disowned by the sales department in an attempt to ease manpower problems there.

However, this involves a cost both in terms of quality and quantity of information available. Quality must suffer because people in the accounts department are not highly skilled at recognising which category a particular piece of gear belongs to. The shortfall in quantity is reflected in the fact that since accounts took responsibility for invoiced sales statistics the weekly sheets have stopped altogether, and thus, it has been impossible to update any graphical information since week 30. The general feeling among the sales department seems to be that soliciting payment from customers is an accounting function and, therefore, accounts should generate the associated statistics. However, one should remember that the sales engineer is responsible for the complete contract and under the G.E. system is supposed to sign off every job before an invoice is submitted to a customer. Accounts submit the invoice according to the sales engineers' instructions and if a customer queries a point of payment the accounts department have to refer to the appropriate engineer as manager of that contract. It makes no sense to say that the invoicing has nothing to do with sales since that department must be accountable for what it does. The fact will always remain that the sales engineer handling a particular job is the best qualified to say what the job involves (unless and until the company has a coherent estimating department based on a good accounting system) while the accounts people are the least well qualified in terms of values quantities and type of gear. By aiming to pick up information as near to source as possible one will maximise the quality of information derived - even the presence of sales administration introduces the possibility of an unnecessary transposing error. Some problems may arise due to phased invoicing but these can be overcome by submitting the 'piece' information with the coding form relating to the final invoice. Orders are the only area in which my proposals incur a manual operating cost greater than a system which only solicited 'value' information from sales engineers. It is essential that 'value' information be available as soon as possible after the completion of each working week in order that graphs can be up-dated. However, 'piece' information would probably not be available for a week or so after receipt of the order and this would be provisional in some cases because some customers are slow to issue full and final manufacturing instructions.

However, the sales engineer could submit his best estimate of customer requirements a week or so after submission of value information. Any errors would be reflected in the invoiced statistics along with changes due to other types of customer action. In the event, many orders will be against a quotation and, therefore, few problems should arise.

It will, no doubt, be argued at great length, that these proposals ask too much of the sales engineers and that their time is more profitably spent attending to customers' requirements. I, for one, cannot accept this view, since in most cases, the engineer will be able to remember 'off the top of his head', what the customer requested. The job may be more difficult for orders, but many of these difficulties would be alleviated by the provision of a retained copy of the coding form at the quotation stage, as with customer requirements, summary sheets. At worst, the provision of this information can only represent a few minutes of sales engineers' time on each contract. One should remember that sales engineers, like area men, have more than one role to play. Interaction with the company is just as important as interaction with the customer. Area and sales engineers may have primary roles associated with the selling to and servicing of customers but they also have important secondary roles associated with the provision of information for use within the company.

The company has a right to expect that the allocation of engineers' time and efforts should reflect a recognition of these roles.

Further, it may prove that the discipline of having to provide this information may have the effect of raising productivity of the sales engineers as seems to have been the case with the area engineers' reporting procedures.

Implications for the marketing/sales area

All the facilities available on the data science proposal will remain, while the extended proposal will make possible a range of analysis which extends far beyond the present capacity. Long lists of computer print-outs will not be necessary since it will be possible to specify a minimum number of print-outs on both a weekly and monthly basis with any further analysis carried out on retained data, as required.

The information required for updating graphs must be reported weekly while information relating to the monthly trading statement would be supplied monthly as at present. All other print-outs would be as required.

An additional report could list all outstanding quotations by area and this could be sent to area engineers and agents instead of the present report sheets. These print-outs could have each job itemised and would require the engineer to indicate through a code the progress of each job. Recent experience has shown that the results of leaving to each area man the decision as to what jobs to report on, are disastrous. The print-out format could include pre-labelled columns in which progress is indicated allowing the print-out to be returned to G.E. for analysis. In this way the reporting procedure could be computerised with the results being submitted back to the computer using the print-out as the coding form. This would minimise the paper costs and the m/c could now be asked to provide a firm forecast of order input. This system which presently operates manually, has worked well, but is rapidly falling into disuse because of the lack of someone to operate it effectively. Computerisation offers an opportunity to maintain and improve this system with benefits, not only in terms of information but also in greater control of the area men themselves. Ad hoc analysis could indicate the degree to which area men were concentrating their efforts where requested.

The ability to combine variables in an ad hoc manner will provide tremen dous flexibility. For example, it may be that sales of 300A fuse switches are declining at an alarming rate. The computer could be asked to combine 300A F.S. with customer type to provide a check list of customers who traditionally buy such items and who should be visited by area men to determine reasons for the decline. Thus the facility allows areas of difficulty to be isolated and targets for interview to be selected to determine reasons for customer behaviour. This is only one example, a great many more possibilities exist.

Implications for standard costing

A good deal of costing activity at G.E. centres on comparison work which attemps to identify rapidly increasing cost elements. This work has the further benefit of allowing latest cost figures to be calculated through the 'PRINCE' system for all standard components. The standard product prime cost summary, issued quarterly, depends heavily upon this ability to calculate latest cost figures for both labour and material/components but it also depends upon the adequacy of the modelemployed for the calculations. It is this modelling procedure which interests me and if standard costing is to remain a part of Ellison procedures, improvements must and can be made. Any improvement in the basic mode will be reflected in both prime cost quarterly reports and cost of sales calculations.

The present procedure for calculating cost of sales involves taking a months sales output at C510 selling price and applying labour and material percentages, which are derived from the standard costing model through the 'PRINCE' system. The fundamental question is, how closely does the standard costing model reflect production in a particular month. ? It is not simply a question of product mix because different percentages are applied to each product group, but the mix of items within each group.

Prior to this financial year, the mix of items within each product group was assumed within the model. As a result of work carried out in preparation for the 1976/77 Sales forecast, the marketing department was able to advise the costing department of suitable amendments to the costing model, to bring it into line with the mix of items manufactured last year. These recommendations involved both additional items and weighting factors. This means that calculations made on cost of sales this year may be more accurate than last year which showed an error against final balance sheet. However, one should remember that the existing model is representative of last year and may be at variance with this year's production.

The recording of 'piece' information in the sales area offers the possibility of a system link between sales and costing. If the intended week of delivery were indicated when the order details were recorded it would be possible to ask the computer to produce an itemised product mix for each list number against projected sales output. This would allow labour and material/component % to be updated monthly or quarterly instead of the present system (It is my belief that this updating may not happen at all this year).

The effectiveness of this system could be checked by comparing projections against sales output achieved. If sufficient time is allowed between the end of each trading month and the appropriate Executive meeting, it may be possible to update the costing model from the current months output, thus eliminating all cost of sales errors arising from inappropriate modelling. This, however, would require that piece information be recorded against every invoice.

Implications for production planning

As with the costing system, it may be possible to introduce a system link to advise production planning of itemised requirements for a particular months production. This would allow excessive demand for particular items i.e. Fuse Switches, Breakers etc., to be anticipated well in advance. This procedure is to some extent carried out manually at present by the Planning Manager, but the opportunity may arise to formalise the process through the sales package.

General remarks on Data Processing at G.E.

The aim of this paper has not been to specify, in exact detail, how a computerised sales ledger should operate or exactly what items of information it should provide. This must be determined against a criteria of cost effectiveness and available resources. However, any system employed at G E. whether computerised or not should, I believe, incorporate the following features :

1. record 'piece' and 'value' information as well as information relating to the customer.

2. incorporate the area engineers reporting procedure;

3. shift the sampling point away from sales administration and accounts to the sales engineers.

The aim of the system should be tighter control of the business through the provision of effective management information rather than statistics and these objectives should remain whatever physical system is employed to handle the 'software'.

Within G. E. a number of people are considering data processing requirements and there is a view which holds that the data processing problems of each department should be tackled according to a 'domino' plan of campaign i.e. solve department A's problem, then move to B's and then to C's etc. This clearly biases the search procedure towards each department having its own machine or bureau facility and this is appaling methodology. It may indeed be the case that this is the correct solution to the company's processing problems but no one should start assuming this to be so. Someone must look at the company's total requirements (Sales, Production Planning, Accounts, Wages and possibly Drawing Office and Material Sheet Record keeping) and determine the cost of meeting all or part of these requirements by a central facility as against other options.

It may emerge that such an approach requires a facility which does not represent either the most cost effective solution or one which the company could afford - at the moment no one knows.! Further, the results of any work should be set down in a written report which can be evaluated by each department against its declared requirements. Perhaps an appropriate starting point would be a written outline from each department setting down its general requirements.

Two extremes must be avoided at all costs. Firstly, short term pressures arising from shortages of labour and other difficulties must not be allowed to push the company into accepting packages, like that offered by data science, simply because they are there - a similar point might be made about keeping 'PRINCE'.

Secondly, an internal debate involving several managers should not be allowed to drag on indefinitely. The former is unacceptable because it may involve the company in severe cost penalties, both in terms of hard cash and opportunity losses and commit the company to facilities which do not adequately serve its needs.

The latter because it also involves opportunity losses arising out of the failure to provide coherent facilities and the excessive amount of time that will be involved in prolonged debate, which will serve only to fog the issues and absorb Managers' time and effort with nil return to the company.

Each department with a data processing requirement should draw up criteria which represents its requirements, both present and future. Some suitably qualified person should be responsible for the general overseeing and searching of the market. The criteria provided by departments will serve to isolate the options relative to requirements, the relative costs will determine the best of the options and the absolute costs will determine the options that the company can afford.

KJM/VW
1st June 1977

<u>MORE NOTES ON DATA PROCESSING</u>

K.J. MOLLOY

7th July 1977

SUMMARY

1. Sales analysis should not be given the same priority as wages, salaries or purchase ledger.

2. Sales analysis should not be postponed because :-

   (a) any delay will involve an opportunity loss ;

   (b) there is no coherent sales analysis presently available ;

   (c) improvements in production, without corresponding improvements in order input may result in short time working or even redundancy in the factory;

   (d) there is no logical reason why sales analysis should be deferred.

3. In the absence of sales analysis facility Customer Requirements Summary Sheets should be introduced to enable a data base to be built up.

4. The Cost/Benefit analysis for business machines given by Mr. Garner (24.6.77.) requires revision.

Mr. Garner[1] is to be congratulated for a useful paper on data processing at George Ellison Limited, which should provide valuable help to those managers who have been considering alternatives to the PRINCE system. Mr. Garner concludes that the company should opt for a business machine and on the cost figures provided (cost is not the only consideration) I.C.L. System 10 wins 'hands down'. I would endorse this conclusion, not only on the grounds of cost, but because this basic machine is capable of considerable expansion through the addition and, or substitution of peripheral devices and will, therefore, meet the companies future requirements (should they grow) with a minimum of cost and disruption at future stages - a point well made by Mr. Garner. However, Mr. Garner's paper makes a number of assumptions and inferences which require further consideration.

A central point relates to the program of implementation for the new machine system, which specifies a production package in the first year, with the assimilation of other packages, including sales ledger/analysis, in the second. I believe that it is a mistake to lump a sales analysis facility in with wages and salaries, regard them as having equal (un)importance, and infer that they can wait until the second year. Indeed, why should wages and salaries wait until year two? Mr. Garner does not, I believe, regard this program as axiomatic, but some readers of his report might, and this could lead the company to incur opportunity costs of the type I outlined in my previous notes.[2]

Why then is it a mistake to defer sales analysis to year two?

Firstly, there is the danger that no coherent sales analysis will be carried out during the intervening time. Members of the sales and accounts department have recently considered placing the sales ledger with a bureau but this would possibly be deferred by those concerned with the feeling that implementation on an in-house machine is not too far away. This, to my mind, represents a worst case condition and could only result in a continuance of the company's ignorance about its own state of affairs, both internally and externally.

It seems to be widely accepted that this company's basic problem is centred upon production, in that poorly serviced and ill-disciplined paperwork routines; an inappropriate and discredited computer package and the general lack of a good production control system have combined together to manifest a production monster which is out of control. This is no doubt true but the unfortunate fact is that the rest of the company is similarly out of control. There is a lack of basic information about the state of the shop floor, the state of the company generally and the state of the company's environment and worst still the company is without the basic systems and routines to handle this information. The result seems to be a reactive style of management which usually puts too much emphasis on the short term aspects of problems. Reliable, basic information is the basis for control whether one is considering production, accounting or marketing and this company must strive to evolve systems and procedures which not only generate appropriate, basic information, relating to the whole business, but which utilise this information to enable managers to make more informed decision. Production problems by their nature generate a great deal of short term pressure, whilst the lack of a good sales analysis facility has longer term penalties and as such may not be fully recognised.

The fact is that any useful sales analysis package will not produce the whole goods, until it has been in operation for some time to enable a reasonable data base to be evolved. The 'piece' information mentioned in my last report [2] is not being collected in any form at the moment and therefore cannot be supplied retrospectively to whatever machine system the board of directors finally chose to adopt. If the implementation of a sales analysis facility is deferred for any reason I would, once again, urge that Customer requirements Summary Sheets [3] be introduced without delay to minimise the association penalties.

Secondly, sales ledger/analysis differs from all other data processing needs in as much as it is the only application not presently met with the aid of a computer bureau service. All these packages justify themselves in cost terms by the amount of labour they save, while the production package, with its accounting information, does a job that could not realistically be considered for a manual system. It is my contention that sales analsysis is more like the production package than any of the others in that it too cannot be carried out to any reasonable degree without the aid of a computing facility. Certainly the company can have the sort of analysis that has been available in the past, but I believe that this has proved inadequate and that the company should aim for much more. Sales analysis is different from wages and salaries etc., because it could do much more than simply replace labour by providing vital management information. The one area where a flexible analytical ability is most important is the area where this company has the least analytical muscle.

Thirdly, there is the point that some managers at G.E. may conclude that sales/marketing is not presently a crucial area, since the existing order book seems adequate to keep the factory employed for the short term future. This view is dangerous and mistaken, because it concentrates on the short term aspects of the situation and disregards the following facts. One should not forget that order input is behind budget, even against the most recent forecast and although there has been a recovery in order input since Christmas, it is by no means clear that this recovery can be sustained against a background of declining confidence, reduced sales force, etc. Also one should remember that any adequacy in the order book is due in large measure to the failure of the factory to complete work at the programmed rate and this sets a hidden trap which must be avoided. A concentration of resources and effort on any major area of difficulty within a company may, while greatly improving the situation receiving attention, highten any other major problem area. For instance, if a new production package, run on an in-house 'mini' computer, provides even a fraction of the improvement hoped for by most of the production orientated managers, output from the factory should noticeably improve and this, I suggest, will tend, ceteris paribus, to run down the order book at a rate proportional to the improvement. It is true that the resulting improvement in delivery performance and in time the company's delivery reputation will tend to compensate, but it would be rash indeed to assume that this will fully compensate. The short term spotlight will at once fall on sales with demands for improved order input and the absence of vital marketing information will be greatly lamented. The improvement in a production failing will have highlighted and intensified an equally crucial failing in sales/marketing. Indeed, it is a true irony that a 100% success with a production planning, control and accounting package on an in-house machine will almost certainly lead to short time working or even redundancy in the factory if order input cannot be improved proportionally. This company must avoid looking at problems in isolation and realise their interdisciplinary nature, since there is not a production problem, a sales problem, an accounts problem, per se, only company problems with special areas of focus. I do not advocate that the company forgo the gains that may be available through the substitution of PRINCE with a more suitable arrangement - whatever that might be - but it should be alive to the consequences of concentrating all its available resources in one problem area.

Fourthly and finally, it hardly seems necessary to defer sales analysis since the people at George Ellison Limited who will be most involved with the implementation of the production package will not be involved with the sales analysis package (with the exception of accounts). This does not change the fact that someone must do a lot of work to implement procedures to service the machine system we finally employ and I accept that some delay may arise because of the chronic shortage of labour in the sales department. However, any delay should not, at the end of the day, be attributable to a failure to realise the need for sales analysis or a failure to give it its correct priority, nor should the company fail to realise the consequences of neglecting such an area.

In view of the above considerations I propose amendments to the cost/benefit analysis given for business machines by Mr. Garner, based upon the following criteria :-

(a) replace the existing PRINCE package

(b) take in-house the other bureau applications including sales ledger/analysis

I.C.L. SYSTEM 10

Costs :

One-off Costs

File set up	£ 3,000
Staff training	£ 2,000
Development costs for software	£ 2,000
Total one-off costs	£ 7,000

On-going Costs

Rental on hardware	£1030 per month	£12,360 p.a.
Maintenance	£ 300 " "	£ 3,600 p.a.
Rental on software	£ 210 " "	£ 2,500 p.a.
Total on-going costs		£18,480 p.a.

Savings :

One-off Savings

Development cost for bureau sales ledger	£ 2,000

On-going Savings

Discontinuation of existing bureau systems	£30,000 p.a.
One punch girl @ £3,000	£ 3,000 p.a.
Non-adoption of additional bureau systems	£ 2,000 p.a.
Total on-going savings	£35,000 p.a.

Cost/Benefit for system 10 assuming all applications in the first year.

	Operating Costs £	Savings £	Benefit £
First year	25,480	37,000	11,520
Second year	18,480	35,000	16,520

I.B.M. SYSTEM 34

Costs :

One-off costs

File set up	£ 3,000
Staff training	£ 1,000
Development costs for software	£ 2,000
Total one-off costs	£ 6,000

On-going costs

Rental on hardware £1600 per month	£19,200 p.a.
Software cost, at max. (1st year)	£ 7,000 p.a.
" " " (2nd year)	£ 1,500 p.a.
Total on-going costs (1st year)	£26,200 p.a.
" " " (2nd year)	£20,700 p.a.

Savings :

One-off Savings

Development cost for bureau sales ledger	£ 2,000

On-going savings

Discontinuation of existing bureau systems	£30,000 p.a.
One punch girl @ £3,000	£ 3,000 p.a.
Non-adoption of additional bureau systems	£ 2,000 p.a.
Total on-going savings	£35,000 p.a.

Cost/Benefit for System 34 assuming all applications in the first year.

	Operating Costs £	Savings £	Benefit £
First year	32,200	37,000	4,800
Second year	20,700	35,000	14,300

References

1. "Report on Data Processing at George Ellison Limited and a review of alternative policies "

   by G.E. Garner (24th June 1977)

2. "Notes on a Proposal for a Computerised Quotations, Orders and Invoiced Sales Analysis System "

   by K.J. Molloy (31st May 1977)

3. "Customer Requirements Summary Sheets "

   by K.J. Molloy (30th January 1977)

APPENDIX K

Computer Development Report

by

B Reynolds
(Data Processing Manager)

December 1977

COMPUTER DEVELOPMENT REPORT

1. RECOMMENDATIONS

The company has committed itself to purchase a mini computer to provide facilities presently produced by various Computer Bureaus. A commitment to a certain course of development has also been made by purchasing manufacturing packages from Deritend Computer Bureau. The actual choice made should provide the companv with a more than adequate alternative to the bureau system presently used, but I must point out that initially, that is all it will provide. The advantages the company requires,to gain more control of its production unit, will not be available until mid 1978 at the earliest.

If the initial set of packages are introduced into the companys present set up, the only benefit likely to be derived would be the ability to operate on a shorter cycle of time, and at present this would probably swamp the works with paper. In order to obtain any, let alone the maximum benefit, these systems must be introduced with a realistic overhaul of the present shop floor documentation, and then be backed up by a management structure capable of enforcing the discipline needed to make it work, which at present is so sadly lacking; also the queue of jobs in the Design must be shortened drastically.

In order to implement this system and ensure that the company pushes forward into other areas of production control that contain real advantages, capacity planning, W.I.P. control, costing, etc. it will take all of the company's present systems manpower for the next 18 to 24 months. Whilst this is being done, the company's Management will receive little if any of the more general but vital information they require to manage the company more efficiently, except by the present methods. This situation cannot, in my opinion, be left over this period of time and I propose the following actions to combat this.

a) Mr. K. Molloy, with assistance from someone in the sales organistion, be allowed, under the general guidance of Mr. A. J. Y. Payne and myself, to design and implement a Sales Progressing System concurrently. This would then provide Management with most of the information it requires from incoming orders through to the completion of those orders.

b) The new Accounts team should be allowed to design and implement a financial package, under the general guidance of Mr. D. I. Watts and myself, concurrently. This would then provide Management with an integrated and accessable accounting system for the next financial year.

c) The other areas of the company at present enjoying the benefit of a 'production problem' be made aware that the 'problem' will shift to other areas, as production increases, and the time to analyse this is now, not when it occurs.

In order to achieve this, the systems put forward would have to rely very heavily on the use of packages supplied or written to order, by outside sources. It will also require a considerable amount of effort and goodwill on the part of the Management in these areas, but I have no doubt that they are prepared to give this in order to benefit from the results that they will then obtain.

During the course of my investigations, I think it is only fair to say that I received the utmost co-operation from the people concerned who, under the present circumstances, are providing the best possible service that is within their capability to give.

I have also detailed a proposed initial implementation plan for your comments and approval. This plan will need to be re-appraised in approximately six months time as it was based on some, at present, uncertain facets. i.e. a new Accounts team not fully operational and the proposed setting up of a much needed Production Control function.

2.

PROPOSED IMPLEMENTATION SCHEDULE

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR
Material Requirements and order processing	xxx	xxx	xxx	xxx	xxx	xxx										
W.I.P./Shop Floor Control				xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx				
Costing											xxx	xxx	xxx	xxx	xxx	xxx
Integrated Financial Systems		xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx					
Order Progress/ Analysis	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx							
Payroll												xxx	xxx	xxx	xxx	xxx

3. BACKGROUND

During its development the company has created a quite comprehensive array of Product data. Unfortunately some of this data is not now being maintained, although it is still being used. The company at present uses a mixture of manual and computer systems to operate on a day to day basis, and uses outside bureau facilities for its computer applications. It is the withdrawal of one of these bureau facilities, and a proposed more expensive replacement, that prompted the company to explore the possibility of processing its own data on an in-house computer.

To this end the company approached various suppliers and a decision was made to lease an NCR 8250 mini-computer. A contract was also made with Deritend Computer Bureau to supply the application software to use on the mini-computer to replace the facility being withdrawn.

4. OBJECTIVES

The primary objective of the new computer systems is to provide an alternative to the service obtained by the use of the I.B.M. 'Prince' production package, at a cost relevant to the current bureau facility. The spare capacity would then be used to bring the other bureau systems back in-house and enhance the present production and costing systems.

I feel these objectives should be broadened to include, 'the provision to management of up to date information in the Accounting and Marketing areas. viz. an on-line integrated financial system, order analysis by value and piece, and order progress reporting'. These systems should then be given as high priority as the enhancement of the production system, because without this information, management faces an uphill task.

5. SURVEY RESULTS

The findings contained in this report are as I found them when I conducted my survey. Since actions may have taken place since then, they may not reflect the present situation nor the correct 'Ellison' buzz words.

5.1 The 'Prince' system run times of once or twice a month make it impracticable for day to day stock recording; as a consequence all purchased items are controlled manually. This run cycle also has another undersirable side effect in as much that work submitted is not batch checked for punchingng errors, etc.,as any batches then rejected would have to wait until the following run to be re-submitted. This practice, although unavoidable, is dangerous, especially as the standard of documentation presented for punching, the standard of punching and supervision in the Punch Room leave a lot to be desired.

5.2. As a result of the manual system imposed by the run cycle for ordering, little attention is given to printouts produced by the 'Prince' package for this purpose. Consequently, all bought out components are ordered by historic consumption instead of being based on future demand.

5.3 The maintenance of files used by the production package has fallen by the wayside because of a variety of reasons. As a result of this, and because no one is detailed to correct them, error reports from the package have grown. Consequently the reputation and level of confidence in the 'Prince' package has fallen.

5.4 By operating a material requirements system in a jobbing environment, without component batching and buffer stocks for the common components, the system has been generating orders to fulfill the present requirement only. No account was taken of machine utilisation, and these small requirements and their consequent poor machine utilisation soon overpowered the capability to manufacture these to meet the production plan. This has led to shortages of components to meet the assembly plan; by then trying to fulfill these, and to make next week requirements, they have only succeeded in creating more shortages and so on. This situation has resulted now in the production unit being run by the shortages and not being geared to produce to a production plan. Due to the creating of this shortage-note system, the department managers and progress chasers do not have time to organise and plan their areas to obtain better plant utilisation. In effect, the vicious circle is now complete.

5.5 The flow of information needed to maintain up to date progress on outstanding works orders is in certain instances non-existent. This is due to a mixture of poor discipline and no incentive to inform the progress departments concerned about job completion. Therefore, little control can be exercised over any product or component, once the order has hit the shop floor, without a good deal of manual effort. Also the paper work used is not of a suitable design to accomplish this task.

5.6 The pressure created by the shortage note system, the progressing difficulties and the dissemination of the progress function, leaves the progress chasers with little time to pay attention to the reports issued by the 'Prince' system for this purpose. The information contained in these reports may not be 100% correct but the bulk of the information is relevant. This has led to orders being manufactured which the system has cancelled as a result of remedial action being taken to correct known discrepancies; therefore, using material and plant facilities that could have been used on jobs that are needed elsewhere.

5.7 At present no problems occur in the Sales Organisation as a direct result of using the 'Prince' or any other computer system. Unfortunately this is because no feedback from their use exists, and they therefore have to cope manually. This must make order progressing very difficult and as a result, customer service must be affected considerably.

This also could affect the company in as much that the majority of the Sales Ledger is factored, and the company concerned with this imposes a credit limit on our customers, over which George Ellison have to accept the additional risk. The company concerned presumably operate this on a day to day basis but only inform us on a monthly basis, so we have no accurate idea of the actual risk we are taking.

Even the available information we have is not given to the Contracts Manager, who did not know a credit limit existed let alone what it was for each customer, or how much they have drawn upon this.

One can, therefore, assume that an order from a customer with a poor credit record can take precedence over one from a customer with a good record. If this information was available to him he would at least have a choice. Whether he exercised it or not would then be at his discretion.

5.8 The present planning system on the surface appears to be well organised if a little labour intensive, with switchboards being planned from the induction of an order into the system. Unfortunately the present queue of switchboards with uncoded sections awaiting design involvement, up to twelve weeks is the case at present, coupled with the production system run cycle, does not give the Planning Department sufficient time to plan the manufacture of the components far enough in advance.

Should a Capacity Planning system exist in this environment, over and under load situations would appear with little opportunity of avoiding action being taken, as it would be upon you too soon. Also the case exists where switchboards have to be planned to the nearest 'coded' design, so that an order can be placed for the majority of the standard components. The alterations then necessary to manufacture the board to the customer's specifications, additional material sheets, are made out later. These cannot be planned at all, with the order for the components and the extraction of the items from the stores taking place at about the same time.

The net result of this is, any components that are extracted from the stores have been ordered for another job and the rest raise shortage notes. This then results in more than one job hanging around awaiting components that have not yet been ordered.

The abolition of this system would obviously be desirable, but in many cases it is necessary to enable jobs to be rushed through to meet run cycle times and fill gaps in the program. The problems this practice causes at present should be eased considerably with the introduction of minimum order quantities for standard components.

5.9 The present practice of keeping various copies of standard product structures, Bills of Material, with the master file held in the Drawing Office, should be avoided as soon as a practical alternative of keeping one master file on the computer can be introduced. This should be mid 1978.

This will not only save storage space but make the same information available to everyone, with the added advantage of only one file to keep up to date. This would then give the Drawing Office the full advantage of a computerised Bill of Material system can offer, a facility they do not enjoy at present except by arduous cross referencing when practicable.

5.10 The company's present financial activities are a mixture of computer and manual systems, with the bulk of the daily work load being fed into various bureau packages. This provides the Accounts with a satisfactory service as far as the payroll and the monthly Purchase Ledger is concerned.

What these systems do not provide from the data they are handling, are the types of analyses the company needs, an automatic summation that would produce the final accounts, not an up to date day by day situation of the individual accounts within these systems.

6. EQUIPMENT REQUIREMENTS

6.1 The equipment required for the first phase of development, the Material Requirements Planning and Order Processing systems to replace the 'Prince' package, have been ordered, and are due for delivery on 9th January 1978. This will consist of:

1 NCR 8250 Processor with 80K BYTES of M.O.S. memory.

1 200 L.P.M. Ling Printer

2 4.9 MEGA BYTE Fixed Disks Drives

2 4.9 MEGA BYTE Exchangeable Disk Drives

2 C.R.T. Terminals

1 NCR 7200 Data Entry Sub-System

The cost of this will be £46,030. If taken over a 5 year lease this will be approximately £1000 per month. The purchase of the software packages to accommodate this will be £7100 and the maintenance and the NCR utility software rental will be £3818 p.a.

6.2 The additional equipment required to advance to W.I.P./SHOP FLOOR Control and Costing will be:

1 32K BYTES of additional memory.

1 Free Standing 4.9 + 4.9 Mega-Byte fixed and exchangeable disk unit

2 C.R.T. terminals

The cost of this will be £14,070 and will increase the lease by £296.88 per month to £1268.11 per month. The purchase of the additional software to do this will be £7700; it will increase the maintenance by £1176 per annum and would involve the purchase of approximately 7 more disk units at a cost of £350.

6.3 The additional equipment required to implement the proposed accounting system will be:

1 C.R.T. Terminal

The cost of this will be £1895 and will increase the lease by £40 per month and will increase the maintenance by £192 p.a. This will also mean the renting of additional software from N.C.R. at an initial cost of £1850 and then an annual cost of £400 per annum plus the purchase of approximately 5 disk packs at a cost of £250.

6.4 The additional equipment required to implement the Order Progressing and Sales Systems will be:

1 C.R.T. Terminal (Initially)
1 C.R.T. Terminal (When the software will allow it).

The cost of this will be £1895 for each and will increase the lease by £40 per month and the maintenance by £192 p.a. and require the purchase of 4 disk packs at a cost of £200.

The second CRT terminal will only be possible when NCR bring out an advanced version of their current software that will allow more than seven hardware attachments to the processor.

The software to carry out the Marketing Systems has not at present been specified and the cost will depend upon the availability of a suitable standard package. If a package has to be written for this, the cost will probably be in the order of £7,000 to £10,000.

6.5 When all of these systems are implemented it may prove necessary to increase the online capacity of the computer. This would then require a further Free Standing 10 MEGA-BYTE Disk Unit and an additional 32K BYTES of Memory. This would cost £10,280 and would increase the lease by £217 per month and the maintenance by £792 p.a.

The above costs are all based on present prices and the equipment etc. specified in 6.1 and 6.2 are included in the Capital Sanction for the computer. I have purposely left all the other additions out of this as I feel all additional features should be justified as and when proposals are made for them.

PROPOSED IN HOUSE COMPUTER SYSTEM TO REPLACE PRINCE BUREAU FACILITY

COST OF REPLACEMENT EQUIPMENT & SERVICES OVER 5 YEAR LEASE

1977	Deposits Paid		5,140	
	Misc. Supplies - Air conditioning, Disk pads, etc.		1,096	
	Data Entry Training		180	
			6,416	£ 6,416.00
1978	Computer Lease 5 x 971.23 / 7 x 1268.11		13,732.93	
	Maintenance of Equipment		3,944.00	
	Additional Supplies		350.00	
	Software Purchase		14,800.00	
	Software Rental		560.00	
	Training Operations		940.00	
	Delivery Charges		290.00	
	Refund of Deposits		(5,120.00)	
	Stationery		200.00	
			29,696.93	£ 29,696.93
1979	Computer Lease 12 x 1268.11		15,217.32	
	Stationery + 10%	220.00		
	Maintenance of Equipment + 10%	4877.40		
	Software Rental + 10%	616.00		
		5713.40	5,713.40	
			20,930.72	£ 20,930.72
1980	As 1979		20,930.72	
	+ 10% on Maintenance, etc.		571.34	
			21,502.06	£ 21,502.06
1981	As 1980		21,502.06	
	+ 10% on Maintenance, etc.		628.47	
			22,130.53	£ 22,130.53
1982	As 1981		22,130.53	
	+ 10% on Maintenance, etc.		691.32	
			22,821.85	£ 22,821.85
	TOTAL COST FOR 5 YEARS			£123,498.09

COST OF PRINCE BUREAU FACILITY OVER 5 YEARS

	No Growth	@ + 5% p.a.	@ + 10% p.a.
1978	24,000	24,000	24,000
1979	24,000	25,200	26,400
1980	24,000	26,400	29,040
1981	24,000	27,783	31,944
1982	24,000	29,172	35,138
	£120,000	£132,615	£146,522

The replacement equipment includes the proposed mid 1978 implementation of W.I.P. Control and late 1978 implementation of Costing. It does not include bringing in house the other bureau facilities on Order Progressing, these would have to be justified on their own merits although only minor additions to the equipment would be required.

Computer lease costs are based on £21.10 per £1000 at the Finance House Base Rate of 8%, this rate will no doubt fluctuate and so will the least cost. A yearly increase of 10% has been included in all maintenance and rental charges from NCR Limited.

29th November 1977

APPENDIX L

Sales Analysis with a Micro Computer

9th. November 1978.

A PROPOSIAL FOR A COMPUTERISED

QUOTATIONS. ORDERS, AND INVOICED

SALES ANALYSIS SYSTEM.

K J Molloy

CONTENTS.

ACKNOWLELEDGMENTS.

The auth●r greatfully acknowledges the help and cooperation received from the staff and management of George Ellison Ltd. Particular thanks is due to Mr. R. Reeve, without whose help, support and incouragement this paper would not have been possible.

K.J.M.

1. SUMMARY

1.1 This paper sets out to describe a short term solution to a permanent need for Sales, Order and Quotation analysis by a means that will:

(a) vastly improve the quality of analysis available;

(b) cover area not presently available but held to be important, including order book analysis;

(c) not require any additional labour;

(d) save the labour of one person;

(e) show a cost profile that is favourable in relation to any alternative.

1.2 It is proposed to employ a P.E.T. 2001 micro computer, manufactured by Commodore. This machine system employs 'BASIC' as a programming language and has a good range of hardware options plus software support.

1.3 The new system will save manual work at all stages of the system including the contract engineers, sales administration and accounts, but will not plot graphs.

1.4 It is proposed that the company exploit its links with the University of Aston to generate the necessary programmes to operate the system.

1.5 The cost of the system will be £2,500. The saving will be £4,840, giving a straight cash benefit of £2,340 in the first year. In addition to the cash benefit the system will produce many intangible benefits that arise from a superb analysis facility.

1.6 Analysis is not the whole story, one also needs synthesis. Developments for the future are discussed, including the need for a graphics facility.

2. INTRODUCTION

The purpose of this paper is to describe a proposal for a computerised Analysis facility to operate on Quotation, Order and Sales data at George Ellison Limited. The analysis produced will serve as the basis for the data base retained by the system for future reference and any management information that is required on a regular basis.

The need for a computerised facility arises out of the existing situation which can be characterised by:

(a) an inability to produce even a minimal amount of data within a reasonable time;

(b) high labour intensity which aggravates '(a)' and maximises costs in terms of finance and inaccuracy;

(c) a severe shortage of permanent labour to carry out the existing analysis.

(d) a failure to give any priority to application areas other than material requirements planning and other related manufacturing and accounting activities when considering the main computer installation (Ref.1 & 2).

(e) a determination not to increase overhead costs by recruiting permanent labour.

The strategy embodied in the proposal centres around the availability of ultra low cost micro computers which are becoming available in increasing numbers to foster and supply a personal user market. These machines are reaching a level of processing power and sophistication which makes them serious contenders for commercial applications. In this case the intention is to replace the whole labour content involved between the collection of contract details and the production of weekly/monthly data and information. This is in effect 1 man month/month. In such circumstances a one off cost of 1 man year could easily be justified - this proposal sets out to do much better than this.

Even a system with such cost limitations must be expected to do more than 'what we do now' because this has proved to be completely inadequate. It is therefore intended to expand the requirements to include additional items including a phased order book.

3. DEFINITIONS OF TERMS

Many of the terms used in this paper have particular meaning and use within George Ellison Limited, while others are in general use amongst systems and data processing specialists. This section aims to dispel any confusion by defining or clarifying the principle technical terms used.

3.1 Accounts Administration - that part of the accounts department which presently compiles sales analysis.

3.2 'BASIC' - a simple, but powerful, high level computer programming language which combines an interactive ability with English like statements.

3.3 Byte - a predetermined number of consecutive binary bits or characters (a bit can be '0' or '1') and represents a discrete area of storage which can be addressed by the programmer.

3.4 C.A.D. - computer aided design.

3.5 Commercial Analysis Function - The function responsible for consolidating, analysing and storing data and producing information relating to Quotations, Orders and Invoices.

3.6 Component Sales Office - the office responsible for the sales of Ellison and MELCO products in kit or component form.

3.7 Conversion Ratio - the ratio of orders to quotations in the current period.

3.8 Data - any group of operands or factors consisting of numbers, alphabetical characters or symbols which denote conditions, values or states.

3.9 Distribution Sales Office - the office responsible for the main stream of Ellison sales specialising in completeequipment to users.

3.10 E.D.P. - Electronic Data Processing.

3.11 Information - generally understood as that which derives from the assembly, analysis or summarising of data into a meaningful form, but more precisely, material evaluated for a particular problem, for a specified individual, at a specific time, and for achieving a definite goal, i.e., information is what moves managers to action. As such Information must be strongly distinguished from 'data' which can be generated, gathered, organised, stored, retrieved and reported without moving a manager one step towards a decision, often, the sheer volume of data hinders managers by making it impossible to see the wood from the trees. Information is the real stuff of communication, data is nothing more than 'noise' in the system.

3.12 Micro Centre - the place where the micro computer will operate and be controlled from.

3.13 Micro computer - small computer based on integrated circuit, micro processer 'chip'.

3.14 M.I.S. - Management Information System - a formal system in the organisation which provides management with the necessary reports to be utilised in the decision-making process.

3.15 M.S. - Machine System.

3.16 Nett value - value charged or intended to be charged to a customer.

3.17 Sales Administration - That part of the component sales office responsible for, the recording of statistics, filing and smooth movement of paperwork in the Component Sales office.

3.18 Smoothed Value - a value derived by the technique of exponential smoothing. This is a weighted moving average which obviates the necessity to retain large amounts of past data. The computational procedure is shown in the following formula:

New smooth value = Old smoothed value
+ x (New Data - Old Smoothed value)

where x designates a smoothing constant between 0 and 1. The old smoothed value is the new smoothed value of the previous time period.

3.19 Standard Deviation - the percentage deviation between the standard value (see 2.20) and the Nett value charged to the customer.

3.20 Standard value - the value of goods sold to customers measured at constant prices. This metric gives a reflection of volume for products which are difficult to quantify and is widely misunderstood at Ellisons. The system for producing these values is in a mess but could be greatly improved.

3.21 Stats slip - a summary sheet used by contract engineers at the quotation stage to record the statistics relating to a contract.

3.22 Trend Curves - a set of graphs used to spot trends in product performance using the smoothing technique described in 2.18.

3.23 Variety - a technical term from cybernetics to describe complexity and defined as the number of possible states of a system.

3.24 V.D.U. - Visual Display Unit.

3.25 'Z' curves - a set of graphs used to summarise data for circulation to managers showing performance for current period, cumulative year to date, twelve month, moving average and order book by selective product groups.

4. THE EXISTING SYSTEM

Within the existing system the treatment of Quotes and Orders is very similar. All basic data is collected by the Sales Offices and

and aggregated by product group, either weekly or monthly. This pre processed data is sent to the commercial Analysis function where component and Distribution data are consolidated into one data base giving product group performance by Name, Export and Total, and within these groups, net value, std.value, std.deviation and conversion ratio. This data base also contains an analysis of Sales for the company which is generated from data supplied by the Accounts department.

4.1 Limitations of the existing system

The most general limitation relates to the high labour content to produce this data base. Within the Distribution Sales office contract engineers have to reformulate price data in a way different from that quoted to customers. The result is that a whole set of calculations are required in order to fill in the 'statistics slip'. This has produced much complaint in the past and certainly does nothing to promote a spirit of cooperation and conscientiousness. Sales Administration has to transcribe details from stats slips to weekly sheets and from weekly sheets to monthly sheets and at every stage calculations are involved. The data is transcribed once more before it becomes a part of the general data base. At every stage, transcription and calculations errors can and do arise, while the sequential nuatre of the operations ensures that errors at any stage are always reflected in the final data base. Similar comments may be made in relation to the component sales office. This office has refused to release data on a weekly basis because of the amount of work involved and has been in the practice of compiling its statistical returns once a month. Similarly the accounts department refused to generate weekly data when this function was transferred from the sales department - a transfer which arose from labour shortages.

Another limitation is perhaps a manifestation of the first. It is unusual for all data to be consolidated before the middle of week 2 of the succeeding month. Preparatory operations are sequential and any delay in transferring data to the Commercial Analysis function results in a delay in the publishing of management Information based on the data base. Such delays often arise from staff shortages, illnesses or absenteeism.

4.2 Output from the existing system

Until October 1977 it was the practice of the company to circulate the whole data base to all senior managers. The level of variety (complexity) reflected in this data base was clearly far in excess of that required by most managers for decision making. Indeed, it might be argued that it hindered effectiveness by making it impossible to see the wood from the trees.

4.2.1 Z Curves

The present system of 'Z curves' was introduced as a substitute for the general circulation of the data base with the aim of simplifying 'the picture'. However, these graphs represent a further level of obstruction from the data base and while they give a summarised amount they do not obviate the need to generate the data base in the first instance. Reducing the level of variety in the reported data increases the variety of the operations required to produce it. This is always the price of transforming pure data into management information; which only succeeds when managers are moved to action by the information they receive.

4.2.2. Trend Curves

In addition to 2 curves another set of graphs is generated. These trend curves show trends for net and std. values and price levels for selected product groups. These trends are produced by exponential smoothing and require a relatively complex calculation for each graph plot. The basis of these graphs is weekly data but, as indicated above, weekly data is not available in several areas. These graphs are not generally circulated but inspected on an ad hoc basis by the chairman and other top managers. They have proved to be of some value in forecasting exercises but are limited by the restricted product range they cover and the difficulty of updating in the absence of weekly data. These graphs have been particularly hard hit in the past by labour shortages and have often fallen several months behind.

4.2.3 Area Analysis

At one time the basic data base contained an analysis of sales by area which was important not only to identify performance in particular export markets but to monitor the performance of Area Engineers against targets. This performance is periodically updated on graphs which are inspected by the Commercial Director, but an inability to maintain these graphs leaves the area engineers with almost complete autonomy.

4.3 Concluding remarks on the existing system

Financial constraints have hit this area of the companies operation must severely and therefore the existing facilities, being only a skeleton of the pre March 1977 set up, must be seen as completely inadequate for the companies requirements. Against this background the demands on this area have grown with the result that many activities have been dropped while retained activities have inevitably suffered a qualitive decline; many of the activities in the system are prime targets for automation anyway and in the absence of such a development, the system will have to draw an additional labour which at the moment shows every sign of not being there. Apart from obviating the need for additional labour the employment of E.D.P. techniques should reduce the work load of Contract engineers and Sales Administration as well as providing a much more flexible system.

5. THE MODIFIED SYSTEM.

This section will deal with the changes to the existing system and the operational consequences.

5.1 The Aims of the proposal

(a) To provide all analysis presently available plus all additional items within reason.

(b) Replace labour in relation to the present system for a relatively small capital outlay.

(c) Employ a rational product format for the data base consistent with all functional areas of the organisation.

(d) Produce hard copy records which includes graphical data, if not graphs themselves.

(e) not prejudice development of any future system in terms of hard or soft ware. This requirement entails that it be possible to interface any device employed with existing and future installations.

(f) Be operational in a relatively short time to enable the system to back track to the beginning of the financial year (October).

5.2 An outline of the new systems

At the centre of the new system will be one of the new generation of micro computers which offer substantial processing power at minimal cost. It is of course, technically possible to do all the proposed items on Ellisons existing computer installation, but this facility is not available at the moment, either to develop a system, or to freely operate it. It is expected that the cost of the new system will only marginally exceed the cost of a new terminal for the N.C.R. installation, yet offer independent processing power.

The new hardware will in effect replace the whole labour content required to carry out calculations in the existing system. Presently, operations could be characterised as labour and calculation intensive, the new system's operations will only be concerned with the inputs and outputs of the system.

Basic data for the system will be collected as near to source as possible. In the distribution sales office the contracts engineers will be required to fill in a coding form which will be the basis of all calculations and aggregations made by the system. Suitable forms will be required at the quotation, order and Invoicing stages of operations with suitable forms for amendments. The same philosophy will operate for the components sales office, a coding form will have to be generated for each customer Enquiry/order/Invoice/amendment. The inputting of this data would be a sales responsibility for Quotations and Orders and an accounts responsibility for Invoices. This will require that the appropriate contracts engineer fill in a coding form at the instruct Accounts stage of the invoicing system to be passed to accounts along with the other papers. Accounts now have control of which jobs are included in a particular accounting period, which should eliminate a source of many past discrepancies between sales figures and accounts figures.

The basic data supplied on coding forms must include the following:

(a) Product Group or Analysis code.

(b) Customers Name and Address.

(c) Delivery Name and Address.

(d) G.E.Quote No.

(e) G.E.Order No.

(f) Net value of product group.

(g) Price terms.

(h) Market (Name, Export, Indirect Export)

(i) Area code.

(j) Customer Order No.

(k) Required Delivery. Week No. or - Weeks Quote.

5.3 Who does what in the new system?

5.3.1 The contract Engineer

As mentioned above the contract engineer will be required to supply all the details of the contract at every stage on a suitable coding form. This process may be simplyfied by employing suitable carbon copy system at the quotation stage. Retained copies will obviate the necessity to complete a whole form at the order and Invoice stages for those jobs where customer requirements do not alter. In many other cases small amendments will suffice. Retained copies offer the further advantage of serving to rapidly familiarise a contract engineer with the outline of a job. (Ref. 3)

The existing system requires the contract engineer to compile net values against product groups which is different from the price composition for the customers. They are also required to calculate standard value. This will not be necessary under the proposed system since only net values and terms will be required. All calculations will be carried out by the machine system. The work content for the engineers will thereby be reduced.

A suitable layout for the necessary coding form for the distribution sales office have been discussed and in principle agreed with the tendering and contracts managers. A similar coding form will be required for contract engineers in the components sales office but this should present little problem.

5.3.2. Sales Administration

Originally it had been conceived that someone from Sales Administration would operate the 'enter data to machine system' function. Miss Denise Nevitt would have been an ideal candidate but her new function may prohibit this but if not Miss Nevitt then her replacement should suffice.

This function would require the following:

(a) Quotations: Upon completion of quotation and before fil ing the data entered on coding forms by contract engineers will be entered to machine system through micro-computer keyboard. This operation directly replaces the manual entry of quotation details on existing weekly sheets for aggregation by product group. Although this operation may require the development of a new skill (Miss Nevitt already has keyboard experience) it eleiminates the necessity for calculations.

(b) Orders: The procedure here is identical to that for Quotations with an appropriate amendment to the process point of recording i.e., Orders are entered to machine system towards the beginning of the order processing system while quotes are entered towards the end of their system. Coding forms from components would be passed over to Distribution Sales Admin. for entry with Data from Distribution office. For sales Admin. the weekly/monthly chore of compiling statistics will disappear.

5.3.3. Accounts Administration

On order to ensure that the Accounts department has complete control of which invoices are recorded by the system it will be necessary that contract engineers supply not only the existing instruction to invoice with necessary papers but also a coding form similar to that employed for Quotations and Orders. The Accounts department will supply details to the machine system to ensure that only items actually invoiced are recorded. The operations involved will be similar to those required of sales administration. Once again all compilations and manipulations would be obviated. Mr.R.Reeve proposes that Mrs.Rita Walton be responsible for this phase of the operation.

5.3.4 (Micro Centre) Commercial Analysis Function

The responsibility of this function will be to take control of data after it is entered in M.S. and supervise weekly/monthly runs. This will require the loading of suitable programmes for the creation, consolidation and updating of suitable files. This function will be responsible for the maintainance and where necessary development of programmes and will supervise the distribution of output. In practice this function might be covered by Mr.Reeve, myself, both or some other suitable person.

5.3.5 A graphical facility

In practice no micro computer system which meet the requirements of this proposal will produce satisfactory graphs that can be circulated to management and therefore someone will be required to translate the numerical output to a graphical form where necessary, i.e., Trend curves and 'Z' curves. This is no more a problem for the new system than the existing one but should be settled relatively easily since all (the considerable) the calculations necessary to plot these graphs will have been prepared by the M.S. The M.S. output will be hard copy thus allowing anyone - Clerk, typist etc. - to fit graph plotting in as a side operation.

5.4 Security in the New System

In order to achieve security -

It is not desirable that data entry operations proceed automatically to data consolidation for the following reasons -

(a) Data entry should take place several times a week while consolidation will be required weekly and monthly therefore the operations for data loaders would be irregular, sometimes requiring data entry programmes but sometimes requiring additional consolidation programmes.

(b) it is thought desirable to separate access to runs and consolidated data since generalised information relating to the performance of the organisation should have restricted access.

(c) This arrangement would reduce the likelihood of files containing 'past' data being corrupted - compartmentilisation ensures that only one compartment can go wrong at a time.

(d) This arrangement not only protects data but also the various operating programmes which will be lost to the operating system every time the M.S. is switched off. Operating programmes will be read from tape for every set of operations.

Restricted access to tapes will achieve on the Micro what is achieved by the pass code system on larger M.S.s. In order to ensure the effectiveness of this system it will be necessary to keep these tapes plus completed data tapes under lock and key.

5.5 THE OUTPUTS FROM THE MACHINE SYSTEM

All outputs from the machine system will be hardcopy, by printer as follows-

Weekly:

1) Data list· list by (a) Quotation N$^{\underline{o}}$.
(b) Order N$^{\underline{o}}$.
(c) Invoice N$^{\underline{o}}$.

2) Consolidation

(a) Nett value (b) Stand value (c) Stand dev (d) Smoothed values for (a), (b) and (c).	X Product Group and Analysis Code.	X Home, X Export, X Indirect Export, X Home.	X Quotations X Orders X Sales

3) The Orderbook

Columns as follows:

(a) Product group.

(b) Total orderbook: Nett; Stand: Stand dev.

(c) Arrears:

	Total X Nett·	Stand:	Stand dev
1 Month	..	..	.. ..
2 Months	..	..	.. ..
3 Months	..	..	.. ..
and +			

(d) For delivery: Total X Nett: Stand: Stand dev

1 Month	..	..	..	..
2 Months	..	..	..	..
3 Months	..	..	..	..
4 Months	..	..	..	..
5 Months	..	..	..	..
6 Months	..	..	..	..
and +				

4) List of Orderbook Customers

Columns as follows:

(a) Customer name and address.

(b) Customer order N^{o}.

(c) Total value of customer order, i) the original order.
ii) the outstanding order.

(d) G.E. order N^{o}, i) Nett outstanding value/G.E. order.
ii) Product groups/G.E. order.
iii) Delivery status/G.E. order.

5) List of Orderbook Orders (by G.E. Order N^{o})

Columns as follows:

(a) G.E. Order N^{o}.

(b) Customer Name and Address.

(c) Customer Order N^{o}.

(d) Total Nett Value.

(e) Outstanding Nett Value.

(f) Product Group(s).

(g) Delivery Promise- week, year.

Monthly: Product Analysis.

1) Quotations.

Columns as follows:

(a) Product Group.

(b) Nett Value -	Current,	Cumulative,	Moving	An.	Total.
(c) Stand. Value-	..	..	..	..	..
(d) Stand. Dev. -	..	..	..	..	..

(e) Convertion Ratio by value and number- (Ref. 4 , 5 , & 6.)
Current and Cumulative.

The above shown by: Home, Export, Indirect Export, Total and Area.

2) Orders.

Columns as follows:

(a) Product Group.

(b) Nett Value:	Actual-	Current.	Cumulative,	Moving	An	Total.
	Budget-	..	..	..	..	..
	Index -	..	..	..	..	..
(c) Stand.Value:	Actual-	..	..	..	..	..
	Budget-	..	..	..	..	..
	Index -	..	..	..	..	..
(d) Stand. Dev;	Actual-	..	..	..	..	..
	Budget-	..	..	..	..	..

3) Salos.

Columns as follows:

(a) Prodct Group and Analysis Code.

(b) Nett Value:	Actual-	Current,	Cumulative,	Moving	An.	Total.
	Budget-	..	..	..	..	..
	Index -	..	..	..	..	..
(c)SStand.Value:	Actual-	..	..	..	..	..
	Budget-	..	..	..	..	..
	Index -	..	..	..	..	..
(d) Stand. Dev;	Actual-	..	..	..	..	..
	Budget-	..	..	..	..	..
	Index -	..	...	..	..	..

The above shown by Home, Export, Indirect Export, Total and Area.

4) List of best Customers By Value.

(a) Customer Name and Address.

(b) Value of Orders.

(c) Number of Orders.

6. THE HARDWARE

This section will begin with a brief look at possible micro systems that could, technically, meet the Ellison specification.

6.1 P E T 2001 Series

This device is a Commodore product and has an integrated V.D.U., keyboard, central processor and tape unit. External units include External Cassette Deck, Memory expansion and printer. The memory for the basic unit is 13K Bytes of Read only memory, which includes an 8K BASIC interpreter; plus 8K (expandable to 32K) Bytes of Access memory. The suppliers offer an Interface which is compatible with RS232 which allows the device to communicate with other equipment (including the Ellison equipment). For more details See Appendix

6.2 The T.R.S. - 80 System

This is a Radio Shack system, marketed by Tandy. This system is not physically integrated, having V.D.U. keyboard, power supply, cassette recorder etc. as discrete units. The memory offers two levels of BASIC (4K and 12K) with up to 16K Bytes of

Random access memory in the basic package. Further expansions are available at a price. Two types of printer are available as is a Mini Disc system. This system is also capable of communication through an RS232C interface. For more details See Appendix

6.3 Research Machines 380Z

This system is physically similar to the TRS - 80. This system offers three levels of BHSIC 2, 9, 12K Bytes with up to 4PK random Access memory. Additional hardware includes cassettee recorder printers and Floppy Disc System. For more details See Appendix

6.4 Other Suppliers of micro computers

Alternative sources of hardware include:

(a) Computer Workshop, London and Manchester.

(b) Comart. Huntington, Cambridgeshire.

(c) The Micronic Company, Twickenham, Middlesex.

6.5

Which system should Ellison buy?

The object of the descriptions given in the above list of systems was not to present an unbiased basis account on which the reader of this proposal could base an opinion of which system is best, but to impress on the reader the fact that several alternatives have been considered and rejected before favouring of the Commodore PET 2001. The main reason for rejecting the alternatives is the cost of the printers used with these systems, typically in the region of £1,000 plus for an acceptable device. Commodore offer a well thought out package with good software support.

Finally, time is too short and the need too urgent to provoke a 'which one' debate within Ellisons and thus the answer to this proposal should be 'yes' or 'no'.

7. THE SOFTWARE.

The Commodore P.E.T. has an 8K BASIC interpreter and therefore it will be necessary to write the system programmes in BASIC. These programmes fall into two categories; firstly, data capture programmes which will interact with personnel supplying basic data relating to specific contracts (input); and secondly, data consolidation programmes, which will consolidate data from different sources and jproduce the required output from the m/c system. BASIC is a powerful high level language, which is easy to learn and to use, therefore Ellisons requirements will present no special problems beyond the need to create the programmes quickly. To facilitate this I propose that the company exploit its links with the University and contract some suitable person to write programmes to Ellisons specification. I have already contacted two people in the University who would be willing to undertake this task.

8. THE COSTS.

It is intended to avoid the trap of giving a 'cost-benefit' Analysis in the traditional fashion for the following reasons:

(a) Most if not all systems contain hidden and untangeable costs. This has certainly been Ellisons experience.

(b) Most systems have hidden or unforseen benefits. It is an unfortunate fact of life that costs are often more easily identified than benefits.

(c) Benefits, even when identified are often impossible to quantify financially.

In the final analysis the company will feel that the immediate short term costs are justified or not. The benefits take the form of labour saving, time saving, quality of information plus a higher degree of flexibility in Ellisons data processing facility. The Cash Benefit Analysis below shows only the immediate short term costs and benefits.

8.1 A Cash Benefit Analysis

	Cost£	Saving£	Cash Benefit£
Hardware costs			
1. P.E.T. 2001 Personal Computer	643	-	-
2. P.E.T. 2020 Printer*	425	-	-
3. Memory Expansion to 32K	450	-	-
4. RS 232C Interface	187	-	-
5. External Tape Deck	55	-	-
6. 10 - C12 Blank tapes	5	-	-
7. Users Handbook	5	-	-
8. Maintainance Contract, 1 year	220	-	-
9. Total Hardware Costs.	1990	-	-
Software Costs			
1. BASIC Assembler	49	-	-
2. BASIC Renumber	35	-	-
3. BASIC Instructor	9	-	-
4. Software Development**	300	-	-
5. Total Software Costs	393	-	-
Sundry Costs	117	-	-
Total Costs***	2500	-	-
Saving			
1. Labour - 1 man year	-	4840	-
Cash Benefit	-	-	2340

*The PET 2020 printer will not be available until January 1979. It is proposed that the system output on the existing Ellison printer until then. This requires the addition cost of £187 for the RS232C interface. This expenditure is not a waste since this interface will allow communication to the existing computer for future system development.

**Soft ware development is notoriously difficult to estimate. £300 is felt to be on the high side thus maximizing the probability of falling within the stated figure.

***All prices shown are correct to the authors knowledge at the time of writing.

9. DEVELOPMENT.

The PET 2001 has been chosen to meet specific short term requirements and therefore many advantages have not fallen within the terms of reference of this proposaln and therefore have not been discussed. Whatever development takes place to Ellisons existing systems the P.E.T. will always have a valuable role in programme development and as a general workhouse when the main facility is tied up. Its use of BASIC makes every manager a potential user and programmes ensuring a wide range of use among personal and applications.

9.1

The system as described has an omission which should be corrected at the earliest possible date. There is no order progressing system for the whole organisation. At the moment the planning department works back from the required delivery date to set, out of material sheet Department dates, out of Drawing Office dates and Out of Sales dates. However there is no record of the performance of these departments in relation to these target dates. Clearly, the data entry side of such a reporting system becomes more complex since data must be entered to the M.S. every time an order moves from one department to another. An initial approach might be to enter all the commitments against each department when orders return from planning to sales, these could be printed out periodically for managers information. The system would not be complete until the M.S. was capable of monitoring progress against these targets but this would require the co-operation of all departments to post order movements. While this is possible it would require some negotiation and has therefore been omitted from the initial package. Another approach might be to include a progress form with the standard documentation on which to record the progress of an order as it moves through the system. Details of completed orders could be recorded and consolidated to give a past event, statistical picture. This approach suffers from two major limitations. Firstly, there is a time lag in the feed-back loop, i.e., by the time one knows that issues from sales are late it is too late to take compensationary action against the orders effected. Secondly, favourable amendments to record forms would be possible at any time in the life of the order. It would, of course, be possible to maintain a record of delivery against promise date but the company needs to know not only that jobs are late, but why and in time to do something about it.

9.2.

The system described stops at the sales analysis stage and this is a convenience more than a necessity. Home market invoices are factored and this releases the company from the task of credit control. However, it would be a relatively simple matter to record payments and compile debts by age. This could be introduced for the existing non-factored debts such as exports and the experience would smooth the way for the demise of factoring.

9.3

Tha main area where the P.E.T. is limited in relation to Ellisons requirements in Graphics. The P.E.T. and the existing N.C.R. m/c at Ellisons cannot plot a smooth line curve (resolution is to one space only) which means that graph plotting must remain a tedious and labour intensive operation. Terminals with saphisticated graphics are under review but clearly cost very much more than micro computers. However I believe that such a facility is required and not simply to replace the existing labour content of the companies management information graphs. Consider the following points:-

9.3.1.

The company has already learned that producing long lists of data makes the managers job more difficult by introducting too much variety into the management info system. The introduction of 'Z' curves was intended to simplify the 'picture' and while this represents an improvement for some managers, others are still bewildered. Why should this be? The answer is that the data is still data and not information - the picture is still too complex. Reading the number of graphs requires more curves/sheet of paper, thus reducing variety in one dimension increases it elsewhere. The result is that managers still have to look hard to see the information they should be getting. Often the picture will turn out to say everything is O.K. - what a waste of time! Much of the data does not relate to every managers activity and indeed, one manager who receives Z curves gets no data on his activity at all. What is the alternative? What cannot be used should not be reported, therefore cut the fixed format, fixed variable reporting and report by exception. A good budget will provide creteria of performance and the use of indices will further limit the variety of the reported information by comparing Budget and Actual to form a pure number. Now managers are free to get on with their jobs and every report is an alarm signal which requires investigation and action.

Once action is indicated managers require further information centred on the area of difficulty and this is where graphics come in. Graphs show present and past data in a comparative form and men are much better at making comparisons than almost any other menial activity. A graphics facility would enable the manager concerned to quickly (a few key strokes) construct the graph he feels is most suitable for his purposes and thus the general source of the exception report could be quickly identified. Clearly, this may not indicate the precise cause of difficulty but the totally irrelevant data will quickly be eliminated by this method.

Finally, the manager may wish to reference hard data containing actual figures etc., in order to determine a precise course of action. The sequence of events starts with highly summarised reports which get more detailed as one moves through the graphics stage to tables or columns of real numbers. However, the growing variety (complexity) of data is countered by the ability to home in on the problem thus keeping the volume of data within the capacity of the manager, i.e., ensuring that the manager receives only information. The conclusion is that there is no best way of reporting information to managers per sa, only best ways for the purpose. Highly complex data is often required by managers and graphs can undoubtedly be a help, but not one or the other, all the time, for all purposes.

9.3.2

Graphics has a great deal of potential within market communication. The Ford Motor Company has already used graphic computing extensivity, not only in the design of cars but in their advertising campaigns, i.e., the Fiesta. The generation of sales literature, complete with illustrations, could also be greatly enhanced and speeded up by the employment of these techniques. All of this kind of activity could be carried out on the same basic terminal that produces graphs for management information.

9.3.3.

The range of potential internal applications is also very wide. Shop floor layout through to machine shop schedulling could all benefit from a graphics terminal.

9.3.4.

Computer aided graphics must have great Drawing office potential in a company that does so much front-end engineering.

The design/modification capability of any drawing office would be greatly enhanced by the techniques and technology that is presently available. However it is necessary to treat CAD separately since the technology involved has different architecture to the terminals discussed in relation to MIS etc.

10. References.

1) K.J.Molloy. 'Notes on a Proposal for a Computerised Quotations. Orders and Invoiced Sales Analysis System.' 31.5.77.

2) - 'More Notes on Data Processing.' 7.7.77.

3) - 'Customer Requirements Summary Sheets.' 30.1.77.

4) - 'Convertion Rates for Switchboards.' 19.2.76.

5) - 'Time-lags Between Quotations and Orders.' 25.3.76.

6) - 'More on Time-lags.' 12.7.76.

APPENDIX M

Proposals for Sales Analysis from the Data Processing Department

S A L E S

A PROPOSAL FOR A COMPUTERISED SYSTEM FOR SALES DEPARTMENT AND STATISTICS IN GEORGE ELLISON LIMITED

January, 1979.

Data Processing Department
Mrs. Danuta Robertson

CONTENTS

A Proposal for a computerised system for Sales Department and Statistics in George Ellison Limited.

1. The Problem

George Ellison have three immediate problems:

1. To improve and speed up the generation of quotations/orders, documents and aggregation of the data base (within the distribution/sales department) at weekly and monthly intervals for analyses and statistics.

2. Due to the planned rapid expansion of the components activities (increase in trade) to reduce (within the Components Sales Department) manual paperwork which will enable the department to carry on increased duties without increasing manpower.

3. To improve the collection and collation of statistical data for the company as a whole (an area which has been neglected for many months).

All the above problems are urgent from the company's point of view and should all be solved as soon as possible.

Moreover, a need exists for a good expandable system which would later include Sales Ledgers and marketing areas.

There also exists a need for a good and flexible data base where information can be stored at the right time and level to obtain information about, e.g. stock, price or market trends for any level of the company's management etc.

At a further level of the components activities George Ellison may need to have access to information about e.g. stock of Melco's products in Düsseldorf, etc.

How can such a system be designed?

A few months ago an attempt to solve the first of the above problems was made by Mr. K. Molley and a project entitled "A Proposal for a Computerised Quotations, Orders and Invoices sales Analyses System" was presented.

The above proposal may be accepted (with a few changes) as the first sub-system for the whole system and the next two parts should be developed. In the end, a fully comprehensive system covering all the above points will be obtained.

More details concerning the system as a whole and the technical proposal for the solution of every sub-system will be described later. The graphical representation of the system will also be attached.

II. A Short Appraisal of the "Proposal".

The study of the project entitled "A Proposal for a Computerised Quotations, Orders and Invoiced Sales Analyses System" by Mr. K. Molley proved to be generally feasible for the Distribution Sales Division as an individual unit.

However, in detail the "Proposal" contains some omissions and inadequate information without which the system (or part of it) would not work, unless further changes or certain eliminations from the proposed system are made later, during the detailed system specification stage.

/continued.......

1. Firstly, the omission of Customer Code Numbers in input data automatically excludes the output reports entitled "List of best customers by value" and the "List of Order Book customers". To produce these reports an appropriate sorting by customer code number and value aggregation is necessary. Technically, no sorting can be done by customer name and address on any small size machine (PET or NCR computers) unless special softwave and subroutines are bought and used. This is very expensive, slow and impracticable.

2. Secondly, there is a lack of clear information about the connection between the input of basic data on coding sheets (quote/order summary) prepared by contract engineers and the methods of the calculations on the coding forms. Who will produce this necessary full information for the Sales Office and Accounts on the quote/order summary and by what method, by machine or by hand, including the manual calculations and re-writing of all necessary prices and totals on to documents?

The method for the quote/order summary described in the "Proposal" serves the system well as a whole (analyses and statistics) but it neglects the expansion of the appropriate values like standard for groups, subtotals and totals on the quote/order summary and stat sheet.

3. Thirdly, one should be careful when designing listings or reports and should consider the limited number of columns (characters) on the line printer (80 characters on PET and 132 characters on NCR). Too wide reports will make the listings impossible to produce or not clear enough to understand.

III. The System

As mentioned above, the complete system will have three sub-systems:

1. The first subsystem is the one proposed and described by Mr. Molloy (with appropriate and necessary corrections).

2. The second subsystem will cover the documentation, prices, stock control, orders and statistics for the Components Sales Department.

3. The third subsystem will merge the data from the above two subsystems and create statistics for sales as a whole and also satisfy the other needs of the company.

Following is a short description of every sub-system:

SUBSYSTEM ONE: For Distribution Sales Department

a) The most controversial part of the subsystem described by Mr. Molloy (where a lot of discussion has already taken place) is the right type of hardware to serve the unique needs of the Distribution Sales Department satisfactorily on a permanent basis.

b) The second, not less controversial, part of the subsystem is the input of the basic information to the system - in other words how the information will be prepared by the contract engineer? Is he going to expand the appropriate prices (starting from the nett value) by using the factors, and will he make other necessary totals on the coding sheet (quote/order summary sheet), or will he only enter the necessary coding and let the machine do the expansions and totals? These two controversial questions must be answered very clearly without delay, before the detailed work on the subsystem starts. (By the way, duplicated manual work should be avoided and machine power used whenever possible).

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To help the decision-makers make the right decision, the following three versions of a possible solution for Subsystem Number One are given below:

Version No. 1

The best and most elegant solution - but with an extra cost involved.

a) Equipment

The Distribution Sales Department is equipped with:

i) NCR VDU, placed on the second floor is linked to the NCR main computer frame;

ii) a separate line printer is placed on the second floor and connected to the NCR main computer which provides hard copy of the information displayed on VDU immediately.

b) Input of Information

i) The contract engineer (the one who likes novelty) starts preparing quotes on the screen by entering the basic data such as group numbers (lists) nett price and price factors only.

The machine will do the calculations and the results will be shown on the screen. When he is satisfied with all points he then releases the quote to the line printer and automatically to the computer (probably on pre-printed stationery which would save the computer printing headers). If he is not happy with his values on the quote, he manipulates his figures again. He outputs to the machine and line printer only the 'good quotes' (the programme will prevent the 'bad quotes' entering the machine and printout).

ii) The engineer who does not like VDU novelty, will give his pre-calculated figures (totals in nett values only) and the price factors to an operator and he will not bother to check the results on the screen, but he will get the hard copy of his quote from the machine anyway and he may check his results against it later. If the figures on both quotes, the manual and the machine are equal, no more concern about the quote is needed. Otherwise he prepares an amendment to his previous quote and the operator will enter this amendment to the machine. A new hard copy quote will be produced for him again.

Version No. 2

The second best and still elegant solution - no extra costs - but hard copy of quotes with delay.

a) Equipment

The Distribution Sales Department is equipped with:

i) NCR VDU - is placed on the second floor and linked to the NCR computer only, but with access to the main NCR line printer.

/continued..........

b) Input of Information

The input to the system will be done the same way as described in Version No. 1 points i) and ii), but with a small difference on the output side. The hard copy of the 'good quotes' will come back to the engineer later (e.g. the next morning) from the main line printer.

Version No. 3

The third version is for implementing the PET micro-computer with an attached 80 characters line printer with the BASIC programming language described in detail by Mr. Molloy in his 'Proposal' together with the costs which are given there in detail as well.

A frank opinion about every version presented above together with a graphical representation of each version in relation to the system as a whole is given below. The costs of each version separately and for the system as a whole is also given.

Opinions about the Versions

i) Version No. 1 or No.2, if chosen, would give a permanent solution to the system as a whole, because the NCR computer with its language (Cobol) makes every system flexible and any future, necessary amendments to the system or programmes can be done 'at home' without extra outside costs.

The controversial part in Version No. 1 is the extra cost for the second NCR line printer attached to the VDU which is about £2,000, but in the future both VDU and line printer placed on the second floor could be shared with the Drawing Office, so two departments might benefit from the same devices.

ii) Version No. 3 with the limited power of the micro-computer (PET) and with the Basic programming language does not allow for so many manipulations necessary to run the system with reasonable speed and accuracy.

There are so many unanswered questions about the micro-computer itself and about the ability of Basic. For example, how does Basic handle the files, how does it sort the data, etc.

The line printer attached to a micro-computer is limited to 80 characters and therefore only narrow reports can be obtained but Mr. Molloy in his "Proposal" expects in some cases up to 130 characters excluding the vertical spaces without which the reports would be quite difficult to read.

All together, with so many uncertainties and the lack of deep knowledge about both micro-computer (PET) and Basic, it is extremely difficult to give proper advice and recommendations on this matter. The only person fully conversant in this area is the author of the 'Proposal' himself - Mr. Molloy, who will no doubt give more explanations if needed.

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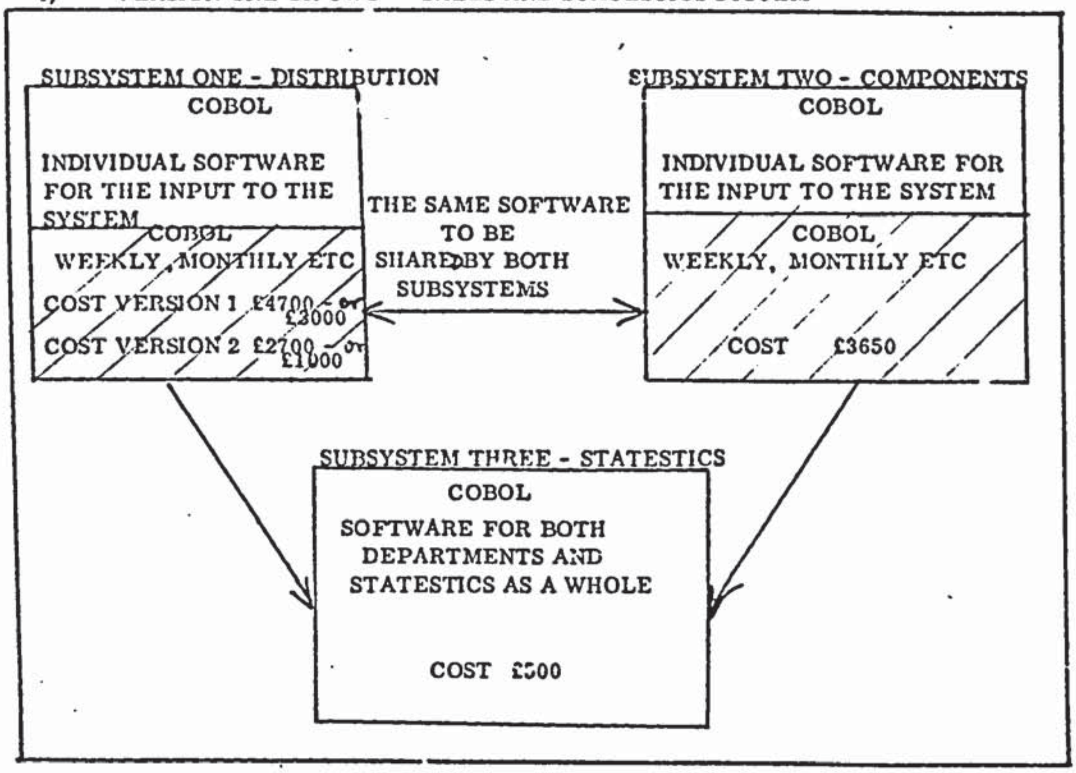
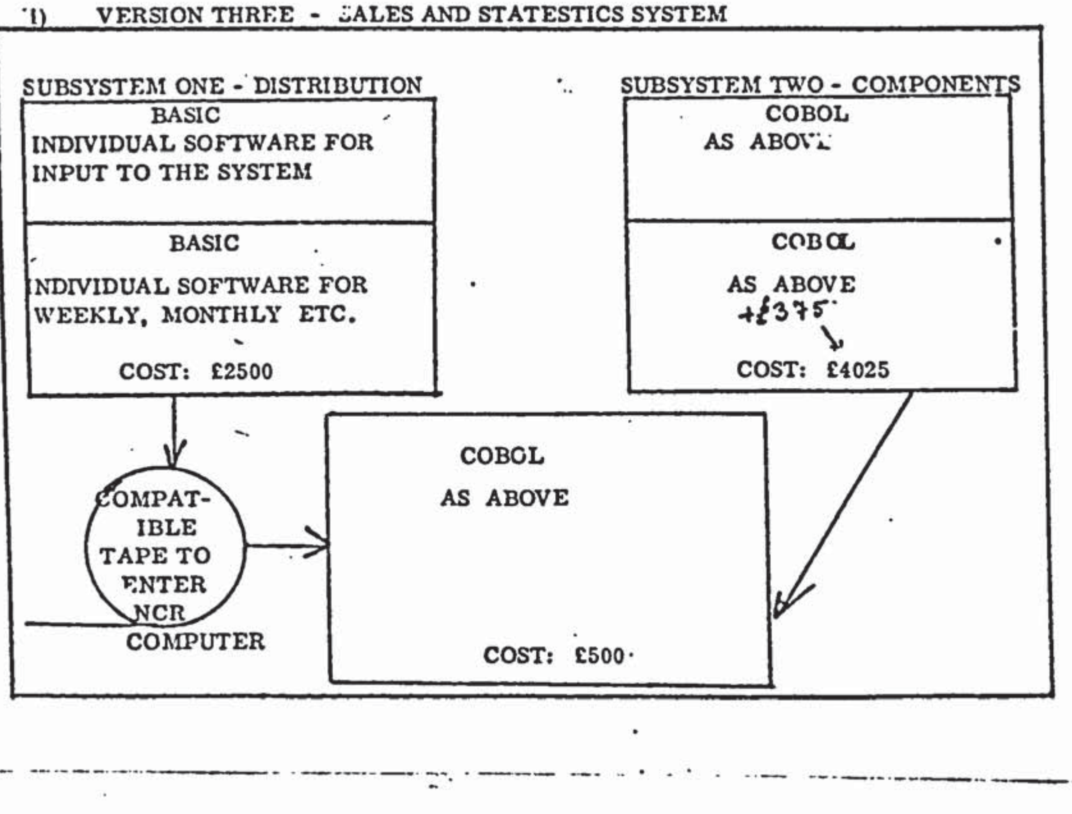
4a

1) VERSION ONE OR TWO - SALES AND STATESTICS SYSTEM



1) VERSION THREE - SALES AND STATESTICS SYSTEM



iii) Conclusion

Generally, the Version chosen by the Distribution Sales Department will have no effect on the system as a whole, because the micro-computer (if Version 3 is chosen) will supply data to the main NCR computer on cassette.

There is only one snag; the files created on the cassettes by the micro computer (PET) must be compatible with the main NCR computer; in other words the recording density, recording modes (which must be Ansi-compatible), inter record gaps, EOT/BOT-ANSI standard reflective tape sensor system - for detecting the beginning and end of the tape, the channels number = 9 plus one for parity check for the NCR cassette reader - this is very important to check in detail before any committment to the micro-computer is made otherwise extra devices or extra outside services might be necessary to rewrite the information from one cassette to another compatible with the NCR (this should be taken as a warning).

2.0 Subsystem Two for Components Sales Department

After investigation of the paperwork in the Component Sales Department the following proposal for hardware and data processing is outlined:

2.1 Equipment

i) The Components Department should have on-line processing with their own VDU linked to the NCR main computer.

ii) Hard copy of daily documents, weekly/monthly analyses and reports will be obtained from the main NCR line printer to which the department will have access.

The arguments for own VDU are as follows:

- the Components Departmen t is expanding mainly due to the increase in trade with Japan.
- the Department is some distance away from the main adminstrative office where other VDU's are installed
- there are only a few employees in the department.

2.2 Data Processing

All inputs and data processing for the department will be done via VDU.
The whole processing will be divided into:

- daily processing
- weekly processing
- monthly processing
- other occasional processing - by request.

2.2.1 Daily Processing

Daily processing will perform the following functions:

1) create and print hard copy of the daily documents - flimsy on line printer.

The way of creating the flimsy is as follows:

- any person in the Component Sales Department can type the appropriate information straight from the customers' order into the VDU.
- all calculations will be done by the machine.
- the following day the four hard copies of the flimsy on pre-printed stationary will be back from the main NCR line printer.

ii) daily processing will perform all aspects of stock control including:

- stock maintenance - stock enquiry;
- stock count;
- stock adjustment;

/continued........

- return to stock;
- new order;
- amend order quantity;
- carrel order
- partial receipt;
- completed receipt - and so on..

The stock control software is already 'in house', but some changes are needed to make it fully acceptable for the components stock.

iii) Daily processing will create and update the Incoming Order Book file by adding new orders to the file, finishing completed orders on the file, cancelling orders from the file, etc.
The Incoming Order Book file is the basic file and holds all necessary data for all aspects of analyses and reports for orders, customers and product.
The Incoming Order Book file will be kept on line to facilitate fast answers to the customers enquiries about order.

iv) The Customers File which will keep current and cumulative transactions (turnovers etc.) will be also updated automatically daily.

2.2.2 Weekly Processing

Weekly processing will also be carried on via VDU, but it will be cumulative batch processing which will give the following reports (hard copy from the line printer).

i) Weekly Progress Chart - for completed orders.

ii) Incoming Order Book contents for Component Department - a report which will contain:

- Customer's number, G.E. flimsy number, all dates and weeks (orders date and week of completion, flimsy date and actual completion week, etc.)
- Product group and all values (Q = nett, C510 = standard, C = current, in yen for Melco product, air and sea.)

This report might however prove that this should be printed only by request - because of the on-line facility.

2.2.3 Monthly Processing

Monthly processing will be similar to weekly processing via VDU.

The analyses and reports will be as follows:

Component Activity Reports for:

i) Invoice Statistics for:
- home market)
- export market) in appropriate layout.
- direct to users)

/continued.......

ii) Incoming Orders for:

- home market)
- Export market) in appropriate layout.
- direct to users)

iii) Monthly Analysis of the components unit input for:

- circuit breakers
- breakers
- spring assisted
- solenoid, etc.

2.2.4. Other Occasional Processing

There are a few other activities in the components sub-system which will need to be updated, changed or just simply listed. This processing will also be via VDU.

i) Prices file - this file is a very important item of this subsystem. It will contain seven prices : C510, C, Q, Sea, Air, yen, stock in £'s. This file will be for on line enquiries, flimsy creation, Incoming Order Book, updating with appropriate values from every order, etc. The price file will be very flexible, so the price changes could be made for a group of items or for individual items. Changes will be made by accepting appropriate price factors from VDU. Hard copy of the price list will be produced if amendments to the prices are made.

ii) Outstanding Orders - all outstanding orders for a period - 6 months - 1 year or more, will be printed by request.

2.3 Codes

In practical terms there is no consistent coding system in Component Sales Department (nor in the Distribution Sales Department).
This situation cannot exist,any longer especially when the computerised systems needs discipline in this matter.

2.3.1. Codes for Components

There is a very good opportunity to present the codes and its logic for the stock components and their prices without which further development of this subsystem would be impossible in the manner expected.
The proposed maximum length for every individual component which has an individual price in the price list is 14 characters, (the same length is generally used in all other G.E. computerised systems).

A. For G.E.'s components the following coding within the group is proposed:

i) For ratings:

RA/0800/2 x 050 x 5/ *
RA 16002 x 100 x 5
RA20003 x 100 x 5

* The meaning of the above code example is as follows:

RA - ratings
0800 - 800 amps
2 x 050 x 5 - 2 x 50 mm x 5 mm.

ii) For Breakers:

- Spring assisted manual closing

GEA/M/080/N/D *
GEA/M/080/N/F **
GEA/M/080/A/D ***
GEAM080AF
GEAM100ND
GEAM100NF
GEAM100AD
GEA/M/100/A/F ****

etc.

The meaning of the above code examples is as follows:

*. GEA - G.Ellison's classification for breakers.
M - manual closing
080 800 amps - ventilated enclosure rating
N non automatic
D drawout

/continued.......

**	GEA	-	as above
	M	-	as above
	080	-	as above
	N	-	as above
	F	-	fixed
***	GEA	-	as above
	M	-	as above
	080	-	as above
	A	-	Automatic with 3-direct acting overloads - wired.
	D	-	as above
****	GEA	-	as above
	M	-	as above
	100	-	1000 amps - ventilated enclosure rating
	A	-	as above
	F	-	fixed

- Solenoid Close (DC coil110V or 220V)

GEA/S/080/N/D *
GEA S 080 N F
GEA S 080 A F
GEA S 100 N D
GEA S 100 N F
GEA S 100 A D
GEA S 100 A F etc

* The meaning of these groups of codes is similar to the above except that S means Solenoid.

iii) <u>For Fuse Switch</u>

FS/060/3	- Triple Pole Fuse Switch 60A complete with door
FS 060 3 N	" " Neutral F/Sw.60A " " "
FS 150 3	" " Fuse Switch 150A
FS 150 3 N	- Neutral Fuse Switch 150A """""
FS 200 3	" " 200A
FS 200 3 N	" " " " " " " "
FS 300 3	" " " 300A "" " "
FS 300 3 N	" " " " " " " "
FS 300 3 S N	" " " 300A Switched Neutral
FS 400 3	" " " 400A
FS 400 3 N	" " " " " " "
FS 400 3 S N	" " " " Switched Neutral
FS 600 3	" " " 600A
FS 600 3 N	" " " " " "
FS 600 3 S N	" " " 600A Switched Neutral
FS 800 3	" " " 800A
FS 800 3 N	" " " "
FS 800 3 S N	" " " 800A " "

etc.

/continued.........

iv) <u>For Links</u>

FSL C60	- Copper Links (set of 3) -		60A
FSL 150	" " "		150A
FSL 200	" " "		200A
FSL 300	" " "		300A
FSL 400	" " "		400A
FSL 600	" " "		600A
FSL 800	" " "		800A

FS CASTELL - Castell Lock and Key
FS AUX 1 Auxiliary Contacts 1-N/O, 1-N/C
FS AUX 2 " " 2-N/O, 2-N/C

etc.

v) <u>Accessories (unwired)</u>

These codes could be prefixed ACC, then numbered segnentially, e.g.:

ACC 0 1 - Shunt Release with aux.sws. and isolating plugs (wired) 30V D.C.
ACC 0 2 " " 110V, 240V, 115V AC.
ACC 0 3 Instantaneous undervoltage coil

etc.

vi) <u>For MELCO's product</u> the Melco's coding will be adapted because that will make the future development in this area much easier.

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2.3.2 CODES FOR CUSTOMERS

Customer coding is still not very clear, but the future extension to the Sales Ledger will require the use of Accounting Numbers for every existing customer, and Accounting Dept's method of creating new customer account codes.

3.0 SUBSYSTEM THREE

This subsystem will merge the data from both previously described subsystems and produce statistics for Sales as a whole and also satisfy the other needs of the company.

The introduction of historical date and some forecastings factors (budgeted values for the month or year) will give the difference in budgeted and actual performance of the orders input and Sales from which "Commercial Report" and figures for "Monthly Finance Report" will be produced , - also the information for drawing "Z" curves can be easily obtained.

- The merged (or separated) data can be used as a base for the projection and forecasting of the demand for some products or components and might prove to be useful for marketing analyses.
- The collected data on the computer files give enormous flexibility for building eg. simulation models for Sales as a whole or for any chosen product or group etc.

The subsystem will be studied in more detail later.

IV COSTS AND BENEFITS ANALYSIS

1.0 COSTS

1.1 COSTS FOR SUBSYSTEM ONE - 3 VERSIONS

i) VERSION ONE

The following costs are assume for VERSION ONE in SUBSYSTEM ONE

A) EQUIPMENT

1) VDU	-		£1700	*
2) NCR Line Printer	-	about	£2000	**
TOTAL COSTS FOR HARDWARE	-		£3700	

B) SOFTWARE

3) Program for daily input to the system and quotes printing	-		£ 250	
4) Unique programs to the departmental individual needs	-		£ 250	
5) Programs for weekly, monthly analyses	-		£ 375	* * *
TOTAL COSTS FOR SOFTWARE			£ 875	
6) SUNDRY COSTS	-		£ 125	
TOTAL COSTS FOR VERSION 1	-		£4700	
		minus -	£1700	for VDU
TOTAL COST WITHOUT VDU			£3000	

* This cost includes cables and instalation work anyway this item is already "in house".

** This is a new piece of equipment which would be required if this version was chosen.

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*** Half of the costs for programming because this programs will be used by SUBSYSTEM TWO as well.

II) VERSION TWO

A) EQUIPMENT:

1) VDU	-		£1700 as for VERSION 1
B) SOFTWARE			
2) PROGRAMMING	-		£ 875 as for VERSION 1
3) SUNDRY COSTS	-		£ 125 as for VERSION 1
TOTAL COSTS FOR VERSION 2	-		£2700
	-	minus	£1700 for VDU
TOTAL COST WITHOUT VDU			£1000

III) VERSION THREE

Costs for VERSION 3 was calculated by Mr. Molloy and is shown in "PROPOSAL".

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1.2 Costs for Subsystem Two

A)	Equipment		
1.	VDU	£2,450	
	Total Hardware	£2,450	
B)	Software		
2.	Price program	150	
3.	Flimsy Program (input of leaders)	50	
4.	Program creating all necessary files and for printing flimsy	250	
5.	Unique programs for the individual departmental needs	250	
6.	Programs for weekly, monthly, analyses	375	*
	Total Software	£1,175	
7.	Sundry Costs	125	
TOTAL COSTS		£3,650	

* Half of the costs for programming; because this program will be used by Subsystem One as well.

1.3 Costs for Subsystem Three

A) No Extra Equipment

B) Software:

1.	Program for merging date for statistics	150	
2.	Programs for budgets/actual performance and other reports and analyses	150	
3.	Programs for producing the information necessary for "Z" curves, etc.	200	*
	TOTAL SOFTWARE	£ 500	

* At the moment this cost is uncertain.

In conclusion cost for VDU which is already "in house" should not be added here again.

	With VDU Cost	Without VDU Cost
Total Costs for System with Version One	£8850	£7150
Total costs for System with Version Two	6850	5150
Total Costs for System with Version Three	7025	7025

SALES AND STATISTICS SYSTEM
– COSTS –

SUBSYSTEMS	VERSION ONE WITH EXTRA LINE PRINTER		VERSION TWO WITHOUT EXTRA LINE PRINTER		VERSION THREE
	WITH VDU	WITHOUT VDU	WITH VDU	WITHOUT VDU	PET – MICRO
[illegible]	+2000 £ 4700	- 2000 £ 3000	£ 2700	£ 1000	£ 2500
[illegible]	£ 3650	£ 3650	£ 3650	£ 3650	£ 4025*
[illegible]	£ 500	£ 500	£ 500	£ 500	£ 500
TOTAL COST FOR THE SYSTEM AS A WHOLE	£ 8850	£ 7150	£ 6850	£ 5150	£ 7025

10850.

* This contains full costs for weekly and monthly software, because it will differ for Subsystem 1 and Subsystem 2 (due to varying programming languages).

2.0 Benefits

It is usually very difficult to measure the benefits which are not supported by 'hard cash figures', despite this, however, the saving on additional labour for calculating and aggregating the basic data or reducing manual creation of documents for both departments should bring some comfort to the company.

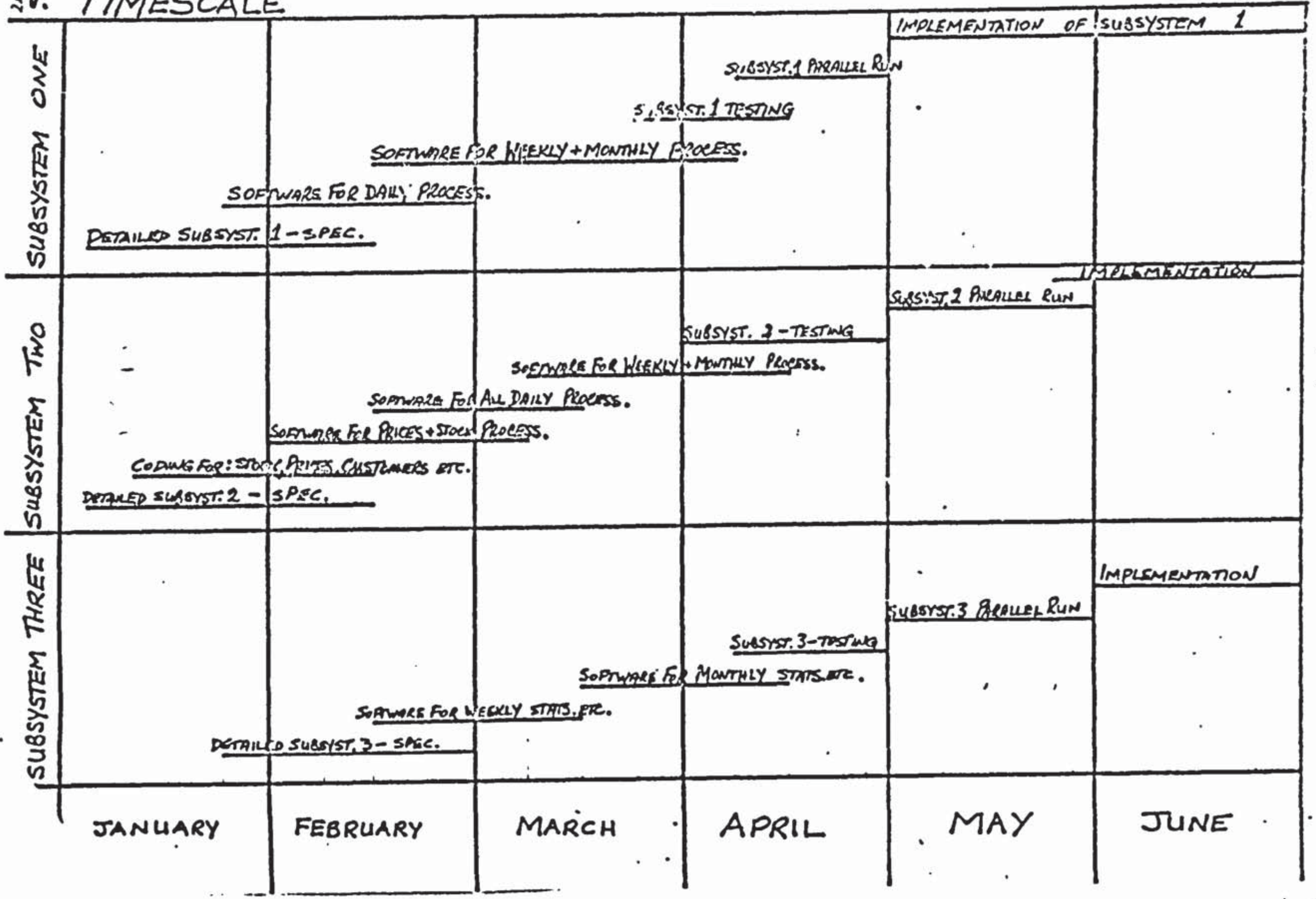
Having a control of stock components will also give some advantage to the department (and customers indirectly - better service).

Improvements in statistics neglected for so long - will allow the utilisation of the pre-programmed subroutines for future forecasting and simulation models might prove useful for the company.

Last Word from the Author

If the given proposal regarding both departments and company statistics does not satisfy all needs, the author would be grateful for any constructive suggestions in this matter.

20 V. TIMESCALE



APPENDIX N

The George Ellison Corporate Strategy Statement

CORPORATE STRATEGY

INTRODUCTION

In reports already submitted and discussed in detail it has been stated that George Ellison's business comprises currently two main elements.

1. Manufacture of components, including medium voltage air circuit breakers and fuse switches, medium voltage oil circuit breakers, high voltage oil circuit breakers.

2. Manufacture of distribution systems up to 11kV principally, though not exclusively, for industrial applications.

Rationalisation of the domestic market over the last 10 - 15 years,

> in part due to the 1948 Monopolies & Restrictive (Enquiry and Control) Act and 1956 Restrictive Trading Practices Act dismantling the price fixing agreements practiced by BEAMA of which George Ellison was and remains a member,
>
> in part due to the excess capacity of the industry having substantially fulfilled the demand created by war time rehabilitation,
>
> and in part due to a substantial and progressive fall in domestic capital investment

is unlikely to be abated by a U.K. decision to remain in the European Economic Community. Indeed, there are substantial reasons for supposing that it will continue at an accelerated rate.

In these circumstances it is inappropriate for George Ellison to contemplate competing in the manufacture of switching devices beyond the medium term future for which the necessary financial and research and development support are wholly inadequate when compared with resources employed by Siemens; A.E.G., Calor Emag, Brown Boveri, G.E.C. (?) and the future of the company rests fairly and squarely upon its ability to provide effective applications of available equipment to the medium voltage main distribution requirements of its prospective customers.

PRINCIPAL ELEMENTS

To this end a Corporate Strategy has been conceived consisting of the following principle elements :-

1. DESIGN, MANUFACTURE, INSTALLATION AND MAINTENANCE OF INDUSTRIAL MEDIUM VOLTAGE MAIN POWER DISTRIBUTION SYSTEMS.

   It may not be inferred that such a system is inappropriate outside the industrial market and all opportunities will be explored. The essential criteria for success is effective applications engineering leading to the employment of the most appropriate equipment available for the end user's requirements.

2. THE MANUFACTURE OF PACKAGED SUB-STATIONS INCORPORATING H.V. SWITCHBOARDS WITH ASSOCIATED METERING & PROTECTION FACILITIES.

The sub-station is the essential heart of any medium voltage distribution system and the continuous development of a unit employing the most commercially/technically effective equipment should be our objective.

3. MEDIUM VOLTAGE MAIN FEEDER TRUNKING.

Feasibility studies with the object of establishing whether or not the company should maintain a manufacturing capability for bus duct systems of which our patented Lambar is an example, have yet to be effectively concluded and no change of significance in this area of activity will be contemplated until the fullest possible research has been undertaken of the market size and of the technical and financial resources required to support our appropriate level of activity.

4. STRATEGIC WITHDRAWAL FROM DESIGN AND MANUFACTURE OF SWITCHING DEVICES AS SUCCESSFUL APPLICATIONS ENGINEERING OF COMPETITOR PRODUCTS LEADS TO INCREASED PENETRATION OF END USER MEDIUM VOLTAGE POWER DISTRIBUTION MARKET (Refer Introduction).

5. EXPANSION OF EXPORT ACTIVITY TO SECURE 30% REVENUE FROM OVERSEAS MARKETS AND THUS REDUCE FROM 95 TO 70% DEPENDENCE UPON HOME MARKET.

Four principal areas of activity of which one has existed for some considerable time will provide the main targets for our attack. They are :-

- (i) Far East - including Hong Kong, Singapore, Malaysia, Taiwan(?), India
- (ii) Middle East - including United Arab Emirates, Iran
- (iii) South Africa - including principally South and East African States.
- (iv) South America - principally Venezuela and Colombia.

6. DEVELOPMENT OF MUTUALLY ADVANTAGEOUS TRADING ARRANGEMENTS BOTH AT HOME AND ABROAD INVOLVING WHERE APPROPRIATE EQUITY PARTICIPATION, WITH :

- (i) suppliers of specific product requirements, e.g. May & Christe, Terasaki, Magrini, Mitsubishi, Rittall Eldon, Krone, Long & Crawford.
- (ii) suppliers of specific component requirement, e.g. Paxtons, Winders.
- (iii) potential users of components for switchboard building, e.g. Boulting, Pernas, Inchcape, Dodsels, Borneo Engineering.

6. (Continued)

The present state of the art in electrical engineering is such that with minor exceptions, Ellison products are not protected either by copyright, registered design or patents. In these circumstances the successful negotiation of manufacturing licence agreements (appropriate in the export market due particularly to the bulk of switchboards) is improbable. However, joint ventures in which George Ellison know-how is paid for in equity rather than cash permits the effective development of such enterprise with the uninhibited support of George Ellison technical and commercial personnel.

Each of the foregoing objectives represent the means rather than the end which is :

THE PROFITABLE EMPLOYMENT OF RESOURCES AVAILABLE IN THE INTERESTS OF THE OWNERS, EMPLOYEES, CUSTOMERS, SUPPLIERS AND SOCIETY AT LARGE.

The sustained period of loss making by the business for over a decade requires now that cash generated is re-injected into an anaemic body. Return on Capital employed is a two part equation. The foregoing notes are principally concerned with Return. The more effective utilisation of assets in the shape of strategically well placed land and buildings forms the basis of an entirely separate activity currently deferred for a variety of political, social and financial reasons.

PFS/ljo
2.7.76.

REFERENCES

Ackoff, R.L., "Towards a System of System Concepts", Management Science, Vol.17,(11), pp.661-671. 1971.

Ackoff, R.L., "A Revolution in Organisational Concepts", Naval War College Review, 1972.

Ackoff, R.L., Redesigning the Future, New York; Wiley, 1974

Ackoff, R.L., "The Future of Operational Research is Past", J. Opl. Res. Soc., Vol.30, No.2, pp.93-104. 1979a.

Ackoff, R.L., "Resurrecting the Future of Operational Research," J.Apl. Res. Soc., Vol.30, No.3, pp.189-199. 1979b.

Ansoff, M.I., Corporate Strategy, Harmondsworth: Penguin Books, 1965.

Apostel, L. Berger, G., Briggs, A.,and Michaud, G. Interdisciplinarity: Problems of Teaching and Resrach in Universities, Centre for Educational Research and Innovation, O.E.C.D. 1970.

Ashby, R.W., An Introduction to Cybernetics, London: Methuen & Co.1956.

Ashby, R.W., "Systems and their Information Measures," in Klir, G.J (Ed), Trends in General Systems Theory, New York: Wiley, 1972.

Axelrod, R. (Ed), Structure of Decision, Princeton: University of Princeton Press, 1976.

Ayer, A.J., Language, Truth and Lager, Harmondsworth: Penguin Books, 1936.

Bannister, D. and Fransella, F., Inquiring Man : The Theory of Personal Constructs, Harmondsworth: Penguin Books, 1971.

Bambrough, R. New Essays on Plato and Aristotle, London: Routledge and Kegan Paul, 1965.

Ben-Eli, M.U., "Amplifying Regulation and Variety Increase in Evolving Systems", Proceedings of the 4th European Meeting on Cybernetics and Systems Research, 1978.

Beer, S., Decision and Control, London: Wiley, 1966.

Beer, S., Brain of the Firm, London: Wiley, 1972.

Beer, S., Platform for Change, London: Wiley, 1975.

Beer, S., Brain of the Firm (2nd. ed.) London: Wiley, 1979a.

Beer, S., Heart of Enterprise, London: Wiley, 1979b.

Bennett, P.G., "Towards a Theory of Hypergames", Omega, Vol.5, (6), pp.749-951, 1977.

Bennett, P.G., "Games and Hypergames : The Basic Ideaś", Operational Research Department: University of Sussex, 1978a.

Bennett, P.G., "Games and Hypergames : An Introductory Illustration", Operational Research Department; University of Sussex, 1978b.

Bennett, P.G., "Hypergames : The Development of a Model of Conflict", Futures, December, pp.489-507, 1980.

Bennett, P.G., Dando, M.R. and Sharp, R.G., "Using Hypergames to Model Difficult Social Issues : An Approach to the case of Soccer Hooliganism", J. Òpl.Res.Soc., Vol.3,1, pp.621-635, 1980.

Bennett, P.G. and Huxham, C.S., "Hypergames and what they do : A Methodique for"Soft" OR", Paper presented to the Young OR Conference, Coventry, 2-4 December 1980.

Bertalanffy, von, L., General Systems Theory , New York: Braziller,1968.

Best, D.P. and Molloy, K.J., "Organismic Modelling : Part 1 - A Difficulty Explored", Management Centre Working Paper No, 182, University of Aston, 1980.

Best, D.P. and Molloy, K.J., "Organismic Modelling : Part 2 - Neurophysiological Evidence , Management Centre Working Paper (in press), University of Aston, 1981.

Bhaskar, R., A Realist Theory of Science , Sussex: The Harvester Press, 1975.

Bieri, J., Atkins, A.L., Briar, S., Lobeck, R., Miller, H. and Tripodi, T., Clinical and Social Judgement , New York: Wiley, 1966.

de Bono, E., The Use of Lateral Thinking , Harmondsworth: Pelican, 1971.

Boorse, H.A. and Motz, L. (Eds), The World of the Atom , London: Basic Books Inc., 1966.

Boulding, K., "General Systems Theory - The Skeleton of Science", in Schoderbek, P.B. (Ed) Management Systems, 2nd.ed., New York: Wiley, pp.20-28, 1971.

Cavallo, R.E. (Ed), "Systems Research Movement", General Systems Bulletin, Vol.IX (3), 1979.

de Chardin, P.T., Man's Place in Nature , London: Fontana Books,(1971) 1956.

Checkland, P.B., "A Systems Map of the Universe", Journal of Systems Engineering, Vol.2, No.2, pp.107-114, 1971.

Checkland, P.B., "Towards a Systems-based Methodology for Real World Problem Solving", Journal of Systems Engineering, Vol.3,(2), pp.87-113, 1972.

Checkland, P.B., "The Development of Systems Thinking by Systems Practice", Progress in Cybernetics and Systems Research, Vol.2, Washington: Hemisphere, 1975.

Checkland, P.B., "Science and the Systems Paradigm", International Journal of General Systems, Vol.3, pp.127-134, 1976.

Checkland, P.B., "The Origins and Nature of 'Hard' Systems Thinking", Journal of Applied Systems Analysis, Vol.5, (2), pp.99-110, 1978.

Checkland, P.B., "The Problem of Problem Formulation in the Application of the Systems Approach", Recent Developments in Systems Methodology for the Social Sciences, Leiden, 1978.

Checkland, P.B., "Techniques in 'Soft' Systems Practice, Part 1 : Systems Diagrams - Some Tentative Guidelines", Journal of Applied Systems Analysis, Vol.6, pp.33-40, 1979a.

Checkland, P.B., "Techniques in 'Soft' Systems Practice, Part 2: Building Conceptual Models", Journal of Applied Systems Analysis, Vol.6, pp.41-49, 1979b.

Checkland, P.B., "Teaching and Testing Systems Methodology", Bayraktar, B.A., Müller-Merbach, H., Roberts, J.E. and Simson, M.G. (Eds), Education in Systems Science, London: Taylor and Francis, 1979c.

Checkland, P.B., "'Primary Task' and 'Issue Based' Root Definitions in Systems Studies", Journal of Applied Systems Analysis, Vol.7, pp.51-54, 1980.

Checkland, P.B., "A Review of 'Heart of Enterprise' by Stafford Beer", Futures, Vol.2, No.5, pp.421-424, 1980.

Churchman, C.W., The Systems Approach, New York: Dell Publishing, 1968.

Clark, P.A., Action Research and Organisational Change, London: Harper-Row, 1972.

Cochran, A.J., "Operating the IHD Scheme : Methodology and Critical Analysis", IHD Publication, University of Aston, 1979.

Cochran, A.J., "Vocational PhD's - Aston's IHD Scheme", IHD Publication, University of Aston, ISBN 0903807 815, 1981.

Collins, H.M., "The TEA-set : Tacit Knowledge and its Relevance to Research and Scientific Networks", Science Studies, Vol.4, 1974.

Collins, H.M., "The Seven Sexes : A Study in the Sociology of a Phenomenon, or the Replication of Experiments in Physics", Sociology, Vol.9, (2), pp.205-224, 1975.

Collins, J.H., "The Application of the Systems Approach to the Design of Computer-Based Data Processing Systems", Journal of Systems Engineering, Vol.4, (2), 1976.

Copi, I.M., Introduction to Logic, London: Macmillan & Co. (4th ed.), 1972.

Coyle, R.G., Management System Dynamics , London: Wiley, 1977.

Dando, M.R. and Bennett, P.G., "A Kuhnian Crisis in Management Science", Journal of the Operational Research Soc, Vol.32, (2), pp.91-104,1981.

Daniel, J.S., "Learning Styles and Strategies - The Work of Gordon Pask", in Entwistle, N.T. and Hounsell, D., How Students Learn, Lancaster: Institute for R & D in Post-Compulsory Education, pp.83-92, 1975a.

Daniel, J.S., "Conversations, Individuals and Knowables : Towards a Theory of Learning", Engineering Education, pp.415-420, Feb.1975(b).

Davis, C., Demb, A. and Espejo, R., Organisation for Program Management , Chichester: Wiley & Sons, 1979.

Descartes, R., Discourse on Method and the Meditations , Harmondsworth: Penguin Books, 1968.

Eden, C., "Operational Research and Organisational Development", Human Relations, Vol.31, (8), 1978.

Eden, C., Jones, S. and Sims, D., Thinking in Organisations , London: The Macmillan Press, 1980.

Eden, C. and Sims, D., "Problem Definition Between Clients and Consultants", Working Paper of the Centre of Organisational Change and Development: University of Bath, 1977.

Eden, C. and Sims, D., "On the Nature of Problems in Consulting Practice", Omega, Vol.7, No.2, pp.119-127, 1978.

Emery, F.E. (Ed), Systems Thinking, Harmondsworth: Penguin Books,1969.

Entwistle, N.J., "Knowledge Structures and Styles of Learning : A Summary of Pask's Recent Work", British Journal of Educational Psychology, Vol.48, pp.255-265, 1978.

Espejo, R., "Local Government : Is It a Viable System?" Management Centre Eorking Paper, University of Aston, 1975.

Foder, J.A., Psychological Explanation : An Introduction to the Philosophy of Psychology, New York: Random House, 1968.

Fransella, F. and Bannister, D., A Manual for Repertory Grid Technique , London: Academic Press, 1977.

Goguen, J.A. and Varela, F.J., "Systems and Distinctions : Duality and Complementarity", Int. J. General Systems, Vol.5, pp.31-43, 1979.

Hardie, W.F.R., "Bodies and Minds", in Edwards, P. and Pap, A. (Eds), A Modern Introduction to Philosophy, New York: The Free Press, 1960.

Harré, R., "The Principles of Scientific Thinking", London: Macmillan, 1970.

Harré, R., The Philosophies of Science, Oxford: The University Press, 1972.

Harré, R., Social Being, Oxford: Basil Blackwell, 1979.

Hempel, C.G., Aspects of Scientific Explanation, New York: The Free Press, 1965.

Hinkle, D.N., "The Change in Personal Constructs from the Viewpoint of a Theory of Implications", Doctoral Thesis: Ohio State University, 1965.

Hollis, M. (Ed), The Light of Reason : Rationalist Philosophers of the 17th Century, London: Fontana/Collins, 1973.

Hollis, M., Models of Man : Philosophical Thoughts on Social Action, Cambridge: Canbridge University Press, 1977.

Holsti, O.R., Operational Code Belief Systems : A Codebook, North Carolina: Duke University, 1976.

Howard, N., Paradoxes of Rationality, Boston: MIT Press, 1971.

Howard, N., "The Analysis of Options in Business Problems", INFOR, The Canadian Journal of Operational Research and Information Processing, Vol.13, No.1, pp.48-67, 1975.

Howard, N., "Applications of Structural Game Theory", ORSA Group, University of Aston Management Centre, 1980.

Hume, D., "Sceptical Doubts Concerning the Human Understanding", in Edwards, P. and Pap, A., A Modern Introduction to Philosophy, pp.123-132, London; Collier-Macmillan, 1748.

Huxham, C.S. and Dando, M.R., "Is Bounded-Vision an Adequate Explanation of Strategic Decision-Making Failures ?", Omega (in Press) 1981.

Huxley, T.H., "On the Hypothesis that Animals are Automata, and its History", in Vesey, G.N.A. (Ed), Body and Mind, London: Allen & Unwin, 1874, (1964).

Ishiguro, H., Liebniz's Philosophy of Logic and Language, London: G. Duckworth, 1972.

Johnson, S.E.A., "Development and Application of a Technique for Analysing Jobs", M.Phil. Thesis, University of Aston, 1979.

Johnson, R.A., Kast, F.E. and Rosenzweig, J.E., The Theory and Management of Systems, London: McGraw-Hill Kogakusha, 1963.

Jung, C.G., C.G. Jung : The Collected Works, Vol.6 : Psychological Types, London: Routledge and Kegan Paul, 1971.

Kapp, R.O., "Ockham's Razor and the Unification of Physical Science", British Journal for the Philosophy of Science, Vol.VIII, pp.265-280, 1959.

Kelly, G.A., The Psychology of Personal Constructs, Vols. I and II, New York: Norton, 1955.

Kelly, G.A., "A Brief Introduction to Personal Construct Theory", in Bannister, D. (Ed), Perspectives in Personal Construct Theory, London: Academic Press, 1970.

Kuhn, T.S., The Structure of Scientific Revolutions, The University of Chicago Press (2nd ed.) 1970 (1962).

Lakatos, I., "Falsification and the Methodology of Scientific Research Programs", in Lakatos, I.and Musgrave, A. (Eds), Criticism and the Growth of Knowledge, Cambridge: The University Press, 1970.

Liebniz, G.W., "Discourse on Metaphysics", in Hollis, M. (Ed), The Light of Reason, London: Fontana/Collins, 1973 (1689).

Locke, J., Essay Concerning Human Understanding, Vols. I and II, New York: Dover Publications (5th ed.) 1959.

Merton, R.K., Social Theory and Social Structure, New York: The Free Press, (1949) Enlarged ed., 1957.

Mitroff, I., "Towards a Theory of Systemic Problem Solving : Prospects and Paradoxes", Internat. J. of General Systems, Vol.4, pp.47-59, 1977.

Molloy, K.J. and Best, D.P., "Checkland's Methodology considered as a Theory Building Methodology", in Trapp, R. (Ed), Proceedings of 5th European Meeting on Cybernetics and Systems Research (EMCSR'80) Vienna, 1980, Washington: Hemisphere, 1981

Molloy, K.J. and Best,,D.P., "Organismic Modelling : Part 3, A Model of Organisation", Management Centre Working Paper (in press), University of Aston, 1981.

Molloy, K.J. and Watt, J.C.,"Parker Ltd.", Case Study, ORSA Group, University of Aston Management Centre, 1980.

Mulkay, M.J., Functionalism, Exchange and Theoretical Strategy, New York: Schocker Books, 1971.

Nagel, E., The Structure of Science, London: Routledge and Kegan Paul, 1961.

Naughton, J., The Checkland Methodology : A Readers' Guide, Milton Keynes: The Open University, 1977.

Naughton, J., "Anti-GST : An Evolutionary Manifesto", Proceedings of the Silver Anniversary International Meeting of the Society for General Systems Research, London, 1979.

Naughton, J., "Functionalism and Systems Research : A Comment", J. of Appl. Systems Analysis, Vol.6, pp.69-73, 1979b.

Naughton, J., "On Craft Knowledge in Systems Research", in Trapp, R.(Ed), Proceedings of the 5th European Meeting on Cybernetics and Systems Research (EMCSR'80), Vienna 1980, Washington: Hemisphere,(in press)1981.

Naughton, J., "Theory and Practice in Systems Research", Journal of Applied Systems Analysis, (in Press) 1981.

Pask, G., Conversation, Cognition and Learning, Oxford: Elsevier,1975.

Pask, G., "Against Conferences" or"The Povery of Reduction in SOP-Science and POP-Systems", Ericson, R. (Ed), Proceedings of the Silver Anniversary International Meeting of the Society for General Systems Research, London, 1979.

Pask, G., "An Essay on the Kinetics of Language, Behaviour and Thought", Proceedings of the Silver Anniversay International Meeting of the Society for General Systems Research, (Ericson, R.,(Ed)), London 1979.

Pidd, M. and Woolley, R.N., "A Study of Problem Structuring", Paper presented to the OR Society Methodology Group, University of Aston, 1978.

Pidd, M. and Woolley, R.N., "Four Views of Problem Structuring", Interfaces, Vol.10, (1), pp.51-54, 1980a.

Pidd, M. and Woolley, R.N., "A Pilot Study of Problem Structuring", J. of the OR Society, Vol.31, pp.1063-1068, 1980b.

Plato, The Republic, Harmondsworth: Penguin Books,(2nd ed), 1974.

Popper, K., The Logic of Scientific Discovery, London: Hutchinson & Co., 1959.

Popper, K.R., Conjectures and Refutations, London: Routledge and Kegan Paul, (5th ed), 1974 (1963).

Popper, K., Objective Knowledge : An Evolutionary Approach, Oxford: The Clarendon Press, 1972.

Popper, K., Unended Quest, Glasgow: Fontana/Collins, 1976.

Prevost, P., "'Soft' Systems Methodology, Functionalism and the Social Sciences", J. of Appl. Systems Aanalysis, Vol.5, No.1, pp.65-73, 1976.

Putman, R.A., "Seeing and Observing", Mind, Vol.78, pp.493-500, 1969.

Radford, K.J., Complex Decision Problems, Virgimia: Reston Publishing, 1977.

Rescher, N., Scientific Explanation, London: Collier-Macmillan, 1970.

Robertson, I.T., "Vocational Education and the Diffusion and Application of Research-Based Knowledge", J. of Further & Higher Education, 5 (1), 1981.

Robertson, I.T and Cochran, A.J., "An Interdisciplinary Action Research Approach to Postgraduate Education", Annual Conference on Postgraduate Psychology, University of Lancaster, 1-3 April, 1980.

Robertson, I.T. and Molloy, K.J., "Cognitive Complexity, Neuroticism and Research Ability", Birmingham: IHD Scheme, University of Aston, 1980.

Robertson, I.T., Molloy, K.J. and Cochran, A.J., "Learning While Doing: An Investigation of Problem-Solvers Tackling Organisationally-Based Problems", Birmingham : IHD Scheme, University of Aston, 1980.

Russell,B., "The Philosophy of Logical Alomism", in Pears, D. (Ed), Russell's Logical Atomism, London: Fontana/Collins, 1972 (1918).

Saunders, G., "Education Into Industry", Industrial & Commercial Training Journal, July, 1980.

Schlesinger, G., Method in the Physical Sciences, London: Routledge & Kegan Paul, 1963.

Schoderbek, P.B., Kefalas, A.G. and Schoderbek, C.G., Management Systems : Conceptual Considerations, Dallas: Business Publications, 1975.

Shannon, C.E., A Mathematical Theory of Communication, Bell System Technical Journal, Vol.27, 1948.

Shaw, M.L.G., On Being a Personal Scientist, London: Academic Press, 1980a.

Shaw, M.L.G. and Gaines, B.R., "Eliciting Entailment", Proceedings of the 5th European Meeting on Cybernetics and Systems Research (EMCSR'80), Trapp, R. (Ed), Washington: Hemisphere, 1981 (1980).

Shotter, J., Images of Man in Psychological Research, London: Methuen, 1975.

Skinner, B.F., Science and Human Behaviour, London: Collier-Macmillan, 1953.

Smith, D.S. and Checkland, P.B., "Using a Systems Approach : The Structure of Root Definitions", J. of Appl. Systems Analysis, Vol.5, (1), pp.75-83, 1976.

Sneed, J.D., The Logical Structure of Mathematical Physics, Dordrecht, Holland: Reidel Publishing, 1971.

de Spinoza, B., "The Eethics", in Works of Spinoza, Vol. II, New York: Dover Publications, 1955 (1677).

Swann Report, "The flow into employment of Scientists, Engineers and Technologists", H.M.S.O., CMND 3760, 1968.

Taylor, D.M., Explanation and Meaning, Cambridge: The University Press, 1970.

Taylor, F.W., The Principles of Scientific Management, London: Harper & Brothers, 1911.

van Rest, D.J., IHD Thesis Summaries, 1970-1979, IHD Publication, Birmingham: University of Aston, ISBN 0 903807 807, 1980.

van Rest, D.J., "The Principles and Practice of IHD Research", IHD Publication, Birmingham: University of Aston, 1981.

Varela, F.J., "The Arithmetic of Closure", Paper presented to the 3rd European Meeting on Cybernetics and Systems Research, Vienna, 1976.

Varela, F.J., Maturana, H.R. and Uribe, R., "Autopoiesis : The Organisation of Living Systems, its Characterisation and a Model," Biosystems, Vol.5, pp.187-196, 1974.

Vesey, G.N.A. (Ed), Body and Mind, London: George Allen & Unwin, 1964.

Wiener, N., Cybernetics, (2nd ed) Cambridge, Mass: MIT Press, 1961 (1948).

Williams, B., Morality : An Introduction to Ethics, Harmondsworth: Penguin Books, 1972.

Woolley, R.N. and Molloy, K.J., "Viability and Weltanschauung in Systems Modelling", Working Paper No. 1, Birmingham: Mentorum, 1981.

Woolley, R.N., and Pidd, M., "Problem Structuring - A Literature Review", J. of the Operational Research Society, Vol.31, pp.197-206, 1981.

Wrightson, M.T., "The Documentary Coding Method", in Axelrod, R.(Ed), Structure of Decision, pp.291-332, Princeton: University of Princeton Press, 1976.

Zeleny, M., "Self-Organisation of Living Systems : A Formal Model of Autopoiesis", Iternat.J. of General Systems, Vol.4, pp.13-28, 1977.