APPLICATIONS OF INTERPRETIVE STRUCTURAL MODELLING AND RELATED METHODS WITHIN THE CONTEXT OF INTERACTIVE MANAGEMENT

Ffrancon Ross Janes

Thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy

Department of Systems Science
City University
London
United Kingdom

November 1992

To my wife, Jenny

Contents

SUPPORTING PAPERS 195

List of Tables

List of Figures

Key to Symbols

D	Total duration of an NGT session
DoH	Department of Health
e	Number of elements dealt with solely by answering questions put by the computer in an ISM session
E	Total number of elements in a model
EITB	Engineering Industry Training Board
IM	Interactive Management
ISM	Interpretive Structural Modelling or Interpretive Structural Model
ISM-PC	Interpretive Structural Modelling for a Personal Computer
N_1	Number of ideas generated from which a selection is made
N_2	Number of ideas receiving at least one vote
NGT	Nominal Group Technique
NHS	National Health Service
P	Number of participants
PC	Personal Computer
RD	Relative Diversity
s.p.	Supporting paper
SODA	Strategic Options Development and Analysis

SSM	Soft Systems Methodology
t	Time spent in answering questions put by the computer in an ISM session
T	Total duration of an ISM session
UNI-ISMS	University of Northern Iowa - Interpretive Structural Modelling Software
V	Number of votes per participant
VDU	Visual Display Unit

Acknowledgements

There are many people whom I should like to thank for their contributions towards various aspects of this thesis.

For reading and commenting on each chapter as it emerged and for general advice on the preparation of the thesis, I am grateful to my adviser, Ewart Carson, Professor of Systems Science. For their support whilst the work was being undertaken and written up, I thank successive Heads of Department, Ray Jowitt and Fred Charlwood.

I am indebted for their unfailing support to Ken Hammer and Richard Jeffery, who helped to run many of the various workshops and organised the computer facilities; I am also grateful to Keith Ellis and Ron Summers for their assistance with several of the workshops, and to all four of them for their interest and contributions in mounting various courses on Interactive Management. Peter Roberts played a key role in the research contracts undertaken for the Department of Health and I thank him for his major contribution in this area.

I would like to thank John Warfield, and his colleagues Alexander Christakis and David Keever for their very warm welcome, infectious enthusiasm and assistance whilst I was at the Centre for Interactive Management in the University of Virginia. This thesis owes its origins to my time spent there; in particular, I am indebted to John Warfield who, as the creator of Interpretive Structural Modelling, made this particular field of research possible.

Others who have contributed to the work include the various clients named in the supporting papers who enabled the planning workshops described to take place.

Nanette Grostate typed the thesis; Ken Hammer integrated the diagrams into the text and helped to present the material in its final form on the Apple Macintosh computer. I am most appreciative of their efforts in dealing with the various chapter drafts and amendments.

To other colleagues who have given their advice and support I am also grateful.

Finally, I would like to thank members of my family: first, my wife Jenny, for her encouragement, support and patience over the long period of the writing of this thesis; also, my parents, Alfred and Mary Janes, and my aunt, Ethel Ross, for their encouragement throughout my education and career.

Declaration

I grant powers of discretion to the University Librarian to allow this thesis to be copied in whole or in part without further reference to me. This permission covers only single copies made for study purposes, subject to normal conditions of acknowledgement.

Abstract

This thesis is about the application of Interpretive Structural Modelling (ISM) and two supporting idea-generation methods, Ideawriting and Nominal Group Technique. Taken together, the three methods, which are all designed for use with participant groups, may be employed in various ways to provide a process of inquiry within the context of Interactive Management.

The applications focus on fifteen planning workshops conducted by the author. In these workshops the methods were used to assist groups from a range of public sector organisations in planning activities such as setting and structuring objectives. Full details of the applications are given in the published papers and reports which are reproduced in the Supporting Papers section of the thesis. A summary of the sequence of methods used in each workshop and the resulting outcomes is given in Chapter 7.

In order to give coherence to the applications, Chapters 2 to 6 present a framework for Interactive Management as a means of exploring complex issues and consider the principles and process of each of the three methods. Five components that help to make work with groups productive are examined: the participant group, the facilitator, the methods, the computer support and the decision support room. The way in which the last two have been implemented at City University is described. In Chapter 4, the principles of ISM as a modelling tool are explained and the operation of the ISM computer software developed at City University for a personal computer is outlined. Chapters 5 and 6 focus on the processes of Ideawriting and Nominal Group Technique and summarise ways in which they have been applied and, in the case of Ideawriting, extended; their benefits and limitations are also discussed. The incorporation of Ideawriting and the concepts of Interactive Management into a process of model building and computer software development is explained.

Chapters 8 and 9 discuss lessons for ISM, Interactive Management and Systems Science which are drawn from the applications. With regard to ISM, these include the creation of a new type of ISM priority structure, called here the composite priority structure. Other lessons for ISM concern ways of making the best use of the method in practice; its benefits and limitations are also assessed. In the case of lessons for Interactive Management, the activities in a complete intervention are analysed and methods for idea categorisation and writing mission statements are explained. With regard to Systems Science, the lessons focus on those aspects of complexity that are addressed by ISM and upon ISM as a modelling tool.

Finally, the conclusions in Chapter 10 show the extent to which the objectives stated at the start of the thesis have been achieved and explain the author's contribution to the knowledge of the subject. Possible areas for future work are also outlined.

Prologue

The purpose of this prologue is threefold: to summarise the main aim of the research; to explain the unconventional format of the thesis; and to outline some important assumptions underlying the Interactive Management approach which provides the context for the Interpretive Structural Modelling (ISM) work undertaken.

First, the main aim of the work is discussed. The research originated out of a period spent in the Centre for Interactive Management at the University of Virginia. This provided an opportunity for the author to observe and assist with a number of applications of ISM and associated methods and to gain experience as an Interactive Management facilitator. The potential of the approach seemed considerable and, on returning to City University, the author decided to teach and conduct research into the subject. The research aim was to transfer the process of ISM from the U.S.A. to the United Kingdom through running a series of planning workshops for organisations and to see how the approach could be developed through these applications. The work is thus in the mould of what is known as "action research" whereby, in this case, the experience of applying ISM and related methods to problem situations has been reflected upon in order to learn lessons about the approach. The application of the approach within the United Kingdom presented an interesting challenge. This was because the management culture in the United Kingdom was thought to be more conservative and less open to new concepts, such as Interactive Management, than in the U.S.A. The notion of groups of individuals in organisations participating in collective inquiry, through the use of formal group methods conducted in a decision support room under the guidance of a facilitator with computer support, was considered to be a somewhat alien concept to British management at that time.

Second, the unconventional format of the thesis is considered. The university ordinances permit members of the academic staff who are candidates for the degree of Doctor of Philosophy to submit either a thesis or published papers embodying the results of their research. Where published papers are submitted they have to be accompanied by a covering paper which presents a reasoned argument in support of the published papers. The eighteen supporting papers included here contain a mixture of journal and conference papers, technical reports, a research memorandum and a book chapter. In order to present a coherent body of work, these have been preceded by ten chapters, rather than simply by a covering paper. The chapters give details of the underlying framework of Interactive Management and the principles of the methods used; they also provide a summary of the workshops and draw lessons for ISM, Interactive Management and Systems Science. It should be noted that the fifteen planning workshops reported on in the supporting papers were not originally designed with a thesis in mind; had they been so designed, the sample of organisational settings would have been selected somewhat differently.

Third, some important assumptions underlying the approach of Interactive Management generally, and ISM in particular, are examined (Warfield, 1976, 1982a, 1984a, 1984b, 1990). The approach depends upon the notion that a group of participants can be assembled to explore complex issues in a participative mode of collective inquiry, and that they will be willing to pool their ideas and be able to reach agreement on the outcome of the process of inquiry. Warfield (1984a) describes Interactive Management as a system of management decision making that has been consciously designed around Simon's (1960) concept, whereby management decision making may be considered to consist of four principal phases called intelligence, design, choice and review. Having adopted this particular model of decision making, Interactive Management assumes that complex issues may be tackled by groups through the use of what Warfield (1982a) calls "consensus methodologies" to accomplish the intelligence, design and choice phases. (For reasons explained in Chapter 3, these are referred to as methods rather than methodologies in this thesis.) The term "consensus" is used here to convey a number of characteristics about the participative nature of the methods. Warfield (1990: 551) states that there is provision in the methods "... for open dialogue, and for equal decision-making powers for all participants, in order to stimulate consensus". However, this should not be taken to imply that, in practice, complete agreement is necessarily reached on every aspect of an issue. Rather, the various parties are prepared to accept the outcome even though disagreement on certain matters may still be present.

With regard to ISM, the assumptions involved in the mathematical theory underpinning the method (Warfield, 1976) need to be clearly understood. In particular, these concern the use of the logical properties of transitivity and (as appropriate in the particular situation) asymmetry or symmetry to make logical inferences. Such inferences are determined by the ISM computer software when creating a map of the group's perceptions of the interrelations among the elements in a complex situation. Any inferences made are logically based on answers already given by the group to questions put by the computer concerning the interrelations.

Clearly, users of ISM and Interactive Management should be aware of these assumptions when considering their use. The notions of: a rational approach to tackling complex issues and decision making; collective inquiry involving openness and participation; the use of formal group methods under the guidance of a facilitator; and logically consistent thinking, imply an approach which may be inappropriate in many circumstances. Users should recognise that, whilst the methods are designed to encourage equal opportunity of participation, they do not have any formal procedures for explicitly analysing power differences and conflicts which may be present among the participants in a group.

This prologue sets the scene for the substantive content which follows.

Chapter 1

INTRODUCTION

1.1 INTRODUCTION

This chapter explains the structure and the objectives of the thesis, gives the background to the work undertaken and provides a chronological listing of the various planning workshops and related activities.

1.2 STRUCTURE OF THESIS

The thesis is about the use of Interpretive Structural Modelling (ISM) and related idea-generation methods within the context of Interactive Management. It draws upon work carried out by the author since 1983 when ISM was used to help groups from a variety of organisations in structuring the complex issues they were facing. The work was undertaken largely in the form of intensive two-day or three-day planning workshops with the organisations concerned. The resulting reports and papers form an important part of the thesis and are contained in the "Supporting Papers" section.

Chapter 2 explains the thinking behind the framework of Interactive Management and discusses the relationship of this work to other approaches, whilst Chapter 3 focuses on five components which help to make working with groups productive and enable Interactive Management to be put into practice.

Chapter 4, with reference to one of the supporting papers, explains relevant aspects of the theory behind ISM and discusses how the ISM software developed at City University works. The distinction between binary and contextual relations used in ISM is also examined.

Chapters 5 and 6 focus on idea-generation methods for use with groups, which may be used to support ISM in some circumstances.

Chapter 7 gives the background to the various planning workshops and summarises the activities undertaken during the workshops and the nature of the resulting products; reference is made to the supporting papers as appropriate.

Chapters 8 and 9 draw out lessons from the work done regarding ISM, Interactive Management and Systems Science. Chapter 10 gives the conclusions and makes recommendations for future work.

1.3 BACKGROUND TO THE WORK

The author was granted a sabbatical year during 1982-83 by City University. The major part of this was spent at the University of Virginia as a Visiting Research Associate Professor in the newly established Centre for Interactive Management. The Centre was set up by Professors John Warfield (Director) and Alexander Christakis to provide consultancy services and short courses for organisations and to conduct research. The Interactive Management framework and associated methods used were designed to help planners and managers in structuring problems, generating alternative solutions and decision making. The author worked with the staff of the Centre on a number of interesting planning workshops, gaining experience in facilitating groups and observing the use of the methods. The workshops involved both public and private sector organisations at local, state and national levels.

The year enabled the author to develop new skills and areas of expertise in Interactive Management with a particular emphasis on ISM and related idea-generation methods. This field of work has since been built up at City University. This has involved studies in the form of consultancy and research contracts with a wide variety of U.K. public sector organisations, usually in the form of two-day or three-day planning workshops. In addition, a range of courses has been given at post-experience level to professional managers and at postgraduate and undergraduate levels within the University. These have all enabled the methods to be researched and, where appropriate, extended.

Initially, the planning workshops were conducted in improvised conditions with computer and associated display facilities set up in a room for the particular workshop. In 1986, a decision support room was constructed in the Department of Systems Science with the help of equipment donated by Apple Computers. This provided a professional setting for future workshops. In 1988 an Interactive Management Unit was established in the Department with the author as Director and two supporting staff.

1.4 OBJECTIVES OF THESIS

The objectives of this thesis are stated below in terms of six primary objectives and two secondary objectives that support them.

Primary objectives :

1. To show how ISM has been extended as a method.

2. To assess ISM critically and to draw lessons from its use.

3. To show how the range of application of ISM has been tested and extended by identifying and exploiting new areas.

4. To demonstrate how ISM may be used as a management tool within the framework of Interactive Management.

5. To assess two idea-generation methods, Ideawriting and Nominal Group Technique, which may be used in conjunction with ISM. In addition, to show how these have been applied and, in the case of Ideawriting, extended.

6. To draw out lessons for Interactive Management and Systems Science.

Secondary objectives :

7. To explain the framework of Interactive Management and show how it has been used to enable the establishment of a decision support room at City University.

8. To explain the principles underpinning ISM as a modelling tool and to outline the operation of the ISM software developed at City University.

1.5 WORK WITH GROUPS

1.5.1 Planning Workshops

The reports and papers resulting from the fifteen planning workshops conducted for organisations from 1983 onwards form an important part of this thesis. The workshops are listed below chronologically and include work with the police service, the military service, health authorities, a county council, a professional engineering institution, a national training board and universities. In some cases the days of the workshop meetings were spread over a number of weeks or months.

The dates given refer to the period from the initial discussion with the client regarding the design of the particular workshop to the presentation of results following the workshop, usually in the form of a report.

University of Virginia, 2/83 - 6/83
Planning for the future of engineering education.
Project carried out for the School of Engineering and Applied Science at the University of Virginia.

Institution of Mechanical Engineers, 8/84 - 10/85
Objectives, priorities, mission and activities for the Institution's Technical Activity Committee on Managing Innovation.
Client: Chairman, Technical Activity Committee B of the Institution.

Metropolitan Police Force, 2/85 - 5/85
Setting objectives and priorities for the Management Support Department of the Force.
Client: Assistant Commissioner, Metropolitan Police Force.

Royal Naval Reserve, 3/85 - 4/85
Identifying and structuring factors affecting the expansion of the Royal Naval Reserve.
Client: Directorate of Naval Manpower Planning, Ministry of Defence (Navy).

Engineering Industry Training Board, 5/85 - 7/85
Setting and structuring objectives for the Board's new Fellowship in Systems Management.
Client: Principal Training Adviser, EITB.

Engineering Industry Training Board, 9/85 - 12/85
Setting and structuring objectives for the Board's Training Development Team.
Client: Development Manager, EITB.

Department of Systems Science, City University, 12/86 - 2/87
Objectives, priorities and mission for the University's Department of Systems Science.
Client: Head of Department.

Hertfordshire County Council, 3/87 - 5/87
Setting priorities for highway schemes in Hertfordshire.
Client: Assistant County Surveyor, Highways Department, Hertfordshire.

Engineering Industry Training Board, 8/87 - 11/87
Products, services and priorities for the Engineering Industry Training Board.
Client: General Manager, Regional Operations, EITB.

West Lambeth Health Authority, 7/88 - 8/88
Setting requirements and priorities for a community speech therapy service.
Client: Team Leader, Speech Therapy Group, West Lambeth Health Authority.

Short Course Unit, City University, 5/88 - 8/88
Setting objectives and priorities for the University's Short Course Unit.
Client: Head of Centre for Continuing Education.

Accommodation and Conference Service, City University, 2/88 - 2/89
Issues, objectives, priorities and mission for the University's Accommodation and Conference Service.
Client: Head of Service.

Hounslow and Spelthorne District Health Authority, 3/89 - 4/89
Solutions and priorities for a community-based speech therapy service for people with learning difficulties.
Client: Manager, Speech Therapy Learning Difficulties Team, Hounslow and Spelthorne District Health Authority.

Civil Engineering Department, City University, 7/88 - 8/89
Issues, objectives and priorities for the University's Department of Civil Engineering.
Client: Head of Department.

Centre for Enterprise Management, City University, 5/89 - 6/89
Issues, objectives and priorities for the University's Centre for Enterprise Management.
Client: Director of Centre.

1.5.2 Courses

Many of the courses on Interactive Management which have been developed by the author since 1983 have involved group work on case studies. Some of these have involved senior managers on post-experience courses working intensively on a particular issue of relevance to them and have produced interesting examples of the application of ISM. Certain other courses involving groups of postgraduate and mature students have also produced interesting results. The courses referred to have included planning workshops, designed for the relevant student group, based on case studies of real-world organisational issues. The participants were thus role-playing for the purpose of the case studies, and the primary aim was to enable them to learn about the use of the methods. Whilst the students involved were usually well informed and could bring professional knowledge to bear on the issues being explored, they did not necessarily all have direct knowledge and experience of the particular organisation referred to in the case study. Moreover, they were not stakeholders in the sense of being actually affected by the activities of the case study organisation. These case studies are thus somewhat different in nature from the work referred to in Section 1.5.1, which involved participants working on real-world problems who were stakeholders and who had extensive first-hand knowledge of the organisation concerned. Nonetheless, the case studies have provided a useful forum for testing the methods, for observing participants' reactions and for training facilitators. Although the results of the cases are not included in this thesis, the lessons for ISM and Interactive Management discussed in Chapters 8 and 9 draw, where appropriate, on the author's experience of teaching ISM through these cases. The Interactive Management courses referred to were taken by students drawn from the following groups.

- MBA in Engineering Management, City University.
- Engineering Industry Training Board Fellowship in Systems Management, City University.
- MSc in Human Communication, City University.
- Postgraduate Diploma in Management for Senior Managers in the Construction Industry, and in the Highway and Transport Industry, City University.
- BSc in Management and Systems, City University.
- Senior Command Course, Police Staff College, Bramshill.

1.5.3 Department of Health Research Contracts

The author was involved, as principal investigator and project manager, in a number of research contracts for the Health Building Directorate of the Department of Health from 1987-90. These were concerned with building models of various aspects of hospital functioning in order to help hospital planners and managers assess the operating costs of alternative designs and operating policies.

The final models were in the form of conventional mathematical equations and did not involve ISM. However, the model building process initially involved a significant amount of group work. This was accomplished using the framework of Interactive Management. The process thus represents an attempt to integrate the participative group approach of Interactive Management with more traditional model building. Accordingly, reference to the work is included in this thesis.

Chapter 2

THE INTERACTIVE MANAGEMENT FRAMEWORK AND RELATED WORK

2.1 INTRODUCTION

This chapter outlines some of the thinking and principles which underpin the framework for Interactive Management. In particular, the contributions of Warfield, Ackoff and Simon are discussed and five components for making group work more productive are introduced. The relationship of this research to other approaches is also briefly examined.

2.2 THE INTERACTIVE MANAGEMENT FRAMEWORK

In using the expression Interactive Management, the term "interactive" refers to the way that Interactive Management both promotes communication and understanding among interacting participants, and enables the interactions among problem components to be examined. The term "management" refers to the way that Interactive Management is concerned both with the management of issues and problems, and with the management of the process of group work.

The framework for Interactive Management referred to here involves a number of important aspects. In particular, the notion that work with groups can be made more productive through due attention to five components: the group, the facilitator, the methods, the computer support, and the decision support room. Also, the notion that appropriate methods may be selected for the intelligence, design and choice phases of management decision making. The framework owes its origins to the work of Warfield (1982a,1984a,1984b). Initial implementation of the framework was undertaken by Warfield together with Christakis and others (Christakis, 1983a; Mackett et al, 1983; Christakis and Keever, 1984; Wood and Christakis, 1984; Christakis, 1985; Mackett, 1985). This work has steadily expanded (Warfield, 1990) with, latterly, increasing emphasis on the design phase. The author's contribution to the framework has been to implement it at City University, adapting it for use in a UK context as appropriate.

2.2.1 Issue, Team and Tools

In order to investigate a complex issue, it is often both necessary and desirable to assemble people of diverse backgrounds who can work together as a team. Typically, the team may include the following categories of people. First, stakeholders, who may be affected in some way by the outcome of the investigation and who have content knowledge relevant to the different aspects of the situation. Second, a consultant, who can work with the client in designing and implementing the necessary workshop(s) and in producing any resulting report. Third, a facilitator, who can take the participants through the steps of whatever formal group processes are adopted. There may be overlap between these categories; for example, the author has frequently fulfilled the role of both consultant and facilitator in a given investigation. In Chapter 9, the various roles in an Interactive Management workshop are considerd in more detail.

As shown in Figure 2.1 the connections between the issue, team and tools themselves give rise to a complex situation that needs careful management. Warfield (1976:26) has described these connections as "the fundamental triangle of societal problem solving". Connection 1, between the team and the issue, indicates that a group has to be assembled with appropriate involvement of stakeholders who have knowledge specific to the issue in order to explore it properly and recognises that the participants will have different perceptions of the situation. Connection 2, between the tools and the issue, indicates that a large range of methodological tools may be available to the group and the appropriate ones for the issue at hand have to be selected. Connection 3, between the team and the tools, concerns the fact that even if the appropriate methods exist for the issue, the group may not be aware of them or may not be competent in their use. Interactive Management provides a framework for exploring complex issues in which these connections are explicitly recognised and managed.

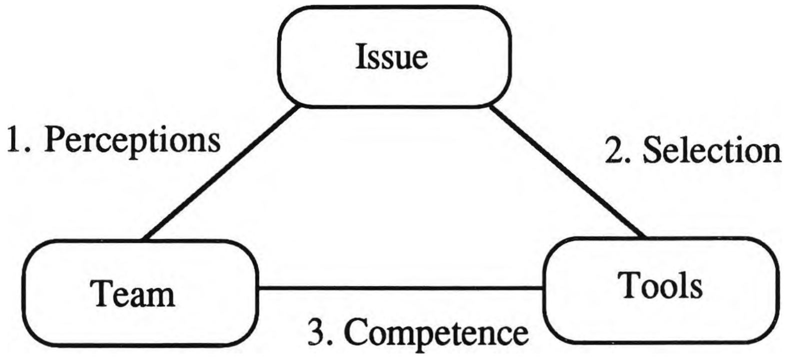


Figure 2.1 Connections between issue, team, and tools (adapted from Warfield, 1976)

2.2.2 Participative, Continuity and Holistic Principles

In his writings on planning, Ackoff (1981) emphasises three operating principles of interactive planning: the participative, continuity and holistic principles. These have a direct bearing on the framework of Interactive Management (Christakis, 1983b).

The **participative principle** emphasises the involvement in the planning process of managers who will be responsible for implementing a plan. It stresses moving away from the idea of an organisation employing external or internal consultants whose function is to do the planning for an organisation. By participating in the planning process, members of an organisation acquire a better understanding of the objectives and ideals of the organisation and learn how other managers see their own roles and problems. They also come equipped with a knowledge of the structure, operation and culture of the organisation. Participation enables managers both to contribute to the development of the plans themselves and to learn about the reasons, logic and arguments that have led to particular decisions. It encourages a sense of ownership of the plans. Managers are thus more likely to be committed to implementing the plans than they are to plans which have been imposed upon them without their involvement. For the above reasons it may be argued that participation in the planning process is as important as the products of planning, i.e., the plans themselves.

Organisations and their environments are constantly changing in ways which cannot be foreseen when plans are formulated. Plans therefore need to be updated to take account of these changes. The **continuity principle** suggests that the performance of a long-term organisational plan should be continuously monitored to evaluate actual outcomes and compare them with desired outcomes. Where deviations occur, explanations for changes in assumptions and expectations should be sought and the plans modified accordingly.

The **holistic principle** recognises the interdependencies of the parts of the organisation and emphasises the idea that planning should be done for an organisation as a whole rather than in a piecemeal fashion. This requires horizontal coordination across the different departments of an organisation: otherwise, conflicting plans may arise with consequent sub-optimisation. The holistic principle also requires integration vertically between the different levels of an organisation, so that management at all levels is involved in the planning process. This principle helps to ensure that solutions developed can be integrated successfully into the environment in which they have to operate. It also ties in with the participative principle stated earlier.

However, all too often, managers spend relatively little time on planning. They may be too busy dealing with the day-to-day running of the organisation and delegate the planning to others. This may result in plans to which they are not committed and which are consequently not implemented. Interactive Management attempts to provide an effective and efficient process which helps managers to plan and to maximise the value of the time they are able to allocate to such activities.

2.2.3 Phases of the Decision-Making Process

Simon (1960), in his writings on the processes of management decision, pointed out the importance, when studying decision making, of understanding the activities of exploration and analysis which precede the moment of choice. He characterised the various phases of the decision-making process as intelligence, design, choice and review. Current management science often focuses on the choice phase of selecting amongst well-defined alternatives. It tends to neglect the preparatory phases of intelligence, where information is gathered and structured, and design, where the various alternatives are generated.

Warfield (1982a, 1984a) has explicitly incorporated the intelligence, design and choice phases into the framework of Interactive Management and has suggested methods which enable them to be put into practice by groups of participants. In the context of this thesis, the phases are used in the following sense.

Intelligence. Exploring, identifying and structuring the components of an issue.

Design. The generation of alternative designs, options or solutions.

Choice. The evaluation and selection of a particular alternative.

The phases should not be seen simply as a linear sequence, but as a process permitting iteration between activities as shown in Figure 2.2.

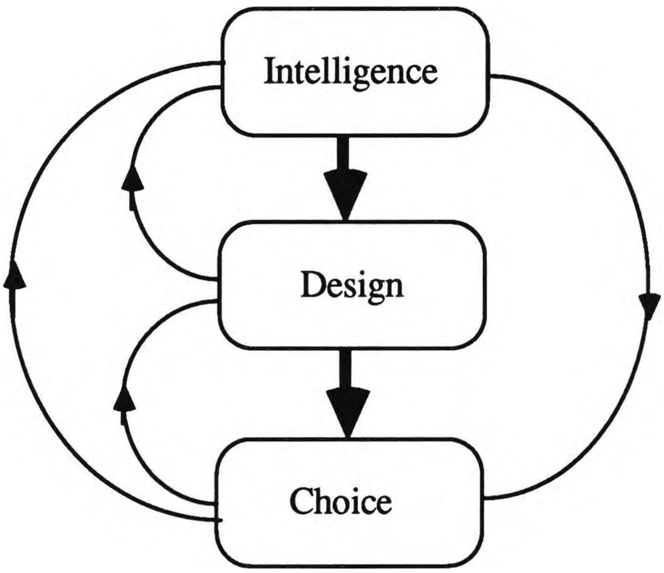


Figure 2.2 Intelligence, design and choice

2.2.4 Making Group Work More Productive

The need to bring together individuals of diverse backgrounds when tackling complex issues such as planning often results in group work involving meetings. Handy (1985:154) suggests that, on average, 50% of the time of managers is spent working in one kind of group or another, whilst for senior managers this may be as high as 80%. Christakis (1984) reported that a study by the EXXON and XEROX Corporations in 1982 had shown that 17.5 million meetings per day took place in the U.S.A. This is approximately four billion meetings per year. However, all too often dissatisfaction with meetings is widespread. Wainwright (1987:5) lists 16 sources of dissatisfaction including: badly run meetings, avoidance of decisions, attendance by the wrong people, wandering from the point, and lack of participation. Poor preparation and poor chairmanship are two primary sources of such dissatisfaction.

In the context of meetings of groups for complex problem solving, the Interactive Management framework incorporates five components which help to ensure that the resulting meetings are productive and overcome many of the common sources of dissatisfaction. Christakis (1983b) and Warfield (1984a) list these components as: the participant group, the facilitator, the computer and peripherals, the situation room, and the consensus methodologies. They propose the ideal of a "Sigma Five" meeting, where "Sigma" represents the integration of knowledge through meetings and "Five" refers to the five components which maximise the likelihood of a successful outcome.

In adapting the framework for use in the U.K, the author has found it helpful to define the five components in the following ways.

Participant Group. Individuals, including stakeholders, with content knowledge relevant to the issue.

Facilitator. To manage the work of the group and guide participants through the steps of the methods used.

Methods. To assist the group in intelligence, design and choice activities.

Computer Support. To run software associated with the methods and to provide display facilities and word processing capability.

Decision Support Room. To provide an environment equipped for efficient group work.

2.3 RELATED WORK

The Interactive Management activities conducted by the author at City University have been undertaken within a Department of Systems Science. A wider context of the work, in terms both of the planning workshops and of teaching, has therefore naturally tended to be that of systems methodologies. Similarly, ISM has tended to be regarded as one of a number of systems modelling tools, itself contained within a wider context of Interactive Management. These relationships are shown in Figure 2.3. The term "systems methodologies" is used here in a broad sense to include methodologies that explicitly emphasise the use of systems ideas, and those that are more associated with management science and operational research but which nonetheless have an inherent systems content.

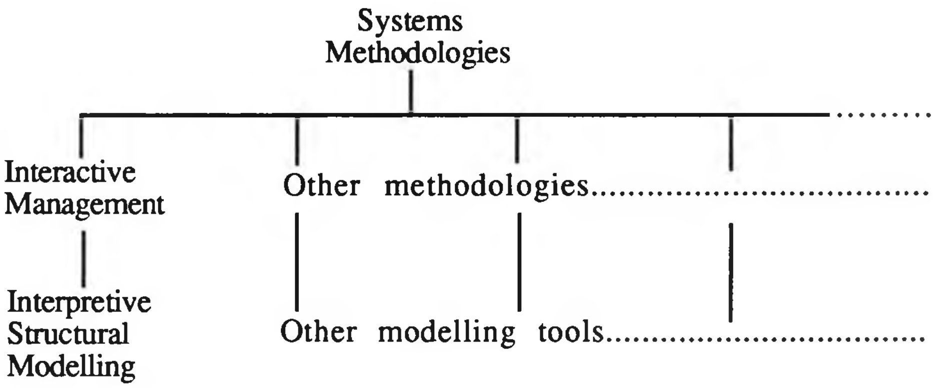


Figure 2.3 Interactive Management in context

2.3.1 Other Approaches

Methodologies that explicitly emphasise the use of systems ideas include those concerned with work in both "hard" systems and "soft" systems (Checkland, 1979). Examples of hard systems methodology are given in classic accounts of systems engineering by Hall (1962a) and Jenkins (1969), and in more recent accounts by M'Pherson (1980, 1981). The modelling approach of system dynamics, originated by Forrester (1961, 1968), may also be considered as a hard systems methodology which is widely recognised and applied, for example, Coyle (1977) and Wolstenholme (1989). Both traditional systems engineering and system dynamics place considerable emphasis on the activities of quantitative modelling and optimisation, although several authors (Hall, 1989; Wolstenholme, 1990; Hitchins, 1992) working in these areas have recently attempted to build bridges and break down the barriers that they see between the so-called hard and soft approaches.

Probably the most recognised and coherent example of work in soft systems is that of soft systems methodology (SSM) developed by Checkland (1972, 1981;

Checkland and Scholes, 1990). Checkland (1978:109) has characterised systems engineering as being "based on the assumption that the problem task is ... to select an efficient means of achieving a known and defined end". Unlike systems engineering, SSM provides a learning system for those exploring problematic situations that involve human activity. This facilitates learning and leads to action being taken so as to improve the situation (Checkland, 1989), rather than to solve the problem. SSM also emphasises the use of the concept "system" as part of a process of inquiry into the world rather than as a label for parts of the world (Checkland, 1987).

Unlike SSM, which emerged from failed attempts to apply the methodology of systems engineering to managerial problems in organisations (Checkland 1989), ISM was originally designed with the primary intention of complementing other approaches where it "may often be a 'front-end' methodology, providing an essential framework against which more quantitative or more specific methodologies may be seen in a better perspective and more fruitfully applied." (Warfield, 1976:p xiii). However, ISM adopts a very different approach to that of conventional systems engineering. In common with SSM, ISM has been designed as a learning process. In ISM, learning is considered to take place through the interaction of participants in producing structural models with the help of a computer and under the guidance of a trained facilitator (Warfield 1982b). It assumes that the well-structured methods used, which are designed for group work, can help the participants to reach a consensual agreement on a problematic situation and the means of tackling it, without explicitly exploring individual worldviews. SSM, on the other hand, is "based upon a phenomenological stance" (Checkland, 1981:318), with an emphasis on understanding different perspectives or worldviews and, more recently, on what Checkland and Scholes (1990:44) call a "stream of cultural enquiry", which includes social and political system analysis.

The traditional focus of operational research and management science has been on the application of the methods of science to complex problems of management. It has been much criticised, for example, by Ackoff (1979), Checkland (1983) and Jenkins (1983): for the gap between the textbook theory and practice of the subject; for trying to mimic "hard" science and being reductionist in approach; for its overemphasis on quantitative modelling and optimisation; for its neglect of systemic and behavioural issues and non-quantifiable factors; and, particularly by Checkland (1983:674), for assuming, like systems engineering, that the problem task is concerned with "a systematic search for an efficient means of achieving a defined objective". However, more recently, other approaches within operational research and management science have been developed which are less open to these criticisms. For example, strategic options development and analysis (SODA) (Eden, 1989), with its modelling technique of cognitive mapping (Eden et al, 1983), and the strategic choice approach (Friend and Hickling, 1987; Friend, 1989). Both of these methodologies have features in common with Interactive Management and ISM: for example, the emphasis on participation, process management, facilitation, group work, structured debate, shared understanding, changed perceptions, and learning.

The originators of SSM, SODA and the strategic choice approach would not necessarily regard them as being particularly concerned with "design". However, these methodologies, along with ISM and interactive planning, have much in common with the ethos of "second generation" design methods as distinct from "first generation" design methods, traditional systems engineering being an example of the latter. Olsen (1982:7-9) distinguishes between first and second generation design methods in the following way. First generation methods are characterised by the use of professional expertise by a professional who informs himself about, and formulates solutions to, a client's problem; and by the development of increasingly complex techniques which tend to make the professional indispensible. Second generation methods, on the other hand, are characterised by the following assumptions: that expertise resides in all stakeholders and not solely in the professional; that there should be an ideal of argument to elicit alternative views and make them clear; that the principle of making things as well understood as possible should be adopted; and that the client should be enabled to maintain control and participate in developing solutions.

2.3.2 Problem Contexts

A framework for grouping problem contexts is described by Flood and Jackson (1991:32-35). One intention of this is to inform potential users of systems approaches as to which approaches might be most suitable in different situations. The framework is based on earlier work concerning "a system of systems methodologies" by Jackson and Keys (1984) and Jackson (1990). The two dimensions of the framework are labelled "systems" and "participants" (Figure 2.4) and suggest a categorisation of problem contexts into ideal types. In the systems dimension, a continuum of system types is envisaged ranging from "simple" to "complex": these terms refer to the relative complexity of the problem situation in terms of the system(s) that make it up. In the participants dimension, three classes of relationship are envisaged and are labelled "unitary", "pluralist" and "coercive": these terms refer to the extent of agreement or disagreement among those who may gain or lose as a result of any intervention using a systems methodology.

		PARTICIPANTS (relationships between)		
		Unitary (U)	Pluralist (P)	Coercive (C)
SYSTEMS (relative complexity of)	Simple (S)	S - U	S - P	S - C
	Complex (C)	C - U	C - P	C - C

Figure 2.4 Problem contexts grouped as ideal types (based on Flood and Jackson , 1991)

A complex system in this framework is characterised, according to the authors, by the following kinds of features: having many elements which are highly interrelated but loosely organised; demonstrating probabalistic behaviour and evolution over time; having purposeful subsystems with their own goals; and being an open system subject to behavioural influences. A pluralist relationship among participants is characterised by features that include: having a basic compatability of interests; showing a divergence of values and beliefs to some extent; not necessarily agreeing on ends and means but demonstrating the possibility of compromise; participation in decision making by all involved; and acting in accordance with agreed objectives. Bearing in mind the limitation that we are here referring to ideal types, these complex-pluralistic features appear to apply reasonably well to the kinds of problem situation for which Interactive Management is best suited. The author would thus position Interactive Management in the complex-pluralist area of the framework.

It is worth considering briefly the features proposed by Flood and Jackson as characterising a "coercive" relationship among participants. These include: not sharing common interests; having conflicting values and beliefs; there being no possibility of genuine compromise; and the need for coercion by some if others are to accept decisions. The methods that form part of Interactive Management, which attempt to promote shared understanding, compromise and consensus, would not appear to be appropriate for a problem situation containing these features.

Warfield (1984a, 1990), Christakis and Keever (1984), and Christakis (1985b), have discussed problem situations in relation to Interactive Management and offer a means of distinguishing between what they term "normal" and "complex" problems. In this classification scheme, problems are considered on four dimensions (Figure 2.5). The first concerns the disciplinary scope of the problem, i.e., the knowledge needed to tackle it may be contained within a single field or discipline, or may be multidisciplinary and cut across a number of disciplines. The second dimension relates to the scope of involvement within the organisation, i.e., the problem may be contained vertically within one section or division of an organisation, or it may cut horizontally across sections of an organisation (Cleveland, 1973) and require a cooperative effort if it is to be tackled. The third dimension concerns whether there is experience of similar problems already solved, i.e., the problem may be open to solution by following a known algorithm or set of tasks, or, alternatively, the problem may be novel and unstructured with no way of resolving it being known in advance. This dimension is based on Simon's (1960) concept of programmed and nonprogrammed decisions. The fourth dimension concerns whether the governing variables or norms in the situation need to be changed. It may be possible to resolve the problem without altering these governing variables, or they may need to be reassessed and changed. This is based on Argyris and Schon's (1978) concept of single-loop and double-loop learning.

In the context of Interactive Management, the classifications suggested by Warfield and Christakis, and by Flood and Jackson are very different but not incompatible. Thus, for example, Figure 2.5 shows profiles of the extreme cases of normal and complex problem profiles. The implication is that, if complex problems of the type indicated are to be tackled, the resources of the Interactive Management approach are desirable, i.e., participant group, facilitator, methods, computer support, and decision support room. Correspondingly, the resources required for this approach would be wasted if used on a problem with a profile of the extreme normal type. Similarly, in the Flood and Jackson scheme, the resources of Interactive Management would be appropriate for problem contexts of the complex-pluralist type, but they would to a large extent be redundant if used in a simple-unitary problem context. Moreover, the notions of multidisciplinarity and horizontal involvement across sections of an organisation imply a plurality of viewpoints among participants rather than a unitary viewpoint.

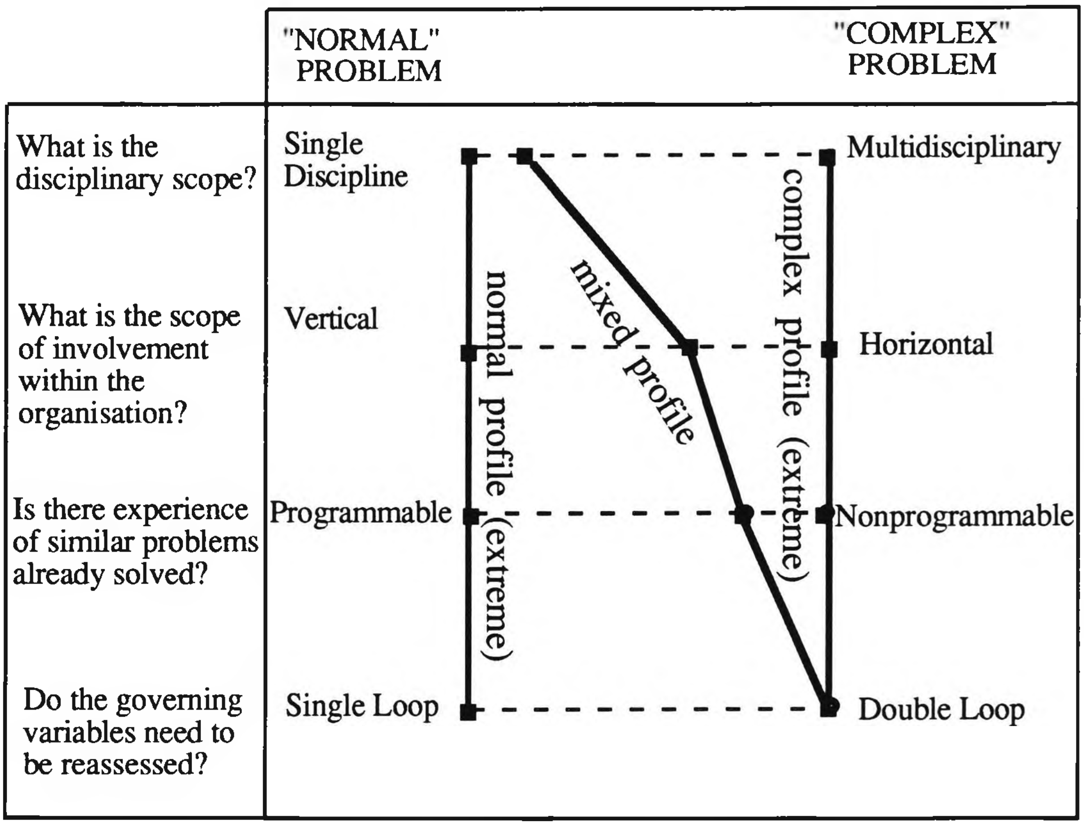


Figure 2.5 Classes of problems and problem profiles (based on Warfield, 1984a and Christakis, 1985)

2.4 SUMMARY

The framework for Interactive Management as a means of exploring complex issues has been introduced and some important contributions to the thinking behind the framework have been examined. Gaining commitment by managers to the implementation of plans through their participation in the planning process has been emphasised. The relation of this work to other work concerned with systems methodologies has been considered; it is concluded that Interactive Management is best suited to problem contexts that may be described as complex and pluralist in nature. Components which can make group work more productive have been introduced. In Chapter 3 these components are examined in more detail as they provide a key to putting Interactive Management into practice.

Chapter 3

FIVE COMPONENTS FOR PRODUCTIVE GROUP WORK

3.1 INTRODUCTION

In this chapter, five components for productive group work, which were introduced in the last chapter, are discussed in more detail. These are: the participant group, the facilitator, the methods, the computer support and the decision support room. The description of the design and operation of a decision support room, equipped with appropriate computer and display facilities, explains how the physical facilities required for Interactive Management have been implemented at City University.

3.2 PARTICIPANT GROUP

In selecting participants for a typical Interactive Management workshop involving intensive work in meetings over a number of days, two requirements in particular have to be taken into account.

First, it is desirable that the participants, as a group, possess the content knowledge necessary to tackle the issue. If the group members do not have an adequate appreciation of the issue, or of the context surrounding the issue, they are unlikely to generate appropriate solutions. In some circumstances supplementary information may be provided from documents or through advisers who are present but not actually participating. However, this is best avoided as it tends to distract participants from the issue under consideration and to interfere with the group dynamics.

Second, the group should provide appropriate representation of stakeholders, i.e., "all those inside or outside an organisation who are directly affected by what it does." (Ackoff, 1981:30). This second requirement ties in with Ackoff's participative and holistic principles described earlier and should be met in order to develop in the participants a commitment to implementation. In the author's experience, this commitment may be enhanced if the client, as a key stakeholder, is involved as a participant in the workshop. Alternatively, the client may be an observer at the workshop and learn from the views and arguments expressed.

Normally, the Interactive Management consultant will decide with the client on the composition of the group needed to maximise the quality of the outcome, taking the above requirements into account. Group size is an important constraint. Olsen (1982:51-55) summarises the findings of a number of writers on group size. Whilst there is clearly no magic number of participants for optimal performance, five to eight members appears to be the best range for a successful task-oriented group. The author's own experience supports this view. Napier and Gershenfeld (1973:25) suggest five to seven. The key considerations are to have enough members to permit a diversity of ideas and opinions but to keep the group small enough to allow everyone to participate fully. Larger numbers may be accommodated with parallel working groups and subsequent plenary meetings. However, this raises the duration and cost of the workshop which may not be acceptable to the client. It is thus not always possible in practice to realise fully the ideals of Ackoff's three principles.

3.3 FACILITATOR

In this section the term "facilitator" is used throughout in the context of facilitating Interactive Management meetings. Christakis (1985c) defines a facilitator as "a person who is capable of managing the process of group work in accordance with the principles of Interactive Management". He emphasises the need for a facilitator to be well versed in the design and conduct of meetings incorporating all five of the components suggested as necessary for effective group work. This implies expert knowledge of the methods used, the ability to diagnose the progress of the group towards resolution of a problem, and sensitivity to behavioural variables during group work. Broome and Keever (1986) offer a similar definition and also suggest that the primary function of a facilitator is to monitor and encourage positive group maintenance roles. Warfield (1982b) emphasises a number of requirements for a facilitator. These include being very skilled in helping groups work together, being familiar with the methods used and being motivated primarily by the wish to see the group succeed in its work. He also refers to the need for a facilitator to have a mix of technical and behavioural training (Warfield 1983).

A key aspect of the role of the facilitator relates to the distinction between process and content. **Process** refers to activities, in particular the steps of the method(s), through which the group progresses when tackling an issue. **Content** refers to information related to the issue, particularly knowledge that individual members of the group have about a situation. The facilitator remains firmly in charge of process when working with a group but is careful not to generate content for the participants. By acting in this way the facilitator can focus on providing the participants with a framework which helps them, as the content experts, to deal with their own organisational problems more effectively. At the same time, the facilitator is seen to be impartial with regard to the direction of any particular outcomes arising from the use of the methods. The roles of the facilitator and participants with regard to process and content are thus quite distinct.

3.3.1 Facilitator Skills

There are various skills which it is helpful for a facilitator to possess. These may be labelled technical skills, behavioural skills and consultancy skills. Each of these is briefly examined below.

(i) Technical skills

These relate to the methods, the computer support and the working environment. The facilitator should have a thorough knowledge of the steps of any methods used and be aware of the potential uses and the limitations of the methods. A knowledge of how to take short cuts when time is limited without destroying the integrity of the methods is necessary. The facilitator should also know how the methods may be used in different sequences to achieve the required results depending on the circumstances and time available. He or she should understand how computer support can be used in conjunction with the methods and be able to coordinate the interface between the computer and the group. The facilitator is also in charge of specifying the decision support room layout which should be organised to provide an efficient and comfortable working environment for the participants and any supporting staff.

(ii) Behavioural skills

These may be regarded as falling into two categories concerned with personal skills and group management skills. **Personal skills** cover a wide range of attributes. An ability to manage effectively the staff and physical resources available is clearly desirable. Other less tangible qualities include having a sense of authority without being domineering, being articulate and a good listener. It also helps if the facilitator has a friendly disposition, a sense of humour and is sensitive to the needs and moods of others. Managing a group for a prolonged period is tiring so stamina is essential. In addition, a facilitator cannot succeed without a high level of **group management skills**. These include managing the group dynamics through being aware of the interactions between the participants and sensing the state of the group, e.g., enthusiasm or fatigue. The flow of the meeting needs to be controlled and the participants' energy focussed on a common task, so that good use is made of their time. The facilitator needs to ensure focussed dialogue with a high level of participation and to see that no particular individuals dominate the talking. He or she must ensure that the steps of the method are clear to the participants and stick to the process without making untried modifications which have not been thought through and often have a tendency to go wrong.

(iii) Consultancy skills

In many circumstances the facilitator may find that his or her role is more than simply facilitating the use of the methods. He or she may be involved in wider consultancy activities within the Interactive Management framework. These may include the design of the whole workshop with the client, embracing the use of a complete sequence of methods to tackle an issue. The methods have to be selected and the exact way in which they are going to be used decided upon. The facilitator may then be concerned with monitoring the progress of the group through the steps of the various methods and making adjustments when appropriate. At a later stage the facilitator may be involved in producing a report for the client on the outcome of the workshop and in following up the implementation of any recommendations.

3.4 METHODS

The methods described here form a core part of the Interactive Management framework. Each provides a process which, under the guidance of a facilitator, can be used to structure the participants' activities and focus their thinking and effort. Warfield (1982a) describes the methods as "consensus methodologies" suitable for intelligence, design and choice activities. The term "consensus" is used to signify a number of characteristics (Center for Interactive Management, 1985). First, that the participative design of the methods is such that all participants have an opportunity to contribute, and to indicate that they have had that opportunity, e.g., by voting.

Second, that the ideas of participants are acknowledged by the group so that individuals feel that their views have been listened to and understood. Third, that the products resulting from the use of the methods are generally agreed by the individuals involved and, that even if they are not in complete agreement with the products, they can "live with" the outcome . The term "method" is used in this thesis rather than "methodology" to describe the individual methods, in the sense that each method provides a way of doing something, or a process for attaining an objective. Interactive Management as a whole may then be considered as offering a process of inquiry constituting a "methodology", in the sense that it provides a set of procedures and, as a field of study, it employs a body of methods, rules and postulates (Webster, 1973).

The seven methods selected by Warfield (1982a) are as follows.

Ideawriting. A quick and efficient idea-generation method for use by groups.

Nominal Group Technique. An efficient idea-generation method for use by groups which allows for clarifying, editing and obtaining an initial ranking of the generated ideas.

Delphi. A method for systematically developing the views of a panel of individuals on an issue through written responses to successive questionnaires when it is not practical for the participants to meet together or anonymity is desired.

Interpretive Structural Modelling. A computer-assisted method for mapping the elements of a complex issue into an agreed diagrammatic structure by an informed group.

Options Field. A method for conceptual design by groups which shows in one diagram all the conceived dimensions of the prospective designs and all the conceived options within each dimension.

Options Profile. A method for selecting specific alternative conceptual designs from an options field.

Tradeoff Analysis Method. A method for evaluating and choosing between alternative designs by comparing the differences between the alternatives, and for clearly documenting the basis of decisions made.

The first three methods can only be used by groups. However, the last four methods, although designed for use by groups, can also be used by individuals. Christakis (1983a) has charted the evolution of these consensus methods; this is illustrated in Table 3.1.

Origins	**Method**	**Originator and Thesis Reference**
1950s	Delphi	Dalkey (Dalkey and Helmer, 1963)
Late 1960s	Ideawriting (Brainwriting)	Geschka (Geschka et al, 1973)
Late 1960s	Nominal Group Technique	Delbecq (Delbecq et al, 1975)
Early 1970s	Interpretive Structural Modelling	Warfield (Warfield 1974a)
Late 1970s	Options Field Options Profile	Warfield (Warfield, 1982a)
Early 1980s	Tradeoff Analysis Method	McDonald (McDonald, 1982: Warfield, 1982a)

Table 3.1 Evolution of the methods

Important features which the above methods possess include:

- Capability of being used effectively by a group for idea generation, idea structuring, design or decision making activities,
- Sound behavioural and technical design,
- Promoting contributions from all participants,
- Encouraging focussed and open dialogue,
- Clear definition of the roles of participants and facilitator,
- Provision for iteration,
- Provision for documentation of results,
- Making efficient use of participants' time.

Warfield (1982a) illustrates the roles which each of the seven methods can play in tackling the intelligence, design and choice phases of the decision-making process (Figure 3.1).

Progress →

MANAGEMENT FUNCTIONS / CONSENSUS METHODS	INTELLIGENCE	DESIGN	CHOICE
1) Ideawriting	●	●	
2) Nominal Group Technique	●	●	
3) Interpretive Structural Modelling	●	●	●
4) Delphi	●	●	●
5) Options Field		●	
6) Options Profile			●
7) Tradeoff Analysis			●

Figure 3.1 Consensus methods and management functions (based on Warfield, 1982a)

This thesis focuses on the principles and applications of the three methods Ideawriting, Nominal Group Technique and ISM. These have been implemented extensively by the author with professional groups within the context of Interactive Management.

3.5 COMPUTER SUPPORT

The use of all the methods discussed in Section 3.4 can be enhanced through the use of appropriate computer support. The term "computer support" is used here to include the computer hardware and peripherals, the software and the computer operator(s). Such computer support during a workshop can serve a number of purposes including:

- Running specific programs which form an integral part of the use of the methods.
- Projecting the computer output onto a large screen for display to a group.
- Running graphics programs which enable the preparation of diagrammatic models.
- Providing word processing capability.
- Printing immediate hard copy of any products of the workshop.

For example, consider a workshop involving the use of ISM. Software associated with the method is used to pose questions to the group of participants. The projection of these questions onto a large screen enables the whole group simultaneously to read each question. As the ISM session proceeds and the computer processes the answers given by the group, graphics software may be used to construct the diagrammatic models resulting from the use of the method. Word processing software may be used by an observer to record for future reference particular points raised during discussion of the questions. A high quality printer, such as a laserwriter, enables the participants to be given the printed products of the sessions as the various stages of the workshop progress.

In this way the computer support enables the methods to be used effectively and helps to make efficient use of the participants' time. The equipment itself does not dominate the proceedings, which might inhibit members of the group. The latter do not have to be computer literate or interact directly with the computer in any way in order to participate; this is done by the computer operator. Rather, the intention is to provide the necessary support quietly and unobtrusively so that participants can concentrate on the issues being explored.

3.5.1 Computing Equipment for the Decision Support Room

Figure 3.2 gives an outline of the current computer hardware configuration of the decision support room at City University and indicates how each piece of equipment may be used during a typical workshop.

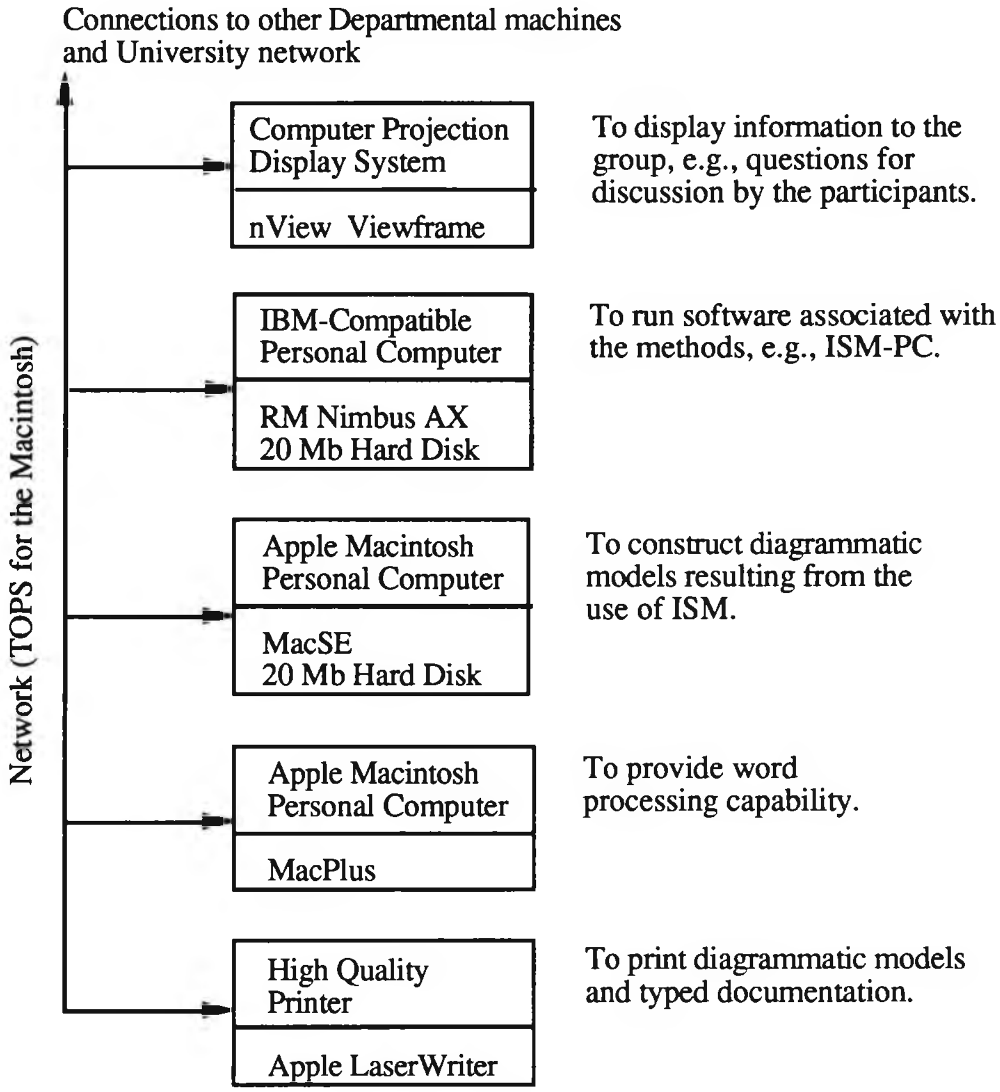


Figure 3.2 Outline of computer hardware configuration

Initially, workshops were run in a seminar room with equipment installed as the occasion required. During ISM sessions elements, such as objectives that were to be structured, were written out in advance on strips of acetate sheets. These could then be displayed in the form of questions put to the group on an overhead projector as required by the computer program. The preparation for the workshops was thus somewhat laborious, but the actual sessions worked well. In 1986, the provision of a permanent room for the workshops, together with the installation of the ISM program on a second minicomputer (Figure 3.3), contributed to improving the reliability of the computer support. This was further improved with the creation of a University computer network which replaced the modems and telephone link. In 1987 an equipment grant obtained from Apple computers enabled the purchase of an Apple computer and laserwriter which simplified the production of the complex diagrammatic models resulting from ISM sessions. Also in that year, the Department's own ISM software for a personal computer became available with resultant improved reliability and transportability. The purchase of a computer projection unit based on liquid crystal display technology enabled the computer output to be displayed directly to the group on a large screen. This made the ISM sessions much less laborious to run. The upgrading of equipment and improved networking has meant that all the products of the group work can be efficiently produced whilst the sessions are in progress. Participants thus leave at the end of the day with the documented results of their work instead of waiting days or weeks by which time some momentum has been lost.

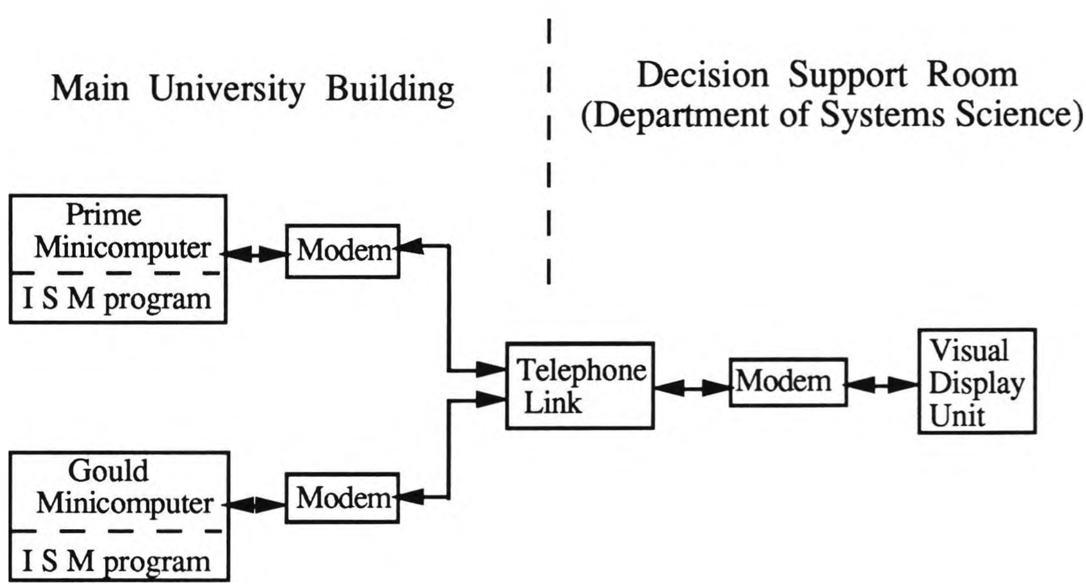


Figure 3.3 Improving the reliability of the computer support

The development of the equipment for the decision support room is listed chronologically below.

1983

- ISM computer program installed on Prime minicomputer in the University and used via a Departmental telephone link, modem and visual display unit (VDU) set up in a seminar room when required for workshops.

1985

- Permanent telephone link, modem and VDU for workshops installed in a seminar room.

1986

- Present decision support room established and provided with permanent telephone link, modem and VDU.

- ISM program installed on University's new Gould minicomputer.

- Decision support room networked to Gould and Prime minicomputers dispensing with need for telephone link and modem.

1987

- Apple Macintosh computer (MacPlus) and Apple LaserWriter printer obtained for construction and printing of high quality graphics.

- First version of City University's ISM software, "ISM-PC", available for use on an IBM personal computer (PC).

- IBM compatible PC (RM Nimbus AX) with 20 Mb hard disk installed to run ISM-PC.

- Computer projection display tablet (Kodak Datashow) purchased to project output of IBM compatible PC onto screen via high quality overhead projector.

- Video monitor (Digivision) installed to enable magnification of diagrams on MacPlus screen.

- Second MacPlus purchased together with 20 Mb hard disk, improving word processing and graphics capability during workshops and offering networking potential.

- All Apple equipment networked together using TOPS Macintosh network. Apple equipment also networked into University Prime and Gould mainframes.

1988

- IBM and Apple equipment fully networked together enabling document transfer.

- Apple MacSE computer with 20 Mb hard disk purchased giving enhanced graphics capability making production of ISM models easier.

- Macintosh large screen (Nutmeg 19) installed to enlarge and improve display of MacSE output and further enhance graphics capability.

1989

- High resolution computer projection display tablet (nVIEW Viewframe) bought enabling projection of both IBM and Apple computer outputs via overhead projector.

- Computer program written for Tradeoff Analysis Method of decision making.

3.6 DECISION SUPPORT ROOM

3.6.1 Physical Environment for Group Work

All too often group work is carried out in an inadequate environment. Common problems include uncomfortable seating, lack of worktop space, inflexibility of layout, poor computer display facilities, a badly positioned overhead projector, and insufficient whiteboard space. This does not help to make a group productive.

Early "decision rooms," such as that developed by Phillips International (MacKensie, 1972; Spooner, 1972), focussed on the high-technology computer support needed to provide instant information for teams of senior managers. More recently, the importance of other features in the design of decision support rooms (or "situation" rooms) as well as computer support has been emphasised (Warfield, 1990:269-272). These include adequate worktop space, flexibility of layout, physical comfort, ample display facilities, provision for multiple roles, retention of information generated by participants, production of the intermediate results of group work, access to on-line software, and videotaping. The intention is to provide a room which maximises the opportunity for participants to work together and to organise their wisdom and knowledge so that they benefit from each other (Warfield, 1981).

In 1982, the Centre for Interactive Management at the University of Virginia constructed such a room. Warfield (1990:267-268) charts the development of four rooms in the USA based on similar principles. In two cases the University of Virginia room was replicated by client organisations. The other two were a room at the University of Northern Iowa (Waller, 1983b) and one constructed for the Centre for Interactive Management on moving to George Mason University from the University of Virginia.

3.6.2 Decision Support Room at City University

Section 3.5.1 refers to the way in which the initial Interactive Management workshops were run in a seminar room adapted for the occasion. This provided a far from ideal physical environment with, depending on the particular room used, many of the problems referred to in Section 3.6.1. In 1984 the author put a proposal to the Board of the Department of Systems Science outlining plans for a decision support room. The design for the room drew upon the author's experience of working in the Centre for Interactive Management at the University of Virginia and incorporated many of the features recommended by Warfield. The proposal was also put to the University's Academic Policy Committee as part of plans relating to the future of the Department. Subsequently, the Department decided to allocate a different and improved location for the room than that originally suggested and the proposal was modified to take this into account. After completion of the necessary building work, the room was opened early in 1986. The proposal, included here as supporting paper N (Janes, 1985a), outlines the purpose of the room and explains the facilities required. The implementation of the computing facilities has already been discussed in Section 3.5. The other physical facilities, as requested in paragraph 3.1 of the proposal, were all implemented. Figure 3.4 shows the current layout of the room.

In a university environment, a room such as this provides a resource offering better quality space than the usual lecturing and seminar rooms. The room has intentionally been designed so that it can be used as a general Departmental resource on occasions when high-quality space is required, e.g., for external meetings and post-experience short courses. All the computing equipment is thus readily portable and, indeed, is normally located in a separate room attached to the decision support room. This enables the equipment to be available for use at all times

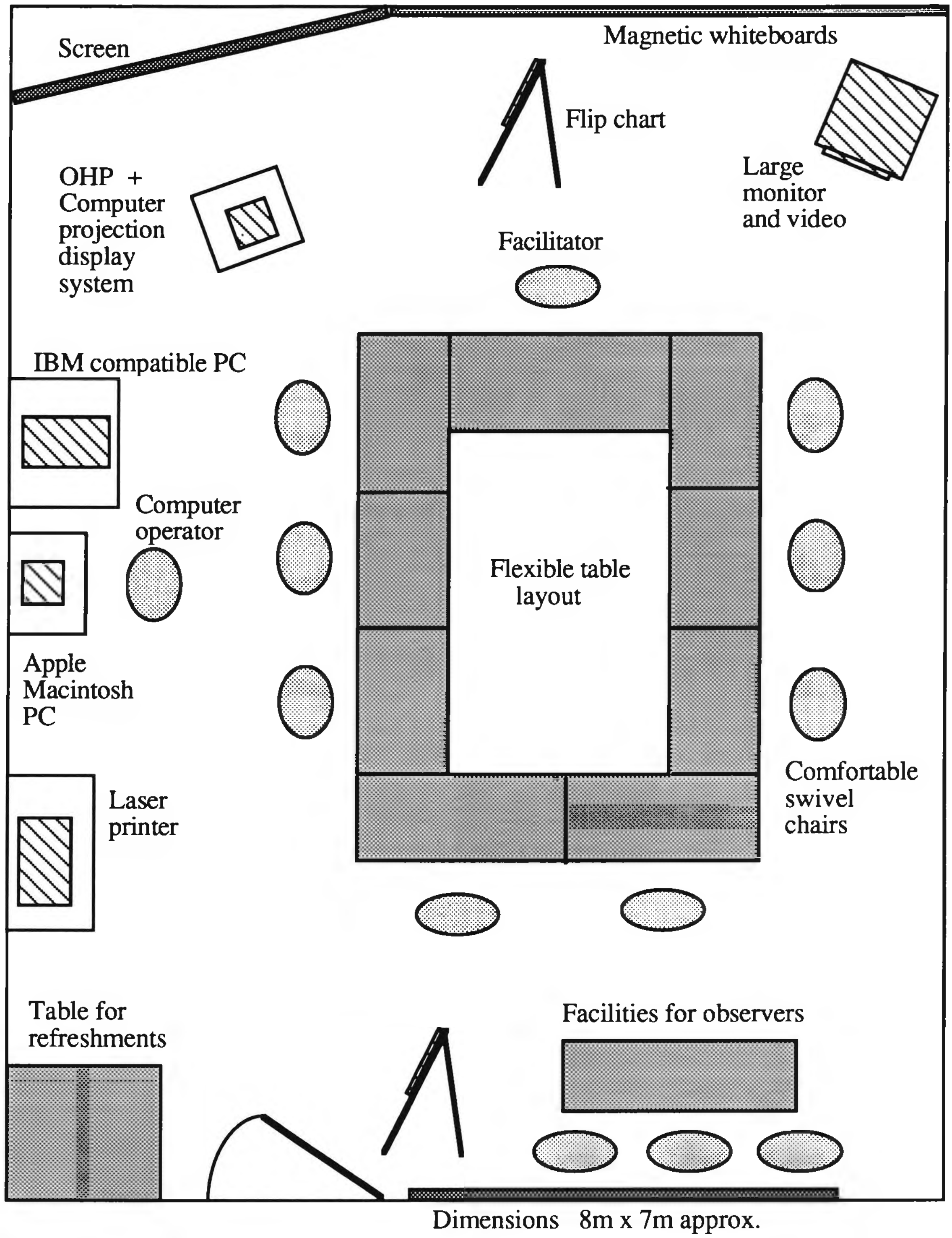


Figure 3.4 Decision support room layout

irrespective of the use to which the room is being put. In this way the room and computing equipment may be used independently. In terms of the politics of ensuring the long-term survival of the facility this is an important aspect of the design. It enables the computing enthusiasts to use the computing equipment at all times, and also enables academic staff who want a high quality room, but not necessarily a decision support room, to have access to one. In this way friction over competition for space in scarce supply has been minimised.

3.7 INTERRELATIONS BETWEEN THE FIVE COMPONENTS

The five components for productive group work described above support one another as shown in Figure 3.5. The arrows in the figure represent the relation "provides support for". Thus the facilitator provides support for the group whilst the methods support both the group and the facilitator. At the bottom of the figure the decision support room supports all four other components. Figure 3.6 shows the interrelations in a simplified form as a transitive digraph where the expression "provides support for" is taken to be a transitive relation.

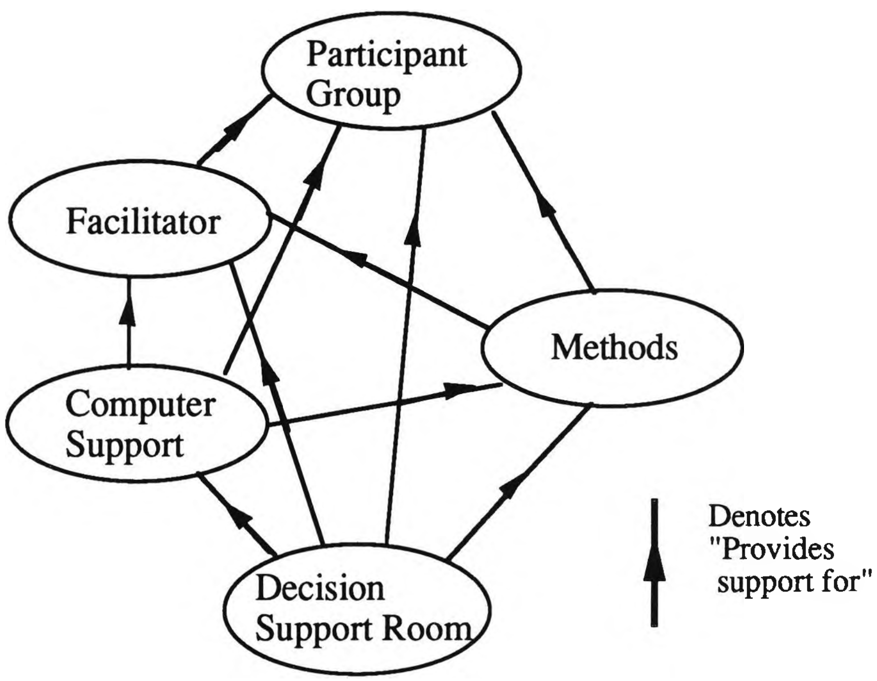


Figure 3.5 Interrelations between the five components

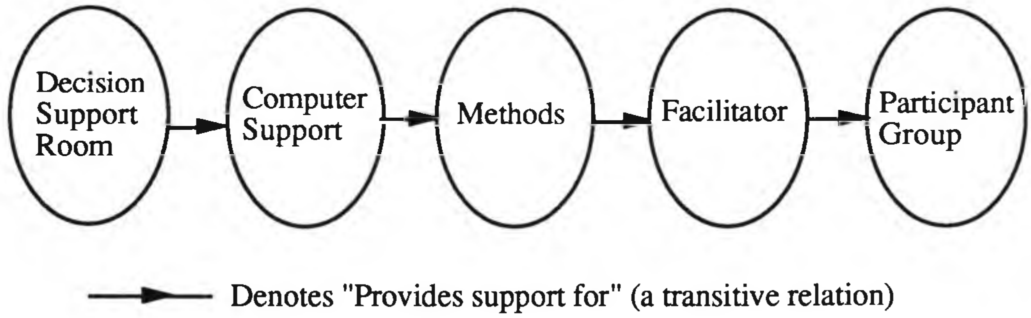


Figure 3.6 The five components shown as a transitive digraph

3.8 SUMMARY

Five components which help to make group work productive and enable Interactive Management to be put into practice have been examined. These are the participant group itself, the facilitator, the methods used, the computer support, and the decision support room. The way in which the latter two have been implemented at City University has been explained, including the evolution of the computer support and the design of the decision support room. Chapter 4 focuses on the principles of one of the methods, Interpretive Structural Modelling.

Chapter 4

INTERPRETIVE STRUCTURAL MODELLING

4.1 INTRODUCTION

Section 4.2 of this chapter summarises a supporting paper by the author which discusses the nature of ISM as a method for structuring complex issues. A major part of the paper presents the author's ideas on the process of ISM; the paper also describes the relations between content, process and context. In Section 4.3 the various types of ISM structures and contextual relations which have been found to be useful are described. Section 4.4 presents an overview of the properties of contextual relations and explains the logical inferences which are associated with each group of relations. The interface between contextual relations and their mathematical counterpart, binary relations, is also considered. Finally, the operation of the ISM software developed at City University for a personal computer is outlined.

4.2 PRINCIPLES OF INTERPRETIVE STRUCTURAL MODELLING

This section should be read in conjunction with supporting paper A (Janes, 1988).

In creating ISM, Warfield (1973a; 1974a; 1976) drew extensively upon discrete or finite mathematics to produce a mathematical language applicable to many complex issues, provided that they can be analysed in terms of elements and their interrelations. From the point of view of the user, the resulting structural models are communicated as a combination of words and digraphs with the mathematics being hidden within a computer program. ISM is particularly useful for working with participants in a group where structured debate under the guidance of a facilitator can help the participants to reach a consensus view on an issue.

In the paper, a number of aspects of managing complexity when using ISM with a group are considered. These include the interrelations between the issue, team and tools, and between content, process and their respective contexts. Languages for modelling structure are examined and ISM is presented as a computer-assisted modelling approach incorporating words, graphics and mathematics. The process of using ISM in practice is considered as a series of seven steps. Each step is elaborated upon and important features are discussed. An example of an application is given concerning the structuring of a set of objectives. As the steps of the ISM process are referred to at various points in subsequent parts of this thesis, they are reproduced here.

1. Identify issue to be studied.
2. Decide on type of ISM to be constructed.
3. Select participant group and facilitator.
4. Generate the element set.
5. Complete matrix of element interactions.
6. Display the ISM.
7. Discuss structure and amend if necessary.

Table 4.1 Process of Interpretive Structural Modelling

4.3 TYPES OF ISM STRUCTURES AND CONTEXTUAL RELATIONS

4.3.1 Types of ISM Structures

Step 2 of the ISM process (Table 4.1) refers to deciding on the type of ISM to be constructed. Warfield (1982b) classifies the types of ISM structure which have been produced in applications into five groups: Intent Structures, Priority Structures, Attribute Enhancement Structures, Process Structures and Mathematical Dependence Structures. These are described in more detail in supporting paper A. In addition, a sixth group could be added termed Category Structures. These are useful when it is necessary to classify a set of elements into categories; the elements might, for example, be objectives, factors or a set of planned projects.

4.3.2 Types of Contextual Relations

In order to build an ISM, a **contextual relation** (Warfield, 1976) has to be selected. Such a relation may be defined as a verb phrase which is used to explore the interconnections between a set of elements. Warfield (1982b) identifies five categories of relations which have proved to be useful in ISM.

Comparative relations, where one element is compared with another. For example: is a higher priority than; is easier to implement than; performs better than; is a more attractive design than.

Influence relations, which express the influence of one element upon another. For example: would help to achieve; is a barrier to; strongly contributes to; influences.

Definitive relations, which enable commonly recognised facts or logical conditions to be shown. For example: is similar to; is a function of; implies; is a subset of.

Temporal relations, where elements are arranged with regard to their time sequence. For example: precedes; should start before; should follow; should finish before.

Spatial relations, which enable elements to be arranged according to their spatial orientation. For example: is below; is to the east of; is to the right of.

Of these five categories, the first three are particularly useful. The fourth category, temporal relations, clearly has many applications but other well-developed approaches exist for sequencing activities on a time scale, for example, Program Evaluation and Review Technique (PERT) or Critical Path Method (CPM) (Anderson et al, 1985). Spatial relations are useful in the specialised activity of automating the machine construction of maps (Warfield, 1982b). Table 4.2 gives examples of applications of the various categories of ISM structures and contextual relations.

4.4 LOGICAL PROPERTIES OF RELATIONS

Step 5 of the ISM process (Table 4.1) refers to completing a matrix of element interactions. An explanation of what this involves is given in supporting paper A. The latter makes it clear that an understanding of the logical properties of contextual relations is essential, since different kinds of logical inferences are possible depending on the properties of the relation.

Type of Structure	Type of Contextual Relation	EXAMPLES		
		Application	**Elements**	**Contextual Relation**
INTENT STRUCTURE	Influence relation	Structuring objectives for a management services department of a police force	objectives	would help to achieve
PRIORITY STRUCTURE	Comparative relation	Setting priorities amongst planned projects for a county council	projects	is a higher priority than
ATTRIBUTE ENHANCEMENT STRUCTURE	Influence relation	Exploring the interconnections between the problems arising in a manufacturing company	problems	strongly contributes to
PROCESS STRUCTURE	Temporal relation	Sequencing the activities to be undertaken before building a distillery	activities	should precede
MATHEMATICAL DEPENDENCE STRUCTURE	Definitive relation	Initial stages in building an economic model	economic variables	is a function of
CATEGORY STRUCTURE	Definitive relation	Classifying services provided by a national training board into categories	services	is similar to

Table 4.2 Types of ISM structures and contextual relations

There are three groups of contextual relations of particular relevance to ISM concerned with transitivity, symmetry and reflexivity. Each group may be divided into three sub-categories (Waller, 1980). This is shown in Table 4.3.

Group	Logical Properties
Transitive Group	transitive, intransitive, mesotransitive
Symmetric Group	symmetric, asymmetric, mesosymmetric
Reflexive Group	reflexive, irreflexive, mesoreflexive

Table 4.3 Logical properties of contextual relations

The logical conditions associated with these properties are given below and the associated logical inferences are illustrated as digraphs in Figures 4.1a,b and c. In each case the terms i, j and k refer to the elements i, j and k respectively.

(i) Transitive group

A fundamental feature of ISM, which has been used in building the mathematical theory underpinning it, concerns the logical property of transitivity. As a result, the contextual relation used must always be transitive. Were a user to attempt to build an ISM using a relation which was intransitive or mesotransitive the resulting model may well be meaningless, since inappropriate inferences would have been made by the computer during model construction.

Transitive contextual relation

"If element i relates to element j and j relates to k, then i relates to k".

For example: is a higher priority than; precedes; would help to achieve.

The transitive property gives rise to two corollaries as follows.

"If i relates to j and i does not relate to k, then j does not relate to k, for if it did transitivity would require that i related to k".

"If j relates to k and i does not relate to k, then i does not relate to j, for if it did transitivity would require that i related to k".

Intransitive contextual relation

"If i relates to j and j relates to k, then i does not relate to k".

For example: serves twice as many people as; is half the area of; is the mother of.

Mesotransitive contextual relation

"If i relates to j and j relates to k, then i may or may not relate to k".

For example: manufactures components for; imports from; sends information to.

(ii) Symmetric group

The restriction to the use of one sub-category of contextual relation, which applies to the transitive group, is a constraint that does not apply to the group of relations associated with symmetry: here, ISM may be used with a contextual relation which is symmetric, asymmetric or mesosymmetric. Nonetheless, the user has to know which of these properties applies to the relation in order to specify which logical inferences are appropriate.

Symmetric contextual relation

"If element i relates to element j, then j relates to i".

For example: is similar to; is as equally important as; starts at the same time as.

Asymmetric contextual relation

"If i relates to j, then j does not relate to i".

For example: is better value for money than; has authority over; finishes later than.

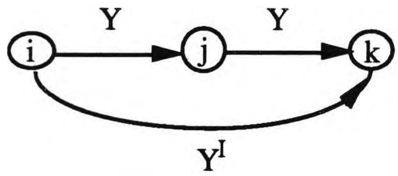
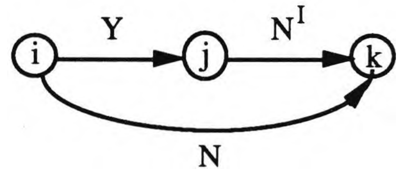
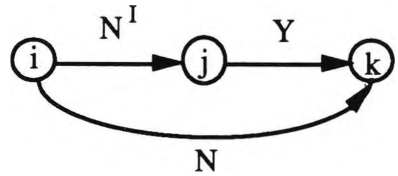
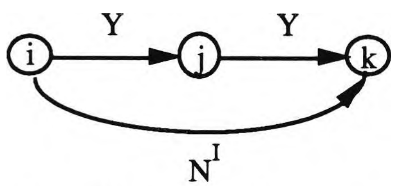
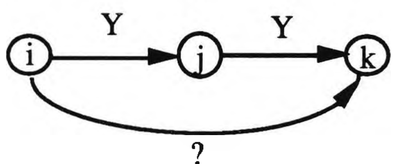
Mesosymmetric contextual relation

"If i relates to j, then j may or may not relate to i".

For example: strongly contributes to; is a barrier to; pollutes the environment of.

(iii) Reflexive group

This is not a particularly important group as far as the user is concerned. The mathematical theory of ISM automatically builds in the logical property of

Property	Digraph	Example of Contextual Relation
Transitive		"is a higher priority than"
Transitive (corollary 1)		"is a higher priority than"
Transitive (corollary 2)		"is a higher priority than"
Intransitive		"serves twice as many people as"
Mesotransitive		"manufactures components for"

i, j, k = elements

$\longrightarrow$ = contextual relation

Y = "Yes", denotes relation exists

N = "No", denotes relation does not exist

Y^I = a logically inferred "Yes"

N^I = a logically inferred "No"

? = no inference can be made

Figure 4.1a Logical inferences for the transitive group of contextual relations reflexivity, so the user does not have to specify which sub-category of the reflexive group the contextual relation falls into. However, the relevant definitions are given here for completeness.

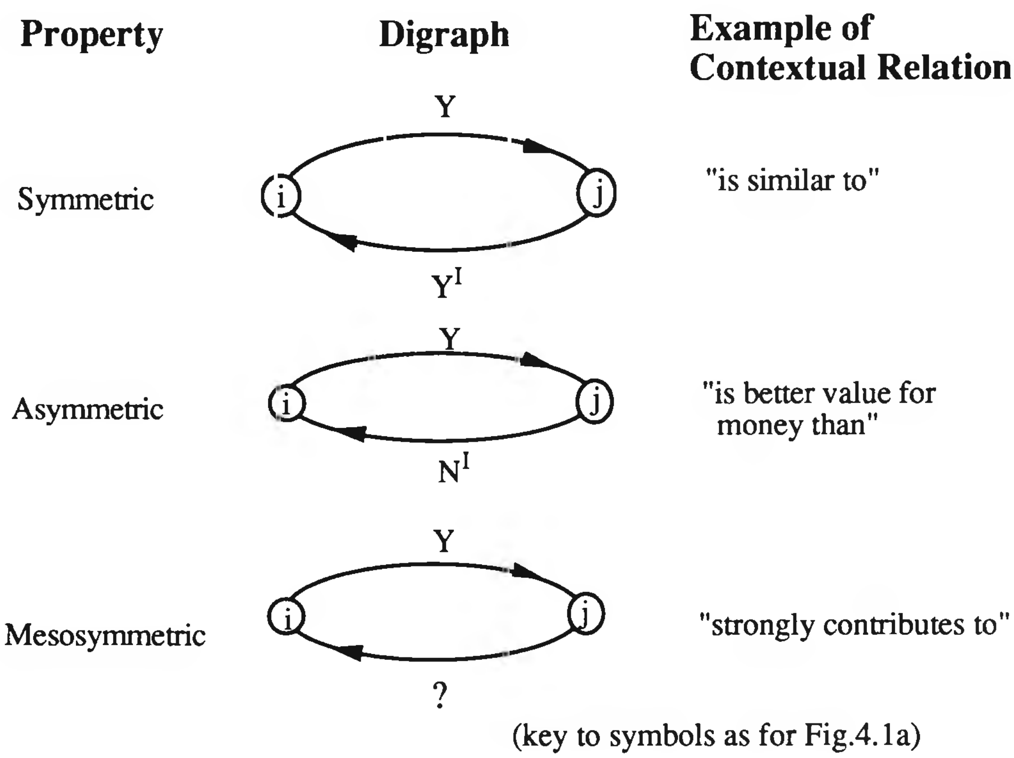


Figure 4.1b Logical inferences for the symmetric group of contextual relations

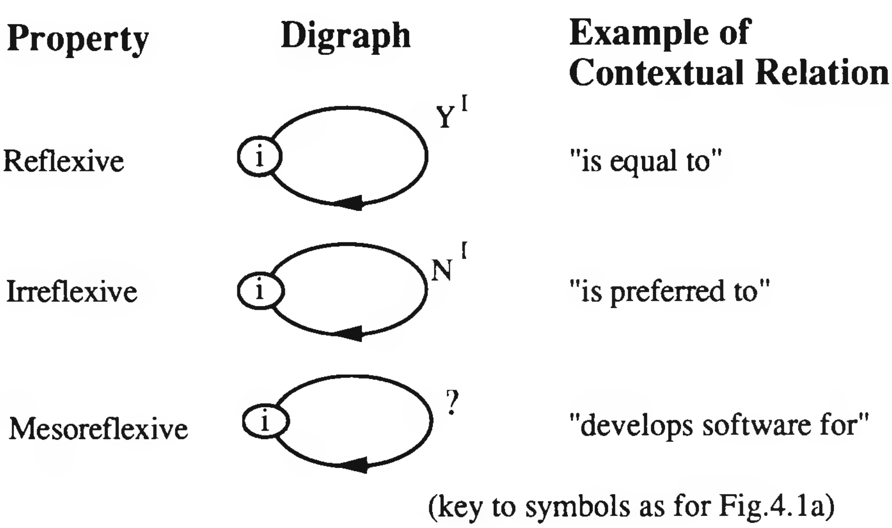


Figure 4.1c Logical inferences for the reflexive group of contextual relations

Reflexive contextual relation

"An element i always relates to itself".

For example: is equal to; can be reached from; is the same area as.

Irreflexive contextual relation

"An element i does not relate to itself"

For example: is preferred to; is situated south of; is older than.

Mesoreflexive contextual relation

"An element i may or may not relate to itself".

For example: develops software for; has confidence in; wastes the resources of.

Any given contextual relation may be classified according to its particular logical property in each of the three groups. Illustrative examples are given in Table 4.4.

4.4.1 Contextual and Binary Relations

Binary relations form the mathematical counterpart of contextual relations. The particular group of binary relations concerned with a binary relation of a set on itself is fundamental to the mathematical basis of ISM.

The distinction between contextual and binary relations can be a source of confusion to users of ISM. Waller's (1980) suggestion that the prefix "meso" (referring to the middle or intermediate case) be adopted to describe certain categories of contextual relations, rather than the prefix "non", which is used to describe certain binary relations, has helped to reduce this confusion. Consider, for example, the transitive group of relations. A transitive contextual relation will always give rise to a transitive binary relation. Similarly an intransitive contextual relation will always result in an intransitive binary relation. However, a mesotransitive contextual relation may result in a non-transitive, a transitive or an intransitive binary relation, depending on the particular situation being considered. For example, "manufactures components for" is a mesotransitive contextual relation which may give rise to an non-transitive, transitive, or intransitive binary relation depending on the specific set of companies being considered, as shown in Figure 4.2. A similar situation applies in case of the symmetric and reflexive groups of

Elements	Contextual Relation	Logical Properties of Contextual Relation
Organisational objectives	would help to achieve	transitive, mesosymmetric, mesoreflexive
Services to be provided	is a higher priority than	transitive, asymmetric, irreflexive
Activities	starts at the same time as	transitive, symmetric, reflexive
Companies	manufactures components for	mesotransitive, mesosymmetric, mesoreflexive
Countries	imports from	mesotransitive, mesosymmetric, irreflexive
Store cashier	serves twice as many people as	intransitive, asymmetric, irreflexive

Table 4.4 Examples of contextual relations and their logical properties

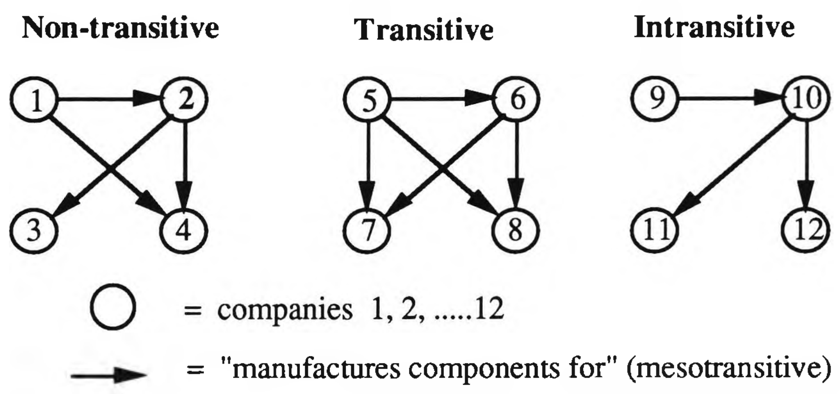


Figure 4.2 Possible binary relations resulting from the use of a mesotransitive contextual relation

relations as shown in Table 4.5. Thus whilst the prefix "non", which is used in the case of binary relations, is quite satisfactory for representing certain specific real-world situations, the prefix "meso" is more appropriate in the case of contextual relations where the abstract logical properties of the relation are being considered without reference to any particular empirical context.

Logical Property of Contextual Relation	**Example of Contextual Relation**	**Resulting Binary Relation**
Transitive	is more important than	transitive
Intransitive	is half the area of	intransitive
Mesotransitive	manufactures components for	non-transitive or transitive or intransitive (depending on particular empirical situation)
Symmetric	is equal to	symmetric
Asymmetric	precedes	asymmetric
Mesosymmetric	imports from	non-symmetric or symmetric or asymmetric (depending on particular empirical situation)
Reflexive	can be reached from	reflexive
Irreflexive	is preferred to	irreflexive
Mesoreflexive	has confidence in	non-reflexive or reflexive or irreflexive (depending on particular empirical situation)

Table 4.5. Contextual relations and resulting binary relations

4.5 CITY UNIVERSITY ISM COMPUTER SOFTWARE

4.5.1 Development of the Software

ISM work at City University during 1983-88 was carried out using ISM software (UNI-ISMS) obtained from the University of Northern Iowa in the USA. This owed its origins to earlier ISM software developed at the Battelle Memorial Institute, Columbus, Ohio. UNI-ISMS provides a powerful and user-friendly program written in Fortran and designed for use on a mainframe or minicomputer. Whilst the software itself works well, there have been various reliability problems with the associated equipment. These include, particularly, the computer being out of action, but also the telephone link being disconnected or failure of one of the interfacing modems. Where an individual user is working alone with a computer program, such problems may be no more than a minor irritation. However, where a group of participants has been brought together specifically for an ISM session at a particular time, the failure of equipment can cause considerable difficulty and frustration. The session may have to be abandoned and rearranged for another date, there is loss of credibility, and a partially constructed model may be wiped from the computer memory. As mentioned in Chapter 3, the installation of the ISM program on a second minicomputer increased the reliability of the system (Figure 3.3). This was further improved with the introduction of a University computer network which linked the decision support room directly to the University minicomputers and eliminated the need for modems and a telephone link.

The need to ensure that the ISM computer program would always be available for use whenever it was needed for work with a group was a driving force in the development of a version for a personal computer. Initially, attempts were made to transfer the UNI-ISMS program to such a machine. However, the memory limitations of the personal computers then available in the Department of Systems Science would not permit this. The initial version of City University's ISM program for a personal computer was written by Mr R.J.Jeffery (1987) whilst a student at the University, under the supervision of the author. This was developed further by Mr Jeffery when he joined the staff of the Interactive Management Unit on graduation. Since 1988, under the name ISM-PC, the software (Jeffery and Janes, 1988a) has been used in place of the Northern Iowa minicomputer version.

4.5.2 Operation of the Software

The software assists in the ISM process (Table 4.1) at steps 5 and 6. It makes the appropriate logical inferences from the answers given, which greatly reduces the total number of questions that the participants have to answer when building a model. It also extracts the information required to construct a digraph, which forms the basis of the ISM, from the resulting matrix.

The set of elements to be structured is normally entered into the computer in text form before the ISM session begins. A maximum of 50 elements may be accommodated in ISM-PC. The facilitator selects the sequence in which the elements are to be examined. As each new element is called up participants are asked to respond to a series of paired comparisons of the elements put by the computer in the following form:

"Is	........(CR)
providing engineering companies with a training consultancy service that identifies training requirements according to a company's business activities	.........(e1)
more important than	........(CR)
providing a business skills training service for engineering companies	........(e2)
over the next 3 to 5 years, given an assumption of maintenance of the existing level of funding?"	........(QP)

Here, e1 and e2 denote the two elements, in this case both services being considered for provision by a national industrial training board. CR denotes the contextual relation "Is more important than" and QP denotes a qualifying phrase. This particular contextual relation is transitive and asymmetric, allowing appropriate logical inferences to be made from answers given as described in Section 4.4.

Each new element selected for inclusion in the model contributes a new row and column to the reachability matrix being constructed by the computer. This is a square, transitive, reflexive, binary matrix (Warfield, 1976:231). It contains information concerning all the possible "walks" amongst the elements in the matrix. Such walks will either have been identified directly by the answers given by the group to the questions posed or they will have been logically inferred. An example of a reachability matrix relating to a set of 12 objectives is shown in Figure 4.3.

Once all the necessary questions put by the computer have been answered, a multi-level digraph may be extracted from the matrix. For simple matrices it is possible to do this intuitively by hand. However, as the number of elements increases this becomes more difficult. Figure 4.4 shows one digraph representation of Figure 4.3. This is clearly not very helpful in clarifying the structure underlying the interrelations. Such a figure has been appropriately termed a "bird's nest" by Waller (1983b).

	1	2	3	4	5	6	7	8	9	10	11	12
1	1	1	1	1	1	1	0	1	0	0	1	1
2	0	1	0	0	1	0	0	1	0	0	0	0
3	0	0	1	0	1	1	0	1	0	0	0	0
4	0	1	0	1	1	0	0	1	0	0	0	1
5	0	0	0	0	1	0	0	0	0	0	0	0
6	0	0	1	0	1	1	0	1	0	0	0	0
7	0	0	1	0	1	1	1	1	0	0	0	0
8	0	0	0	0	1	0	0	1	0	0	0	0
9	0	0	1	0	1	1	1	1	1	0	0	0
10	0	1	0	1	1	0	0	1	0	1	0	1
11	0	1	0	0	1	0	0	1	0	0	1	0
12	0	1	0	1	1	0	0	1	0	0	0	1

Figure 4.3 Reachability matrix

A number of techniques have been described for systematically developing a multi-level digraph from a reachability matrix. For example, Warfield (1973a) describes methods whereby successive hierarchical levels are identified from a system subordination matrix. Such a matrix is asymmetric and the methods do not work when cycles are present as a result of symmetric entries. Warfield (1974a, 1976) and Sage (1977) describe a method, developed by Warfield, based on the use of reachability and antecedent sets. This enables a reachability matrix which is not necessarily a subordination matrix to be analysed, i.e., it may be an asymmetric or a non-symmetric or a symmetric matrix. Unlike the methods based on a subordination matrix, it enables cycles arising from symmetric entries to be dealt with.

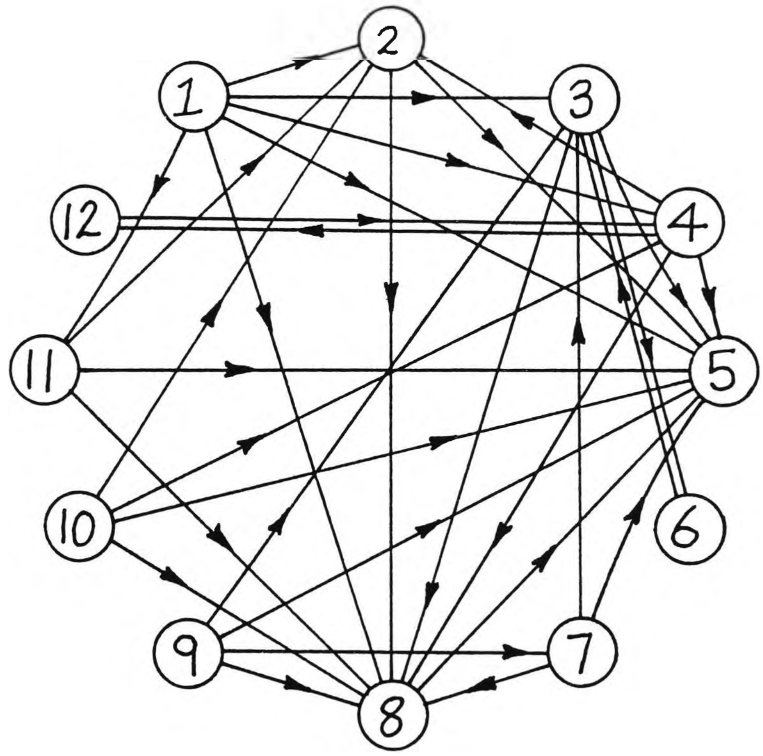


Figure 4.4 "Bird's nest" digraph representation of the reachability matrix in Figure 4.3

ISM-PC analyses a reachability matrix through first identifying any cycles present in the matrix by searching for any symmetric entries. Those relations between the elements within any cycle identified are then deleted but all elements in the cycle and their respective relations with other elements in the matrix are retained. The matrix is then treated as a subordination matrix. Elements at successive hierarchical levels are identified together with the relations between those elements and elements at other levels. This provides information which enables the user to draw a minimum-edge digraph. In this digraph no transitive relations are shown. It may be regarded as a skeleton structure portraying the bare bones of the issue being explored. Figure 4.5 shows such a digraph corresponding to the reachability matrix in Figure 4.3. It is clearly a much easier structure to interpret than the digraph of Figure 4.4.

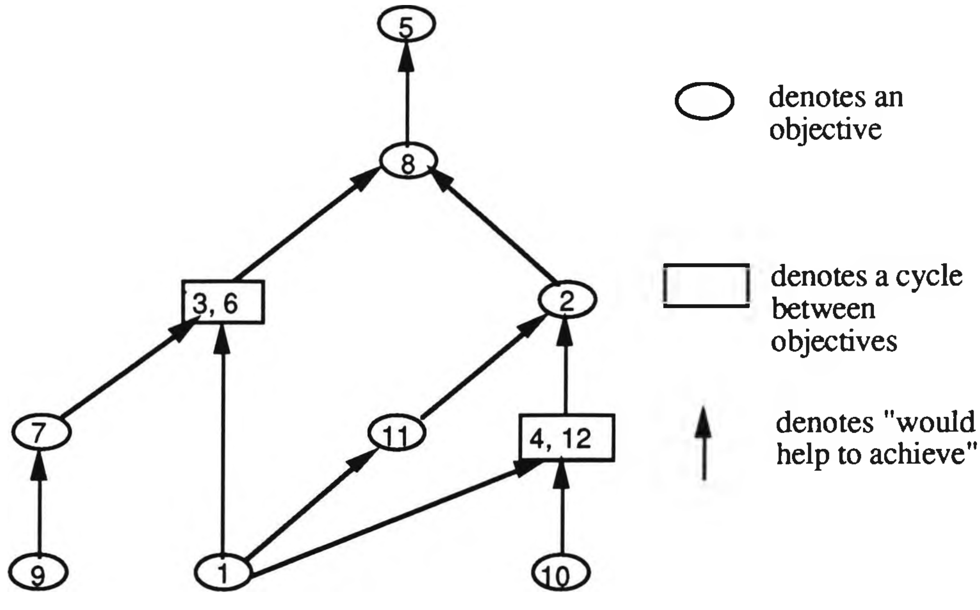


Figure 4.5 Multilevel digraph representation of Figure 4.3

The software has been designed to make the human-computer interface user-friendly and is, accordingly, menu driven. Elements are typed in as text together with the contextual relation and qualifying phrase. The elements may be called up in any sequence by the facilitator for inclusion in the model. Their wording may, if necessary, be edited during the ISM session as may the wording of the contextual relation or qualifying phrase. Elements may be added to, or deleted from, the model as required. The model may be displayed at intermediate stages after completion of questions concerned with any one element. All questions and answers are recorded for reference. The reachability matrix may also be displayed.

4.6 SUMMARY

The principles underlying ISM as a modelling tool have been examined and the process of constructing such a model has been described as a series of steps. The various types of structure resulting from the use of ISM have been clarified. Considerable attention has been paid to the important topic of contextual relations and their logical properties, a clear understanding of which is essential if ISM is to be used appropriately. The development of ISM software for a personal computer at City University has been described and the principles on which the software operates have been outlined. The next chapter examines an idea-generation method for use with groups which may be used to accomplish one of the steps of the ISM process.

Chapter 5

IDEA GENERATION USING NOMINAL GROUP TECHNIQUE

5.1 INTRODUCTION

In Section 3.4 the methods used to put Interactive Management into practice were outlined. The next two chapters discuss the idea-generation methods, Nominal Group Technique (NGT) and Ideawriting. Both provide highly structured processes which have been found to be useful in supporting the application of ISM. For example, NGT may be used to assist a group in generating the elements to be structured in an ISM session, whilst Ideawriting may be used prior to an NGT session to help participants identify relevant issues of concern. This chapter examines Nominal Group Technique. The process underlying the method is explained. Examples of applications are given and an analysis made of data collected. Benefits and limitations of the method are also summarised.

5.2 PROCESS OF NOMINAL GROUP TECHNIQUE

Nominal Group Technique (Delbecq et al, 1975; Gill and Delbecq, 1982) is an idea-generation method for use with groups. It provides a process for generating ideas in groups, for clarifying and editing the generated ideas, and enables participants to make judgements giving an initial ranking of the ideas. The use of the term "nominal group", from the theory of groups, refers to a group "in which the ideas of members working independently are then pooled." (Napier and Gerschenfeld, 1973:208). NGT is a method that works well as a means of accomplishing step 4 of the ISM process (Table 4.1), that of generating the element set. The process of NGT is usefully described and implemented as five steps as shown in Table 5.1.

Careful preparation of the trigger question prior to the session is essential, since the ideas generated during the NGT, and hence the resulting elements used to construct the ISM, are produced in direct response to it. Preferably, it should be tested beforehand to ensure that it is unambiguous and elicits appropriate responses. For example, the question "What are the major goals and objectives of your organisation?" might be regarded as a rather poor trigger question. It does not have a single focus but is compound in that it asks for ideas about goals and objectives at the same time. These are two terms that are open to various interpretations. The word "major" may be too restrictive and inhibit the ideas put forward. The term "organisation" may be ambiguous, e.g., is it meant to include only the subsidiary plant of the company in which the participants work or is it meant to include the whole company? In addition, there is no time scale stated. Does the question refer to existing or future goals and objectives? And if future, how far ahead? More careful preparation could have produced a less ambiguous question. For example, "What should your division of the company be trying to achieve over the next three years?"

1. Clarification of a trigger question.

2. Silent generation of ideas in writing by each participant.

3. Round-robin recording of ideas on a flipchart.

4. Serial discussion of each idea for clarification and editing.

5. Voting to obtain a preliminary ranking of the ideas in terms of importance.

Table 5.1 Steps of Nominal Group Technique

Step 1 gives the participants an opportunity to discuss the trigger question. This helps to ensure that, as far as possible, it is clear and unambiguous and that they all interpret it in the same way. Minor changes to clarify the question may be made by the facilitator at this stage as a result of the discussion. Step 2 is carried out in silence with participants preparing individually their own responses to the trigger question. The facilitator can observe when people are running out of ideas and move on to the next step. In step 3 the facilitator takes one idea from each participant in turn and writes it on a flip chart. As the sheets fill up they are displayed on the wall so that they are visible to all. No discussion of the ideas is allowed at this stage and the facilitator should record the ideas in the words of the participants. The round-robin recording may continue until all ideas are exhausted, or a limited number of rounds may be undertaken if the group is large and there are time constraints.

Step 4 gives the participants an opportunity to discuss each of the ideas in turn in order to clarify them. This is by far the most time consuming step and the facilitator should ensure that the discussion is focussed and that items are dealt with efficiently. A certain amount of editing may be carried out to make the idea statements as clear and unambiguous as possible. One helpful criterion is to consider whether they are clear enough to be understood by someone not present at the NGT session. Finally, in step 5, participants are asked to choose individually from the clarified, edited list, a prescribed number of ideas, e.g., six, which they consider to be most important given the context of the trigger question. They are then each asked to rank their six selected ideas. The rankings are collected anonymously and the scores for each idea are displayed to the group. The facilitator then takes the group through a brief discussion of the resulting rankings.

Prior to the first step it is desirable for the facilitator to give an introduction to the process. This should be used to explain the NGT steps and to remind the participants of the purpose of the session and of how the resulting ideas will be used. In addition, they should be encouraged to contribute as fully as possible, e.g., by reminding them that they all have a unique contribution to make. (Moore, 1987:26).

This description of the NGT steps is modified from that stated in Delbecq et al (1975), which does not include step 1 above but which does include a second and final vote at the end. Since the trigger question is the focus for the generation of ideas, which will themselves become the raw material for the ISM session, the inclusion of step 1 (Christakis, 1982) to clarify the trigger question is an important modification. Also, since the generation of ideas is an intermediate stage in the ISM process, rather than an end in itself, there is no real need to repeat the voting for improved accuracy.

5.3 APPLICATION OF NGT

The use of NGT to generate the element set for subsequent structuring using ISM has been described by a number of authors (Wood and Christakis, 1984; Keever, 1985; Ayiku, 1986; Moore, 1987; Cromer and Broome, 1988). The author has used the method in the context of Interactive Management with many groups of professionals attempting to deal with issues of organisational planning. Table 5.2 summarises these NGT's giving information on the type of organisation and professionals involved, the type of elements generated, and the kind of ISM subsequently constructed. Examples of specific trigger questions used and resulting ideas generated are given in the supporting papers discussed in Chapter 7.

The NGT method has also been used in case studies with groups of professionals on post-experience and postgraduate courses. For the reasons discussed in Section 1.5.2, these are treated separately from the real-world work with organisations referred to above. Case studies involving work such as organisational objective setting and structuring are not listed here as they would duplicate the sort of examples shown in Table 5.2. However, Table 5.3 gives examples of the use of NGT in case studies which illustrate its application in other contexts.

5.3.1 Data on Timing and Ideas

For 11 of the 13 NGT's listed in Table 5.2, a detailed record was kept of the number of ideas generated and the timing of the various stages of the process. Table 5.4 shows this analysis. Care must be taken in reading too much into such quantitative data since there are many influences at work which are difficult to measure. For example, the number of ideas generated will be affected by the knowledge, creativity and breadth of vision of the participants, and by the complexity of the issue being explored; in addition, the duration of step 4 in particular will be affected by the number of ideas generated, by the participants' ability to articulate their thoughts clearly, and by the level of disagreement amongst them. The skill and style of the facilitator in steering the process and focussing the discussion also have an impact on the meeting duration.

In the second column of Table 5.4 the number of ideas originally recorded in step 3 is given. After clarification, elimination of duplication and editing in step 4, the final number of ideas is usually smaller as shown in the third column. For these NGT's the average reduction is 9% from 44 to 40. The range in the total number of ideas, from 28 to 61, is wide as is the range in the clarification time per idea, from 1.8 to 4.5 minutes. Figure 5.1 illustrates the increasing trend of the total duration (D) of an NGT session as the number of participants (P) increases.

Case * No.	Organisation	Participant Group	Elements Generated	Subsequent ISM Structures
1	University Dept. of Systems Science	Academic staff of the department	Objectives for the department	Intent and priority
2	University Accommodation and Conference Service	Administrative and tutorial staff of the service	Objectives for the service	Composite priority
3	University Dept. of Civil Engineering	Academic staff of the department	Objectives for the department	Composite priority
4	University Short Course Unit	Administrative and academic staff of the unit	Objectives for the unit	Intent and priority
5	Proposed University Centre for Enterprise Management	Manager and academic staff of the centre	Objectives for the centre	Intent, composite priority and priority
6	University School of Engineering	Academic staff of the school	Topics to be included in a plan for engineering education	Attribute enhancement
6	University School of Engineering	Academic staff of the school	Issues relating to computers in engineering education	Attribute enhancement

* Case numbers refer to the planning workshops as sequenced in Chapter 7 (see Table 7.1)

Table 5.2 Use of NGT with professional groups in organisations

Case * No.	**Organisation**	**Participant Group**	**Elements Generated**	**Subsequent ISM Structures**
7	National Industrial Training Board: Fellowship Programme Steering Committee	Members of the steering committee	Objectives for the programme	Intent
8	National Industrial Training Board: Training Development Team	Members of the training development team	Objectives for the team	Intent
9	National Industrial Training Board: Regional Managers	Regional managers of the board	Products and services for the board	Composite priority
10	Urban Police Force: Management Support Department	Senior police officers and civilian staff of the dept.	Objectives for the dept.	Intent and priority
14	National Professional Engineering Institution: Technical Activity Committee	Members of the technical activity committee	Objectives for the committee	Intent and priority
15	Defence Ministry: Military Reserve Force	Senior military officers and civilian staff of the ministry	Factors contributing to expansion of a military reserve force	Attribute enhancement

* Case numbers refer to the planning workshops as sequenced in Chapter 7 (see Table 7.1)

Table 5.2 (cont) Use of NGT with professional groups in organisations

Participant Group (no. in group)	**Elements Generated** (no. of elements)	**Subsequent ISM Structures**
Senior police officers (8)	Steps to take prior to implementing a Policing-by-Objectives scheme in a police force (35)	Process
Senior police officers (8)	Objectives of implementing a Neighbourhood Policing scheme in a police force (33)	Intent
Engineering managers in the construction industry (5)	Levels of service to be provided to customers by a metropolitan water authority (40)	Attribute enhancement
Engineering managers in the highways and transport industry (7)	Major impacts of the Eurotunnel on the UK (36)	Attribute enhancement
Speech therapists and clinical psychologists (7)	Factors contributing to the effective functioning of multidisciplinary teams in the care of the elderly (44)	Attribute enhancement
Police officers (5)	Ways of overcoming the barriers to effective communication in a police force (26)	None
Defence systems engineers (5)	Ways of overcoming the barriers to effective communication in a company (28)	None
Senior military supply officers (6)	Problems of measuring performance in a corporate plan (27)	None

Table 5.3 Examples of use of NGT with professionals on postgraduate and post-experience courses

Organisation and Case No.	Number of participants	Original number of ideas recorded (a)	Final number of ideas	Introduction and 1. Clarification of question	2. Silent generation of ideas	3. Recording of ideas	4. Clarification of ideas (b)	5. Voting	Total duration	Clarification time/idea (b/a)
	Number			Minutes					h min	min
1.University Dept. of Systems Science	9	55	52	10	10	40	165	35	4 00	3.0
2.University Accommodation and Conference Service	8	44	39	10	10	40	125	25	3 30	2.8
3.University Dept. of Civil Engineering	5	28	28	10	10	20	125	20	3 05	4.5
4.University Short Course Unit	6	37	32	8	12	25	150	30	3 45	4.1
5.Proposed University Centre for Enterprise Management	4	50	41	10	10	25	105	30	3 00	2.1
7.Industrial Training Board: Fellowship Steering Committee	8	39	31	15	10	25	120	45	3 35	3.9
8.Industrial Training Board: Training Development Team	9	45	41	7	10	45	130	40	3 52	2.9
9.Industrial Training Board: Regional Managers	8	38	37	20	10	25	135	35	3 45	3.6
10.Urban Police Force: Management Support Department	12	68	61	4	11	45	190	35	4 45	2.8
14.Professional Inst.: Technical Activity Committee	4	44	44	5	10	35	80	30	2 40	1.8
15.Defence Ministry: Military Reserve Force	7	37	36	10	10	20	120	30	3 10	3.2
Average	7 (7.3)	44	40	10	10	31	131	32	3 33	3.0

Table 5.4 Data on number of ideas and timing of NGT steps

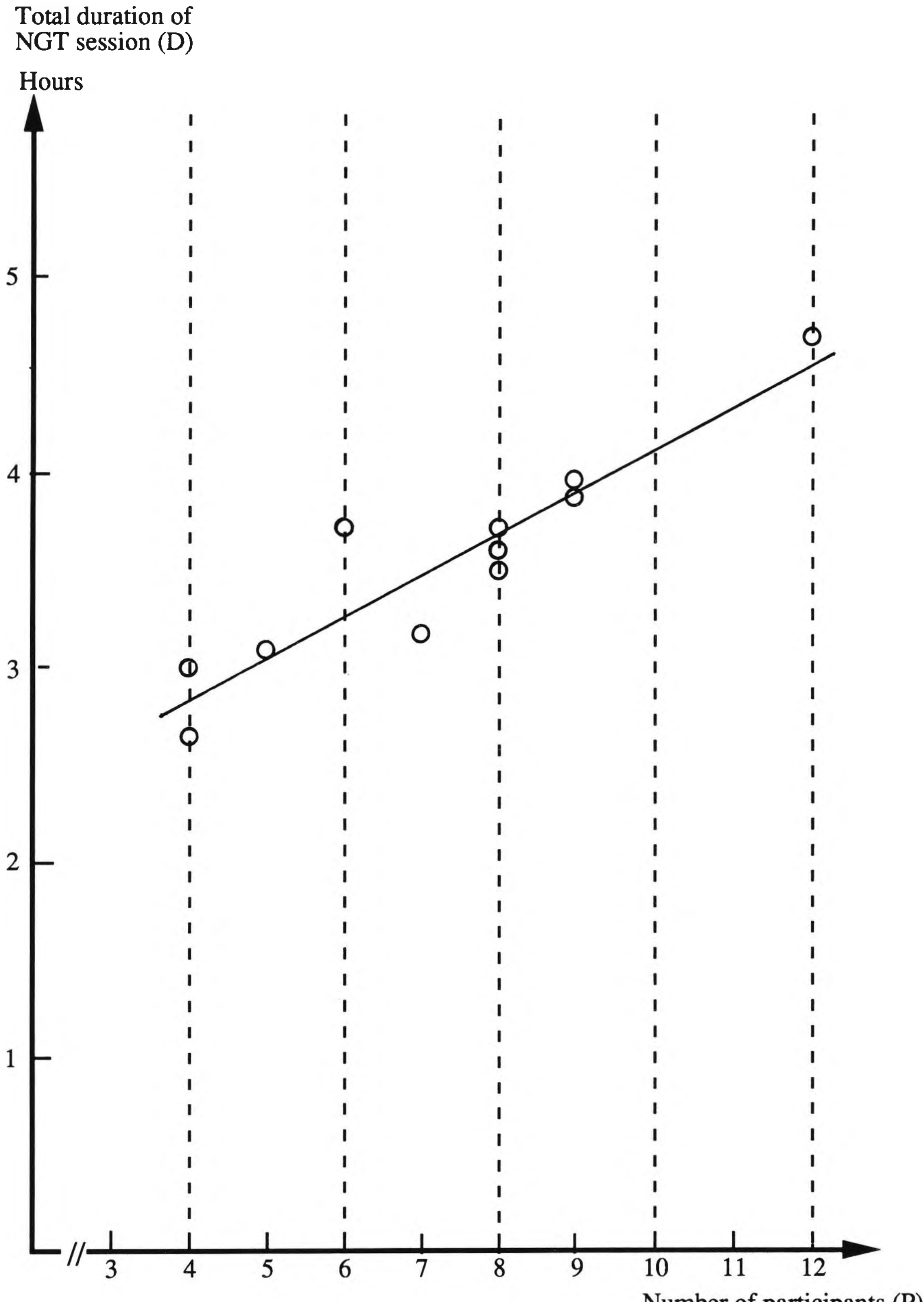


Figure 5.1 Relation between number of participants and the duration of NGT sessions

The linear regression equation :

$$D(min) = 118 + 13.1P$$

was calculated from the data and used to draw the line in Figure 5.1. The correlation coefficient between the two variables is 0.92 and the standard error of estimate 14 minutes. However, given the small sample size, and the factors mentioned other than the number of participants which may influence the meeting duration, care should be taken in treating this as anything other than a rough guide.

Based on the data, Table 5.5 gives typical timings for a group of seven to eight participants. Clearly, it would appear that when NGT is used in contexts similar to those described here, e.g., professional people engaged in planning activities such as objective setting for an organisation, a duration of the order of 3.5 hours for a group of this size should be anticipated and planned for. The data would certainly seem to contradict the statement by Moore (1987:25) that:

"With an average-sized group [five to nine members], the entire [NGT] process can be comfortably completed in 90 minutes..... In no case should the [NGT] session be permitted to last over three hours."

NGT Step	**Range** (min)	**Typical Time** (min)
1. Introduction to method) Clarification of trigger question)	5 - 20	10
2. Silent generation of ideas	10 - 12	10
3. Round-robin recording	20 - 45	30
4. Serial discussion of ideas	80 -190	130
5. Voting	20 - 45	30
	TOTAL	3h 30 min

Table 5.5 NGT: typical timing

5.3.2 Illustration of Idea Clarification

The supporting papers contain a number of examples of NGT products giving a complete list of the clarified, edited ideas reached at the end of step 4. In order to demonstrate the importance of this step, typical examples are given below illustrating the way in which ideas recorded in step 3 may be rephrased after discussion in step 4. The selection of ideas is taken from a planning workshop where the regional managers of a national industrial training board were identifying the products and services they thought the board should be delivering for the engineering industry in the UK over the next 3 - 5 years (supporting paper I, Janes, 1987b). The number preceding each idea refers simply to the sequence in which the particular idea was recorded.

(i) Ideas after recording in step 3

1. To provide to companies a training consultancy service that relates training requirements to a company's business activities.

3. To influence national developments in education and training in the best way for the Industry.

4. Establish standards of training and codes of best training practices.

6. Develop training materials <u>with</u> the industry where these have a wide applicability.

13. Ensure an adequate supply of suitably qualified people to meet the needs of companies.

(ii) After discussion for clarification and editing in step 4

1. Provide companies with a training consultancy service that identifies training requirements according to a company's business activities. (Income generator).

3. Influence national developments in education and training to the advantage of the Industry (e.g., National Council for Vocational Qualifications; Technical Vocational Initiative,...).

4. Establish standards of training.

36. Establish codes of best training practices.

6. Develop training materials with the Industry on a demand led basis. (Income generator).

13. Take measures to influence the supply of suitably qualified young people to meet the needs of companies (e.g., careers activities, teacher retraining,....).

The changes may be summarised as follows:

Idea 1: activity of consultancy service made more specific and identified as a potential income generator.

Idea 3: examples given and clearer phrasing.

Idea 4: split into two (4 and 36).

Idea 6: focus on the demand in the market and identified as a potential income generator.

Idea 13: more specific, more realistic, and examples given.

5.3.3 Voting

In Section 5.2 the voting procedure used in step 5 of the NGT method was explained. Warfield (1990:492-494) proposes the interesting concept of using the resulting NGT voting data to measure the diversity of opinion among participants with regard to the relative importance of the ideas generated. The measure proposed for "Diversity" is $(N_2/5) - 1$, where N_2 refers to the number of ideas that receive at least one vote from any participant with each participant selecting five ideas from the total list. The -1 term in the expression ensures that if all participants vote for the same five ideas, then $N_2 = 5$ and the Diversity measure is equal to zero.

It is suggested here that this concept of diversity could be extended to take into account the number of participants, the total number of ideas generated, and the number of votes per participant. The new measure tentatively proposed is termed "Relative Diversity" to distinguish it from the term Diversity referred to above. Consider, for example, the expression:

$$RD = \frac{1000((N_2/V) - 1)}{PN_1}$$

where:

RD is the measure of Relative Diversity,

N_2 is, as before, the number of ideas receiving at least one vote, i.e., the total number of ideas selected,

V is the number of ideas that each voter is allowed to select, i.e., the number of votes per participant,

P is the number of participants,

N_1 is the total number of ideas generated from which the selection is made.

Thus, for example, for a particular value of N_2, the RD measure would indicate a lower level of diversity of opinion among participants if either V or P or N_1 or any combination of them was relatively large. Table 5.6 shows the calculation of RD for the 11 NGT cases in Table 5.4.

On this basis, the case showing the lowest level of Relative Diversity is No.10. Although the N_2 figure of 39 is the joint largest in this case, the relative values for number of votes per participant, number of participants and number of ideas generated are also all large, thus reducing the RD measure. Correspondingly, in case No.5, the N_2 figure of 25 is much lower. However, as there were only four participants with seven votes each, a maximum of only 28 ideas could have been selected. The resulting RD value, which takes this into account, is in fact the largest in the table, indicating the greatest level of relative diversity of opinion amongst the voters for the cases cited.

Case No.	No. of participants P	Total No. of ideas generated N_1	No. of ideas selected N_2	No. of votes per participant V	Relative Diversity RD
1	9	52	39	9	7.1
2	8	39	26	6	10.7
3	5	28	15	7	8.2
4	6	32	25	8	11.1
5	4	41	25	7	15.7
7	8	31	25	7	10.4
8	9	41	28	7	8.1
9	8	37	23	8	6.3
10	12	61	39	8	5.3
14	4	44	18	7	8.9
15	7	36	21	7	7.9
Average	7	40	26	7	9.7

Table 5.6 Relative diversity of opinion based on NGT voting.

5.4 BENEFITS AND LIMITATIONS

Various writers (Delp et al, 1977:14-18; Olsen 1982:421) have discussed benefits and limitations of NGT. Warfield (1976:68) lists reasons why Ideawriting (Brainwriting) is effective, many of which apply equally well to NGT. Based on the applications cited in this chapter, and drawing in part upon the above writings, the author's own observations lend support to the following benefits of NGT. (1) The potential to generate a large number of clarified, edited ideas. (2) A written record of all ideas is obtained. (3) Encouragement of contributions from all those who might otherwise be reticent. (4) Reduction of dominance by aggressive, high ranking or articulate members of the group. (5) Increased stakeholder input to the process. (6) Silent generation of ideas minimises the interruption of concentration. (7) A subtle pressure on people to contribute. (8) Clarification through structured discussion helps to eliminate misunderstanding. (9) The group remains focussed on the issue or problem without rambling discourse. (10) Premature criticism and evaluation of ideas is avoided, conflicting ideas being tolerated and debated. (11) Learning is promoted through discussion of different perceptions of ideas. (12) Focussing on a subset of solutions is avoided. (13) A preliminary ranking of ideas is obtained. (14) The resultant product is owned by the group as a whole. (15) For part of the time participants work in parallel rather than in sequence.

A number of limitations of NGT should also be noted. (1) It is a single theme, highly focussed process. (2) The group has to be brought together which may be difficult and/or expensive. (3) A trained facilitator is needed. (4) It is time consuming. (5) Resources are required, e.g., suitable room, tables and chairs, flip chart, wall space, paper and pens. (6) The number of people who can participate in a single NGT session is restricted; Delbecq et al (1975:69-70) and Moore (1987:25) suggest that ideally the group should contain between five and nine members. Care is thus needed when deciding to embark on the use of NGT to ensure that it is an appropriate tool and worthwhile for the issue being considered.

5.5 SUMMARY

The process of Nominal Group Technique as an idea-generation method for use with groups has been described as a series of steps. Applications of the method with a variety of professional groups in a UK context have been summarised. These support the use of NGT as a powerful means of generating the element set for subsequent ISM work. Data on these applications with regard to the timing of sessions and number of ideas generated have been recorded and analysed. The way in which ideas are clarified during the NGT process has been illustrated. Based on an analysis of the NGT voting scores an alternative measure has been proposed for the relative diversity of opinion amongst participants. The benefits and limitations of the method have been summarised. The next chapter examines Ideawriting, a related idea-generation method.

Chapter 6

IDEA GENERATION USING IDEAWRITING

6.1 INTRODUCTION

In this chapter a second idea-generation method, Ideawriting (also known as Brainwriting), is examined. The method has proved useful in encouraging participants to think about the wider issues concerning their organisation prior to the generation of the elements which will form the basis of an ISM session. The process underlying the method is explained and examples of applications are given. The way in which Ideawriting and the concepts of Interactive Management have been used to assist in the development of computer models and software for the Health Service is also discussed. The benefits and limitations of the method are compared with those of NGT.

6.2 PROCESS OF IDEAWRITING

Ideawriting (Warfield, 1976:66-68, 1982a) is a quick and efficient idea-generation method for use by groups which stresses written communication. It has a number of variants including: Brainwriting Pool (Geschka et al, 1973), Method 635 (Warfield et al, 1975) and Recorded Round-Robin (Rickards, 1974). The basic components of Ideawriting involve asking participants to generate ideas individually in writing in response to a trigger question. Lists of ideas are then exchanged and the generation of ideas continued. This process proceeds until all participants have seen, and had an opportunity to contribute to, all the lists of ideas. The lists are then edited and organised.

The author has found it helpful to present the method to the participants as a series of steps, and to extend it to include a clear process for the categorisation, editing and presentation of the resulting ideas. The steps are as shown in Table 6.1. Prior to the session an introduction to Ideawriting should be given covering the same points as the introduction to NGT (Section 5.2). The first step then proceeds as for NGT with participants being given the opportunity to clarify any aspects they wish of a carefully prepared trigger question.

1. Clarify the trigger question.

2. Silently generate ideas in writing.

3. Exchange lists of ideas and continue idea generation.
(Repeat step 3 systematically until each sheet has been seen by each participant.)

creative activity

----

analytical activity

4. Identify headings to categorise the ideas.

5. Categorise and edit the ideas.

6. Prepare a short presentation.

7. Present a summary of the ideas.

Table 6.1 Steps of Ideawriting

Steps 2 and 3 are carried out in silence. After each participant has written down three or four ideas in response to the question, the facilitator asks each member to pass his sheet to his neighbour. The process of idea generation and rotation of sheets amongst participants continues at intervals until each sheet is returned to its originator. In this way participants are stimulated repeatedly with the ideas of others. The period between each exchange is controlled by the facilitator and does not usually exceed five minutes. Step 3 concludes the essential creative activity, as indicated by the dotted line in Table 6.1, the remaining steps being more analytical in nature.

In step 4 participants are asked to think about the ideas produced and to identify and agree a list of headings to categorise the ideas. It is helpful in step 5 to follow a procedure so that the participants can make efficient use of their time. A procedure that works well is as follows:

5a. Denote the categories identified in step 4 by a letter, e.g., Finance (F), Manpower (M) ....

5b. Label the ideas on each list, e.g., F, M......

5c. Re-list the ideas under the relevant headings.

Thus each participant can take one (or more) of the category labels, e.g., F, and go down each list in turn, labelling the appropriate ideas. Alternatively, each participant can take one of the lists and categorise all the ideas on that list using the complete set of labels. The ideas can then be re-listed on clean sheets of paper under their identified categories. A certain amount of editing and elimination of any duplicated ideas can be done during step 5c. Steps 6 and 7 usually only apply when several Ideawriting groups have been working in parallel and it is desirable for them to present their ideas to one another.

6.3 APPLICATION OF IDEAWRITING

Table 6.2 gives examples of ten different settings where the method has been used with professional groups and where a detailed record of data was kept on both the ideas generated and the timing of the sessions. Supporting papers C and D, relating to cases 2 and 3 respectively, give examples of complete Ideawriting products. (The designation of case numbers in the table has been made so as to be consistent with the case numbers 1 to 15 used elsewhere in this thesis. Thus references to cases 2, 3, 5 and 14 appear in other chapters, whereas cases 16 to 21 are referred to in this chapter only.)

The first four cases relate to work previously referred to in Table 5.2. In these Ideawriting was used in conjunction with NGT and ISM. In cases 2, 3 and 5 the method was used to help the participants in thinking about issues of concern prior to using NGT to generate the elements for an ISM session. In case 14 the method was used to examine the activities necessary to implement intent and priority structures subsequent to the use of NGT and ISM. In case 16 Ideawriting was used prior to an NGT session and in cases 17 and 18 the method was used on its own. The last three cases relate to the use of Ideawriting as an aid to computer model building and are discussed in Section 6.4.

6.3.1 Data on Timing and Ideas

Table 6.3 gives data on the number of ideas generated and the timing of the various Ideawriting steps for the 10 cases listed in Table 6.2. In cases Nos. 2, 3, 18, and 20, where the number of participants exceeded six, multiple groups were run in parallel. In case No.21 two groups were run on the same topic on different occasions.

Case No.	Organisation	Participant Group	Ideas Generated	Use
2*	University Accommodation and Conference Service	Administrative and tutorial staff of the service	Issues facing the service	Focussing thinking prior to use of NGT and ISM
3*	University Dept. of Civil Engineering	Academic staff of the department	Issues facing the department	Focussing thinking prior to use of NGT and ISM
5*	Proposed University Centre for Enterprise Management	Managers and academic staff of the centre	Requisite activities to achieve a viable centre	Focussing thinking prior to use of NGT and ISM
14*	National Professional Engineering Inst.: Technical Activity Committee	Members of the technical activity committee	Activities to implement intent and priority structures	Actions to be taken subsequent to use of NGT and ISM
16	Systems Engineering Division of a Defence Manufacturing Company	Defence systems engineers	Barriers to communication in an organisation	Focussing thinking prior to use of NGT
17	National Industrial Training Board: Training Development Team	Managers of, and Fellows on, a one-year professional course	Ways of securing more company-sponsored delegates for the course	Assisting managers in marketing the course
18	National Health Service	Managers of scientific departments	Indicators to measure effectiveness of NHS managers	Identifying performance measures to improve resource management
19	Department of Health: Health Building Directorate	Hospital architects and nursing advisers	Factors influencing the operation of hospital linen services	Identifying factors prior to building a computer model of operating costs
20	Department of Health: Health Building Directorate	Hospital architects, catering managers and advisers	Factors influencing the operation of hospital catering services	Identifying factors prior to building a computer model of operating costs
21	Department of Health: Health Building Directorate	Hospital architects, pathology medical and scientific staff, managers	Factors to be included in a cost model of a pathology department	Identifying factors prior to building a computer model of operating costs

* Case numbers refer to the planning workshops as sequenced in Chapter 7 (see Table 7.1)

Table 6.2 Examples of use of Ideawriting with professional groups

	Number of participants	Original number of ideas listed	Final number of ideas	Number of categories of ideas	Introduction and 1. Clarification of question	2. Silent generation of ideas / 3. Exchange lists and continue	4. Identify category headings / 5. Categorise ideas	6. Prepare presentation / 7. Present summary	Duration: steps 1 - 5
Case No.	Number				Minutes				h min
2a	4	54	54	10	6	24	40	30	1 10
b	3	46	41	8	"	"	"	"	"
3a	6	69	54	9	7	23	35	35	1 5
b	5	49	46	6	"	"	"	"	"
c	3	32	27	7	"	"	"	"	"
5	4	84	84	8	10	20	45	Not Applicable	1 15
14	5	47	34	5	5	20	55	NA	1 20
16	5	83	64	9	10	25	45	NA	1 20
17	6	82	66	16	5	33	45	30	1 23
18a	4	75	38	5	8	22	40	NA	1 10
b	4	44	25	5	"	"	"	"	"
19	4	56	42	7	10	33	45	NA	1 28
20a	4	70	63	10	5	25	55	NA	1 25
b	3	78	74	10	"	"	"	"	"
21a	5	116	105	8	10	28	60	NA	1 38
b	6	146	95	8	8	30	57	"	1 35
Average	4 (4.4)	71	57	8	8	26	47	32	1 21

Table 6.3 Data on number of ideas and timing of Ideawriting steps

The second column gives the total number of ideas originally listed by all the participants at the end of step 3 of the process. After categorising and editing in step 5, the final number of ideas is usually smaller as shown in the third column, the average reduction here being 20% from 71 to 57. The next column lists the number of categories into which the ideas were grouped. The remaining columns give data on the timing of the various stages of the process.

	Ideawriting Step	Range (minutes)	Typical Time (minutes)
	Introduction to method)		
1	Clarify trigger question)	5 - 10	8
2	Silently generate ideas)	20 - 33	26
3	Exchange lists and continue idea generation)		
4	Identify category headings)	35 - 60	47
5	Categorise and edit ideas)		
6	Prepare short presentation)	30 - 35	32
7	Present summary)		
	Totals:	Steps 1 - 3	0h 34min
		Steps 1 - 5	1h 21min
		Steps 1 - 7	1h 53min

Table 6.4 Ideawriting: typical timing

Based on these data, Table 6.4 gives typical timings for a group of four to five participants. For the complete process a period of just under two hours should be allowed. If no presentations are required 1h 20min should enable steps 1 - 5 to be accomplished. When time is very restricted, the core idea-generation steps 1 - 3 can be completed in around 35 minutes.

6.3.2 Illustration of Idea Categorisation and Editing

This subsection gives an example of the way in which the intermediate steps 4 and 5, for categorising and editing the ideas generated in steps 2 and 3, are accomplished.

The example is taken from case No. 3 (see supporting paper D) in Table 6.2, where issues facing the Department of Civil Engineering in a university were explored before generating and prioritising objectives for the department using NGT and ISM. The 14 participants were split into three groups based on subject divisions in the department and three Ideawriting sessions were run in parallel. The following products relate to the work of one group of six participants responding to the trigger question "What are the issues facing your Department/Division/Research Centre over the next five years?".

(i) Ideas at the end of step 3

The ideas written on one of the six sheets resulting at the end of step 3 are reproduced verbatim below. A total of 69 ideas had been generated at this stage by this group. (The symbols R, S, I, etc., are explained overleaf.)

1. Increasing research performance of the department as a whole ....(R)
2. Increasing student intake in the department ....(S)
3. Creating a more cooperative environment in the department ....(I)
4. Improving the staffing in the "structures" area ....(D)
5. Increasing demands on staff time: continuing reduction in any significant periods of time to work on new ideas in relation to teaching and research ....(A)
6. Increasing interchange of staff with other institutions ....(X)
7. Increasing the amount of consultation and consensus in activities ....(I)
8. Improve the perception of the school of engineering which may have far reaching effects on the department ....(I)
9. Research funding seems to be almost a full time job ....(R)
10. Create special unit for advanced technology in artificial intelligence and robotics in construction industry ....(R)

ii) Headings to categorise the ideas at the end of step 4

After discussion the group identified nine category headings for the 69 ideas and denoted each by a letter as indicated below.

S - Student recruitment	D - Staff development
I - Staff identity	E - European dimension
R - Research	X - External interaction
A - Administration	F - Finance and funding
C - Course development	

(iii) Categorised ideas at the end of step 5

The appropriate letters were then allocated to each of the 69 items as illustrated in (i) above and new lists were drawn up under each of the nine headings. After this process of categorisation, elimination of duplication and editing, 54 ideas remained. The list below shows the 11 issues finally listed under one of those headings, "Research".

<u>Research</u>

- Research time curtailed.
- Technical support to laboratories.
- Recruitment of good quality research staff.
- Increasing research performance.
- Falling research funding.
- Development of special units for new advanced technology.
- Research/teaching balance.
- Research interests.
- Organisation [of research].
- Policy development [for research].
- University support [for research].

As case 3 in Table 6.3 shows, in slightly over one hour the three Ideawriting groups had generated, edited and categorised a total of 127 ideas. This gives an indication of the effectiveness of Ideawriting as an idea-generation method for use with groups.

6.4 BUILDING COMPUTER MODELS

Cases 19, 20 and 21 in Table 6.2 relate to research contracts concerned with computer modelling for the Health Building Directorate of the Department of Health.

The author was principal investigator and project manager for the contracts, which were undertaken by a City University team working on a part-time basis. It is not the intention to go into any detail with regard to the model equations and resulting software, which are peripheral to this thesis and were, in any case, under the direction of the author's colleague P.C.Roberts, Visiting Professor in the Department of Systems Science. However, the application of Ideawriting and the use of the concepts of Interactive Management as an integral part of the modelling process have played a significant part in the success of the project. It is this contribution to the work by the author which is focussed upon here.

The work involved the development of computer models and resulting software which would enable hospital planners and managers to determine the operating costs of particular hospital services: the operating cost implications of alternative operational policies and alternative designs could thus be assessed before the particular policy or design was implemented. This has become increasingly important with the realisation that the operating cost of a modern hospital over three years exceeds the cost of building the hospital (Moss, 1985). The life-time operating cost thus dwarfs the building cost by an order of magnitude. To date, models and software for both linen and catering services have been completed and are in use in the National Health Service.

6.4.1 Model Building Process

For each model the project team comprised two groups: a modelling group consisting of the City University team, and a consultative group appointed by the Department of Health. The modelling group members were responsible for designing the model building and software development process (Table 6.5). They also defined the mathematical equations that showed the cost implications of the design parameters in the operational process, i.e., linen or catering. Based on these equations they produced a computer model and software. The consultative group members were drawn from the Health Building Directorate of the Department of Health (DoH) and from the National Health Service (NHS), and were all expert in some aspect of the particular system being modelled. They worked with the modelling group in providing specialised knowledge of the processes involved, in analysing these processes, and in reviewing the models produced.

1 **Initiation**

- Assemble project team:
  - modelling group (City University)
  - consultative group (DoH/NHS)
- Establish scope of model ....CG

2 **Knowledge Acquisition**

- Identify relevant design and operational factors (Ideawriting) ....CG
- Construct diagrammatic models (signed digraphs) ....CG

3 **Dynamic Simulation Model**

- Construct simulation model (system dynamics)
- Review simulation model interactively ....CG

4 **Cost Model**

- Draw up mathematical equations
- Represent equations in spreadsheet format
- Review cost model interactively ....CG

5 **Validation**

- Collect cost and operational data ....CG(I)
- Check cost model estimates
- Adjust cost model parameters
- Review cost model interactively ....CG

Table 6.5 Model and software development process (Linen)
(continued overleaf)

6 Documentation

- Write user guide to software
- Design questionnaire for user trials
- Prepare draft project report

7 User Trials

- Test software and guide on users
- Obtain feedback from users
- Modify software and user guide
- Review cost model, trial results, and draft report ....CG

8 Deliverables

- Prepare and deliver final versions of:
  - software
  - user guide
  - project report

9 Support

- Supply users with software
- Advise users on software
- Update software

Key CG: consultative group meeting
CG(I): consultative group - individual activity

Table 6.5 (cont.) Model and software development process (Linen)

Following a feasibility study (Roberts and Janes, 1987; Roberts, Moss and Janes, 1988), it was agreed that the first model should be concerned with hospital linen services. Criteria involved in the selection of linen services as a topic were: that they were financially significant; that data were available; that the resulting software would be immediately useful; and that they were a building-related topic. A consultative group was appointed by the Department of Health involving people with expert knowledge of the various aspects of the linen service function, e.g., architecture, management, nursing, and engineering. At intervals throughout the project, which took approximately nine months, the consultative group met in the decision support room at City University to contribute to the model building process.

Initially, Ideawriting was used with the group to identify the design and operational factors that influence the linen service function. Signed digraphs (Roberts et al, 1983) were constructed with the group, under the guidance of a facilitator, for each category of factors identified, e.g., distribution, storage, manpower, etc. A dynamic model was then built, using the STELLA system dynamics software for the Apple Macintosh computer, in order to provide a visual simulation of the linen function. This enabled the group to check assumptions about the stocks and flows of linen in a hospital. A cost model was then constructed and represented in spreadsheet format. After validation and user trials the resultant software was introduced to managers in the Health Service through a national seminar. The participation of the consultative group throughout the project ensured: that the resultant model incorporated the factors and relationships which the group felt were necessary; that the model behaved in a realistic way; and that the model and software were in suitable form for use within the Health Service. The work is described in more detail in supporting papers P and Q (Roberts and Janes, 1989; Roberts, Janes and Pope, 1988).

The development of the catering services model and associated software followed a process very similar to that shown in Table 6.5 with one relatively minor difference. A sequential processing diagram was constructed in place of a system dynamics model, as the former was considered more appropriate for the activities involved in the catering function. The catering services model is described in Roberts, Janes et al (1990).

6.4.2 Roles of Interactive Management and Ideawriting

In this subsection the role of Interactive Management and Ideawriting in the linen model building process will be further clarified.

Chapter 2 discussed Ackoff's participative, continuity and holistic principles which have a direct bearing on Interactive Management. A key theme underpinning the model building process was, through the consultative group, to involve the client organisation in the process, so that the eventual model would incorporate the features that the client wanted, and so that the software would be in an acceptable form. This theme relates to the participative principle. The consultative group was involved directly at various stages of the process: for example, in establishing the model scope, in knowledge acquisition, in model construction, in data collection, and in regular reviews of the model and software. This aspect relates to the continuity principle. The selection of individuals for the consultative group was made so as to ensure that those included covered the range of specialist knowledge of the linen service function needed to build the model; potential users of the software were also involved. This aspect relates to the holistic principle.

Chapter 3 discussed the five components for productive group work which enable Interactive Management to be put into practice: participant group, facilitator, methods, computer support and decision support room. These were consciously designed into the model building process and played an important part throughout the project. The consultative group members were under the guidance of a facilitator during their various meetings in the decision support room, with the process for each meeting being planned carefully in advance. The method of Ideawriting played an important role in identifying at the outset the relevant factors that influence hospital linen services. It also enabled the consultative group to contribute quickly and effectively to the model building and helped in team building. Other formal methods, not listed as consensus methods (Section 3.4), were used in a participative mode, i.e., signed digraphs and system dynamics. Computer support was provided extensively in various ways at the group meetings, for visual display of both the spreadsheet and system dynamics models, production of diagrams and word processing. The decision support room provided an environment and display facilities which enabled the group to work efficiently during the meetings.

6.5 COMPARISON OF IDEAWRITING WITH NGT

The benefits of NGT were discussed in Section 5.4 Although the majority of these benefits also apply to Ideawriting, differences should be noted. Whilst Ideawriting does generate a large number of ideas, it does not provide a process for clarifying the ideas through structured discussion (see NGT benefit No.8). Conflicting ideas are thus tolerated but not debated (benefit No.10), and discussion of different perceptions does not occur (No.11). Also, there is no step for obtaining a ranking of the ideas (No.13). These points illustrate some of the advantages of NGT over Ideawriting.

Section 5.4 also summarised the main limitations of NGT. The first three of these apply to Ideawriting. However, Ideawriting is less time consuming (see NGT limitation No.4), and has the advantage that it may be applied in various ways depending upon the time available. For example, with reference to Table 6.4, it may be used just for generating ideas (steps 1 - 3), or for generating, categorising and editing ideas (steps 1 - 5), or for generating, categorising, editing and presenting ideas (steps 1 - 7). Ideawriting requires fewer resources than NGT (limitation No.5): a room with tables and chairs, together with paper and pens, is needed but flip charts and wall space are unnecessary. Ideawriting is also far less restricted with regard to the number participating (limitation No.6). Whilst an Ideawriting group should not contain more than six members (Warfield, 1976:66; House, 1982), several groups may work simultaneously under the guidance of one facilitator in one room. With NGT, a different facilitator is required for each group, and it is difficult for more than one group to work in a single room owing to noise interference during the lengthy clarification step.

Thus it may be seen that each method has certain advantages over the other. Deciding on which method to use will depend upon the particular circumstances. For example, if clarification and ranking of ideas are required, NGT may be appropriate. However, if these are not needed, or a large number of people are to participate with limited resources or time, Ideawriting may be more appropriate.

6.6 SUMMARY

Ideawriting has been presented as a method which may be used for idea generation with groups and, if required, for categorisation, editing and presenting the resulting ideas. The process has been described as a set of steps, and a clear procedure put forward for the activities of idea categorisation and editing. An illustration of the use of this latter procedure has been given. The way in which Ideawriting has been applied in a variety of contexts has been summarised. Data from applications have been recorded and analysed regarding the number of ideas generated and the timing of the steps of the process. The incorporation of Ideawriting and the broader concepts of Interactive Management into a process of computer modelling and software development for the Health Service has been explained. Finally, a comparison has been made between the benefits and limitations of Ideawriting and those of NGT. Chapter 7 examines applications of ISM, a number of which have been supported by the use of Ideawriting.

Chapter 7

APPLICATIONS OF INTERPRETIVE STRUCTURAL MODELLING

7.1 INTRODUCTION

Whilst Chapter 4 examined the principles underpinning ISM, this chapter gives an overview of the applications of ISM which were listed chronologically in Section 1.5.1 and which are discussed more fully in the supporting papers (denoted by s.p.). In most of the cases considered, the idea-generation methods discussed in Chapters 5 and 6 were used to support the ISM work undertaken. All the applications referred to were carried out as Interactive Management planning workshops. The participants were professional groups dealing with real organisational issues as distinct from students working on case studies.

7.2 INTRODUCTION TO PLANNING WORKSHOPS

The fifteen workshops were undertaken as and when the opportunities to do them arose, usually following requests from clients. The particular combination of methods used and the type of ISM structures developed in each case were thus to a considerable degree related to the needs of the clients and the organisational issues involved. Consequently, the sequencing of the various cases in this chapter could have taken a variety of forms, for example, according to chronological sequence, or particular methods used, or type of organisation. To give the work coherence the cases have, in fact, been grouped largely according to type of organisation.

Cases 1 to 6 describe applications within university academic and administrative departments. Cases 7 to 9 relate to workshops undertaken for a national industrial training board involved in the engineering industry. Cases 10 to 13 concern workshops carried out for a variety of public sector organisations, including a police force, a county council and district health authorities, whilst cases 14 and 15 relate to work with a professional institution and a defence ministry respectively.

In each case the background to the workshop, the activities undertaken and the nature of the resulting products are summarised with reference to the supporting papers as appropriate. Where known, subsequent developments relating to the workshops are also briefly described. Table 7.1 gives an overview of the sequence of methods used in each workshop.

7.3 THE PLANNING WORKSHOPS

1. University Department of Systems Science (s.p.B)

A new head of department was appointed following a period of substantial change and reorganisation within the university. The department had been established and directed by two professors over a period of some 18 years. The new head, a senior lecturer in the department, saw his role primarily as that of chairman and manager rather than academic leader and wished to involve the academic staff in rethinking the future direction of teaching and research.

A workshop was held over three consecutive days to produce and structure objectives for the department for the next five years. All full-time academic staff involved in both teaching and research were invited to participate. Initially, NGT was used to generate a set of objectives for the department. Two ISM sessions were then held to develop an intent and a priority structure for the department based upon these objectives. Finally, a mission statement in the form of a set of key goals was produced.

Supporting paper B (Janes and Jowitt, 1989), a conference paper written some 18 months after the workshop, describes the work undertaken and gives details of the resulting products. It also considers implementation of the products and the way that they were used as a management tool. The full set of 52 objectives generated is not given in the paper but a subset of the objectives is shown in the intent and priority structures. However, examples of other full sets of NGT products are included in supporting papers C, D, I and J (see Table 7.1).

Subsequent to the workshop, the results, as presented in a paper to the departmental board of studies, were circulated by the academic registrar to all schools, departments and centres in the university. This was done to provide an example of how one department had approached the problem of setting objectives and priorities, and to encourage other departments to examine what they should be trying to achieve.

Case No.	s.p.	Planning Workshop	Ideawriting	N G T	Idea Categorisation	I S M Intent/ Attribute Enhancement	I S M Clusters/ Levels	I S M Priority/ Composite Priority	Group Work
1	B	University Dept. of Systems Science	-------	Objectives	-------	Intent	-------	Priority	Mission Statement
2	C	University Accommodation and Conference Service	Issues	Objectives	Objective Categories	-------	-------	Composite Priority	Mission Statement
3	D	University Dept. of Civil Engineering	Issues	Objectives	Objective Categories	-------	-------	Composite Priority	Mission Statement
4	E	University Short Course Unit	-------	Objectives	-------	Intent	Clusters	Priority	-------
5	F	University Centre for Enterprise Management	Requisite Activities	Objectives	Objective Categories (before priority)	Intent	Levels	Composite Priority and Priority	Mission Statement
6	G	University Engineering Education	Needs	1. Topics 2. Issues	-------	Attribute Enhancement	Levels	-------	-------
7	A	Training Board: Fellowship Programme	-------	Objectives	-------	Intent	Clusters and Levels	-------	-------
8	H	Training Board: Development Team	-------	Objectives	-------	Intent	Clusters	-------	-------
9	I	Training Board: Regional Managers	-------	Products and Services	Product and Service Categories	-------	-------	Composite Priority	Mission Statement

Table 7.1 Sequence of methods used in the workshops
(s.p. denotes a supporting paper)

Case No.	s.p.	Planning Workshop	Ideawriting	N G T	Idea Categorisation	I S M Intent/ Attribute Enhancement	I S M Clusters/ Levels	I S M Priority/ Composite Priority	Group Work
10	J	Police Force: Management Support Dept.	- - - - - - -	Objectives	Objective Categories	Intent	Levels	Priority	Mission Statement
11	K	County Council: Highway Schemes	- - - - - - -	- - - - - - -	- - - - - - -	- - - - - - -	- - - - - - -	Priority	- - - - - - -
12	L	Health Authority: Speech Therapy Service	- - - - - - -	Requirements	- - - - - - -	Intent	Clusters	Priority	- - - - - - -
13	M	Health Authority: Speech Therapy Service	- - - - - - -	1. Obstacles 2. Solutions	- - - - - - -	Attribute Enhancement	Clusters	Priority	- - - - - - -
14	—	Professional Institution: Technical Activity Committee	Implement - ation Activities (done at end)	Objectives	- - - - - - -	Intent	- - - - - - -	Priority	Mission Statement
15	—	Defence Ministry: Military Reserve Force	- - - - - - -	Factors	- - - - - - -	Attribute Enhancement	- - - - - - -	- - - - - - -	- - - - - - -

Table 7.1 (cont.) Sequence of methods used in the workshops
(s.p. denotes a supporting paper)

Some four years after the workshop, following the appointment of another head of department, a second workshop was held. By this time the top half of the original priority structure had largely been implemented. In addition, there had been a considerable turnover of staff in the intervening period, so that over half the participants in the second workshop were not members of the department at the time of the first workshop. A new departmental plan was thus needed to reflect new interests, to focus on new challenges, and to take account of changing circumstances of both the department and the university. The methods of Interactive Management were successfully used again, this time to identify issues facing the department, to generate objectives for the next three to five years, and to set priorities amongst these objectives

2. University Accommodation and Conference Service (s.p.C)

A new head was appointed to manage three previously separate areas of activity within the university. These were the student accommodation office, the university conference office and the university halls of residence, which were all to be brought together as one service. Prior to the planning workshop the service had no corporate identity and was referred to informally as "the accommodation area". The new head of service was an internal promotion, under the office of the university secretary. The management structure was complicated by the fact that although the two managers of the halls of residence reported to the head of the service, the hall wardens, who had responsibility for the management of the students in the halls, reported directly to the vice-chancellor.

At the request of the head of service, a workshop was run over two consecutive days in order to set objectives and priorities for the next five years. Eight participants took part including the head of service, all the relevant managers, a hall warden and two hall tutors. Initially Ideawriting was used to identify the issues facing the service. NGT was then used to generate objectives for the service and these were placed into categories. Objectives requiring significant new resources for implementation were identified. A sequence of short ISM sessions was then carried out to produce a composite priority structure as follows. First, the eight category headings into which the objectives had been placed were prioritised; then the objectives within each category were prioritised. (The resulting type of ISM structure will be referred to as a composite priority structure to distinguish it from the conventional linear priority structure described in the previous case, No.1.) Finally, the group formulated a mission statement and put forward suggestions for a corporate name for the service.

Supporting paper C (Janes and Jeffery, 1989), a report on the workshop produced for the client, gives details of the methods used and the resulting products. Some 18 months after the workshop, the service produced a progress report (Rhodes, 1990) on the objectives and priorities. It was pleasing to see the extent to which the recommendations in the workshop report had been implemented.

3. University Department of Civil Engineering (s.p.D)

This workshop concerned a department of civil engineering organised into four divisions with a number of successful research centres. At the time of the workshop, student entry to undergraduate engineering courses in the university had generally been declining for some years. This had contributed to the situation whereby the number of full-time teaching staff in the department of civil engineering had fallen by over 40% to around 20 over a ten-year period. In addition, the university had introduced a staff appraisal scheme, one aspect of which explicitly required academic staff to report annually on their progress in achieving departmental objectives. There was thus a requirement for the department to set objectives and priorities. The recently appointed head of the department asked the Interactive Management Unit to run a workshop with the aim of examining the objectives of the department and structuring them as an aid to strategic planning.

The workshop was run on three days spaced at intervals over five months, owing to the difficulty of bringing people together on consecutive days. The sequence of methods used followed a pattern similar to that of the previous case, No.2. At the first meeting, all academic staff of the department were invited to participate in an Ideawriting session where they worked in three groups to identify the issues facing the department. On the second day, members of the departmental advisory committee, consisting of the seven senior staff of the department in charge of the various divisions and research centres, were invited to identify a set of objectives for the department using NGT. These objectives were then categorised. The complete list of objectives and categories was circulated for discussion among staff in the various divisions and research centres. At the final meeting, members of the departmental advisory committee were asked to set priorities between the objectives using ISM and to identify those objectives requiring significant new resources for implementation. They also wrote a mission statement for the department.

The priority setting in this case was particularly difficult to achieve, as described in Section 5 of supporting paper D (Janes et al, 1989) the client report. In part, this was due to the delay of several months between the NGT and ISM sessions leading to a loss of continuity and impetus. However, it was exacerbated by the unwillingness of the participants to make any assumptions about limitations on the future level of available resources for the department. The workshop illustrated the need for participants to have an agreed criterion for assessing importance during an ISM session.

4. **University Short Course Unit** (s.p.E)

A short course unit was created within an established university centre for continuing education. The stated aims of the unit were to provide an administrative and support service to academics in mainstream university departments who wished to offer self-financing short courses and, in addition, to offer its own programme of short courses. A manager was appointed to run the unit and various academic staff were seconded to it on a part-time basis to help in starting up its activities.

To assist those involved in planning for the unit, a workshop was arranged over two extended half-days in order to explore the objectives of the unit. There were six participants including the secondees, the unit manager and the director of the centre for continuing education. During the workshop, objectives were generated using NGT and an intent structure was developed using ISM. Sub-groupings of objectives within the intent structure were subsequently identified and labelled.

Prior to the workshop, a trial intent structure was produced by the unit manager with the help of a facilitator. This made explicit the conflict between the requirement to become self-funding in a short period on the one hand, and that of providing a low-cost administrative service to academic departments on the other. Subsequent to the workshop, the unit manager, again with the help of a facilitator, used ISM to set priorities amongst those objectives identified as having resource implications for the unit.

During the study various problem areas facing the unit were identified and clarified. These are listed in supporting paper E (Jeffery and Janes, 1988b), the client report, which also gives details of the various ISM products. In the period since the workshop took place, the problem areas have been tackled and the objectives in the top four levels of the five-level priority structure have been implemented. The unit has thus moved a considerable way towards implementation of the intent structure.

5. University Centre for Enterprise Management (s.p.F)

The purpose of this workshop was to use the methodology of Interactive Management as part of the design process in creating a centre for enterprise management. The initiative for the centre came from one of the author's colleagues, a professor of engineering management at the university. The professor wished to establish a centre of excellence which could focus university skills and research capability on improving the performance of enterprises in both the private and the public sectors. The intention was that the Interactive Management Unit would become a founder member of the centre and, accordingly, it was suggested that Interactive Management be used to help design the centre.

The workshop involved four meetings spaced at weekly intervals and took a total of two and half days. The four participants consisted of the professor, together with the members of the Interactive Management Unit, including the author. Initially, Ideawriting was used to identify requisite activities for a viable centre. This was followed by the use of NGT to generate objectives for the centre. Two ISM sessions were held, the first to form an intent structure and the second to set priorities.

Supporting paper F (Janes, 1991), a research memorandum, gives details of the activities undertaken and the resulting products. It also discusses a number of interesting and novel features of the work. The first relates to the intent structure. Prior to building an intent structure as a group, each of the participants took the same subset of objectives and used ISM to construct their own individual intent structures. Consensus and disagreement subgraphs (Waller, 1979) have been used to illustrate the sort of differences in views of the participants which the structured argument of an ISM session helps to resolve (s.p.F, Section 5). The second feature relates to the priority setting. A composite priority structure was initially constructed. This has certain advantages and limitations when compared with a linear priority structure (s.p.F, Section 6). To overcome these limitations a composite aligned priority structure was devised which may be re-displayed as a linear structure if required.

In terms of the application of the methods of Interactive Management, the workshop was most productive. It resulted not only in a very helpful set of products for planning purposes, but also in a convergence of the various views of the participants and in some important team building. The centre itself, however, did not come to fruition, as the professor concerned accepted the offer of an attractive research chair at another institution. This happened shortly after the workshop and the impetus behind the centre was thus lost.

6. University: Planning for Engineering Eduction (s.p.G)

This project was undertaken whilst the author was on sabbatical at the Centre for Interactive Management, then located in the School of Engineering and Applied Science at the University of Virginia. As part of the process of learning about Interactive Management, the author was invited by the centre to run a series of meetings in order to look at the future of engineering education. Faculty and administrators associated with the school were invited to take part and some 20 people from a wide range of engineering disciplines actively participated in the project.

The first activity involved the use of Ideawriting in order to involve all the participants in thinking about why they should be planning for the long-term future of engineering education. For the rest of the project the participants worked in two groups. One examined the topics which should be included in a plan for the future of engineering education. The other group considered issues related to computers and engineering education. In each case NGT was used to generate ideas and this was followed by the use of ISM to explore the interrelationships between the generated ideas.

The results of the project were documented by the author in a report (Janes, 1983) for use by the centre and the school. Supporting paper G, a conference paper (Janes, 1987a), summarises these results and provides an explanation of how such

ISM maps should be interpreted. The project showed clearly what engineering educators should be doing in order to make engineering education programmes responsive, rational and effective. It was also of considerable value to the author in learning about the practice of Interactive Management.

7. Industrial Training Board: Fellowship Programme (s.p.A, Section 5)

This workshop, and the two described later in cases 8 and 9, relate to work undertaken for the Engineering Industry Training Board (EITB). During 1991, the EITB was effectively privatised into the Engineering Training Authority which assumed most of the work of the Board. To avoid confusion, the organisation will be referred to throughout by its former name for the purposes of this thesis.

One of the major concerns of the EITB is to ensure effective training and development of people to meet the needs of the U.K. engineering industry. As part of this, the EITB runs a number of fellowship schemes based at various universities, whereby able young graduate-level engineers working in industry can spend an intensive period on specially designed programmes which enhance their professional development. The Department of Systems Science at City University won a contract to run one such programme. This was a one-year Fellowship in Systems Management, involving intensive periods of study at the university combined with a major project undertaken in the student's own sponsoring organisation.

The fellowship steering committee, whose members were appointed by the EITB, consisted largely of senior engineering managers from industry. To enable the committee to influence syllabus design at an early stage and to ensure that the programme had clear objectives, it was decided to use the methods of Interactive Management. The eight participants at the first session consisted of five engineering managers representing the steering committee, together with academics representing those in the university who would be involved in designing and running the programme. Here, NGT was used to generate, clarify, edit and rank objectives for the programme. At the subsequent ISM session, conducted by the academic team, an intent structure was developed based upon these objectives. The structure was used to provide the ISM application described in Section 5 of supporting paper A (Janes, 1988).

The workshop enabled the steering committee to make a direct and significant contribution to the early stages of the design of the fellowship programme. The products of the workshop were subsequently used by the academic team in planning the course. The fellowship ran successfully for three years and the department then decided to expand it into an MBA degree in Engineering Management run jointly with the university's business school.

8. Industrial Training Board: Training Development Team (s.p.H)

A new manager was appointed to lead a training development team within the Engineering Industry Training Board (EITB). This was an internal promotion and the manager wished to involve all the team members in rethinking the role of the team. The responsibilities of the team covered training development for craftsmen, technicians and technologists, including the impact of new technologies.

The planning workshop involved nine members of the team, including the manager, and was run over two days. On the first day, NGT was used to generate a set of over 40 objectives for the team for the next two years. The objectives were subsequently classified into groups. On the second day an intent structure was built using ISM, and the objective groupings previously identified were mapped onto it.

The objectives in the intent structure were selected for inclusion in the ISM session on a basis of the NGT voting scores. In this case the voting was carried out twice. The first vote was done during step 5 of the NGT session itself, using the procedure described in Chapter 5. The second vote was conducted using postal voting in the three-week interval between the two days of the workshop, after the participants had had an opportunity to reflect on the objectives. There was a very high degree of agreement between the two sets of votes with regard to the objectives selected. This lends support to the use of the votes obtained during step 5 of an NGT session as the main basis for selection of items for a subsequent ISM session.

Following the workshop, the results were written up as a client report (Janes, 1985b), and a presentation on the results and conclusions was made to the manager and his team. Supporting paper H (Janes, 1992), a conference paper, describes the work undertaken and gives details of the resulting products.

The workshop enabled all the team members to contribute directly to identifying the team's focus and to planning for the future of the team. It enabled them all, including the new manager, to learn about what their colleagues thought the team ought to be doing. It was thus an important team-building experience for the participants and there was a high degree of commitment to the resulting products which formed a basis for the future activities of the team.

9. Industrial Training Board: Regional Managers (s.p.I)

Within the Engineering Industry Training Board (EITB), a team of regional managers is responsible for operations throughout the U.K. The general manager for regional operations was concerned that little opportunity existed for the regional managers to be consulted over the contents of the three-year corporate business plan for the organisation, preparation of this being the responsibility of staff at EITB headquarters. He wanted to create a means of providing the regional managers with such an opportunity. They were, after all, directly in touch with training in the engineering industry throughout the country; they were also the people who would be responsible for implementing a major part of any such plan.

A two-day business planning workshop was thus arranged prior to the review of the corporate plan by the Board. This was designed to enable the regional managers collectively to formulate their ideas on the products and services which they thought the EITB should be delivering on behalf of the engineering industry over the next three to five years. Initially, the eight participants, including the general manager, identified a set of over 30 such products and services using NGT. As the intention was to develop a composite priority structure, a procedure similar to that described in Section 6 of supporting paper F was then followed. The participants first grouped the products and services into categories and decided on a heading for each category. ISM was then used to set priorities between the category headings; subsequently, priorities were set between the items within each category. Using this information the participants then wrote a mission statement for the EITB. It should be noted that this was the first time, as far as the author is aware, that ISM has been used to construct a composite priority structure of this kind.

The workshop enabled the regional managers to become involved in the planning process and to provide a clear picture of where they thought the EITB should be directing its efforts. Supporting paper I (Janes, 1987b) a report produced for the client, gives details of the approach used and the products of the workshop. The information generated gave the general manager a firm basis from which to represent the views of his regional managers during the process of revising the corporate business plan for the organisation. Three years or more after the event the workshop report is still referred to.

10. Police Force: Management Support Department (s.p.J)

This planning workshop was carried out for a newly formed management support department in a large urban police force. A reorganisation had brought together, as one department, a number of existing functions concerned, for example, with management services, policy analysis and public affairs. Twelve people participated in the workshop, including senior management representing activities within the new department, together with some representatives from related areas outside management support. The intention was to assist them in strategic planning through the production and structuring of objectives for the department.

The workshop ran over three days spaced at weekly intervals. On the first day, over 60 objectives for the department were identified using NGT. On the second day, ISM was used to develop an intent structure from a subset of the objectives. Prior to this the Interactive Management team had sorted the objectives into categories which formed the basis for identifying hierarchical levels within the intent structure. At the start of the third day, the intent structure and levels were reviewed with the group. ISM was then used again, this time to create a linear priority structure from the same subset of objectives. The last phase of the workshop involved the participants in formulating a set of major goals for the department using the information produced during the NGT and ISM sessions.

A few days after the end of the workshop, the results were presented by the author and another member of the Interactive Management team to the chief officer of the force and his senior colleagues. These results are contained in supporting paper J (Janes and M'Pherson, 1985), a report produced for the client.

Subsequently, the Assistant Commissioner in charge of the newly formed department, who had himself been a workshop participant, confirmed that the workshop had been most helpful in the following ways. It had helped a number of people, including senior staff who would be involved in running the department, to make a significant contribution to the planning process. The methods used had been effective in helping participants to work together in order to generate and structure objectives and to set priorities for the department. In addition, the report resulting from the event had provided a valuable document which contributed to the planning and organisation of the department.

11. County Council: Priorities for Highway Schemes (s.p.K)

This case concerns the use of ISM in setting priorities between capital highway schemes for a county council. The council already had an established method which was used to assist in specifying a 20 year programme for such schemes. Top ranking schemes, representing spending on road improvements for the next seven years, were designated for active design work; other schemes, representing spending for the remaining 13 years, were placed on the reserve list. The priorities were reviewed each year. The ranking was constructed using a weighted score for each highway scheme which was based on eight components including, for example: improvements in safety, which carried the highest weighting; economic and employment benefits; environmental effects; and impact on public transport. However, painstaking though the ranking method was, the question of the total cost of each scheme did not explicitly form part of the ranking and so assessment of schemes on a comparative "value for money" basis was not possible.

ISM appeared to offer a tool for comparing highway schemes which would allow their respective costs to be taken into account. Accordingly, a one-day ISM workshop was arranged at the request of the assistant county surveyor. Six county officials participated, representing different aspects of the highways committee policy areas, for example, construction, traffic, safety and finance. ISM was used to set priorities between the 47 highway schemes in the 20 year programme using a contextual relation based on "value for money". The cost of the schemes ranged from £0.5m to £22.1m in value. To reduce the number of schemes to a manageable size for an ISM session, the 47 schemes were first grouped carefully into 25 sets. Each set contained between one and four schemes, the grouping being done so that the sets represented the complete spectrum of cost and ranking scores. One scheme from each of the 25 sets was used to provide the elements for the ISM session, these being representative of all 47 schemes The participants then positioned each of the remaining 22 schemes into the ISM priority structure by hand, using the position of the 25 representative schemes as a guide but making appropriate adjustments after discussion. This resulted in a final priority structure which could be directly compared with the ranking produced by the established method.

Supporting paper K (Janes, 1987c), a report written for the client, gives the results of the workshop. Various aspects of the work were later expanded upon in a project report by the client (Bellinger, 1987), who also acted as an observer at the workshop. This concluded that although the priorities obtained using ISM were not radically different from those obtained using the council's established method, the changes which did occur generally resulted in improvements. The cost and effort involved in mounting the ISM session were considered to be much less than other alternative methods which had not produced satisfactory results. However, whilst Bellinger also considered that ISM could be a most useful tool for elected council members, he did query the extent to which they would accept highway scheme priorities set by the collective and sometimes subjective view of council officers.

12. Health Authority: Speech Therapy Service 1 (s.p.L)

Both this case and the next one, No.13, concern work with community-based speech therapy services in district health authorities, each relating to a different application of ISM. The cases had similar origins, in that both the clients had attended a course on ISM, given by the author each year to postgraduate students. The clients thus already had some familiarity with ISM and NGT.

This first case relates to a district health authority speech therapy service in inner London. A new chief speech therapist for the elderly had been appointed to improve the provision of therapy for elderly people in the community. Staffing for the service had been expanded from one and a half to five full-time posts, and better planning and organisation were needed. At the request of the chief speech therapist, a planning workshop was arranged for the group in order to structure requirements for the service.

As the client was familiar with NGT, it was agreed that she should use the method with the group prior to the formal workshop, in order to generate a set of requirements regarded as necessary to achieve a high quality service. On the first day of the workshop, ISM was used to examine how these requirements would help to achieve one another, producing a requirements structure similar in form to an intent structure. Clusters of elements in the structure were identified and labelled. On the second day, priorities were set between the requirements, again using ISM. The requirements were then examined to see which of them were achievable with existing resources and which needed additional resources. This enabled two priority sub-structures to be displayed, relating to existing and additional resources respectively. Finally, the group drew up a statement of the key requirements for the service.

Supporting paper L (Jeffery and Janes, 1989), a conference paper, describes the workshop and its products. It also reports on the implementation of the results. The paper was based largely on the report (Jeffery and Janes, 1988c) produced for the client. In this particular case, the client herself published an article (Slate, 1990) some 18 months after the workshop, on the impact of the use of ISM on the service; part of this is appended to s.p.L.. The impact was most significant: the workshop helped to establish a team identity, and led to the production of an operational policy and the reorganisation of the service; the ISM structures were used successfully to make a case for more resources for the service; a treatment strategy was developed with a consequent reduction in workload; and the therapists felt a sense of greater job satisfaction.

13. Health Authority: Speech Therapy Service 2 (s.p.M)

This workshop was undertaken at the request of the manager of a speech therapy service for people with learning difficulties. The service was located in an outer London district health authority and had a group of six full-time therapists, including the manager. In order to improve the organisation and operation of the service, a planning workshop was arranged in which they all participated. It was aimed primarily at helping the group to set priorities for the service for the next two years.

Prior to the workshop, the Interactive Management Unit staff held a series of advisory meetings with the manager. It was agreed that NGT should be used with the group twice: first, to identify obstacles facing the service, and then to consider solutions in the form of ways of overcoming these obstacles. As the manager was familiar with NGT and was keen to build up her own skills in the use of the method, it was agreed that she should conduct the NGT sessions herself, prior to the formal workshop. On the first day of the workshop, ISM was used to create an attribute enhancement structure showing how the solutions contributed to one another; clusters of solutions were also identified and labelled. On the second day, priorities were set between the solutions. The resulting priority structure was then split into two sub-structures: one relating to solutions that were seen as requiring significant additional resources for implementation; the other relating to solutions which could be achieved with the existing level of resources.

The results of the workshop and recommendations arising from it were written up for the client in a report (Jeffery, Janes and Hammer, 1989), included as supporting paper M. For a number of the participants, it was the first time that they had worked together as a team. They unanimously agreed that the workshop had been an excellent team building experience. The manager of the service later confirmed that the workshop had been extremely helpful in identifying problems and service needs, and in setting priorities. She also commented on the importance of the workshop in team building and in generating a commitment to common goals.

14. Professional Institution: Technical Activity Committee

The work described here was undertaken for a technical activity committee on managing innovation, most of whose members were engineering managers in large industrial manufacturing companies. The committee was one of a number within the engineering management division of the Institution of Mechanical Engineers. The institution had circulated a policy statement to its boards and committees, in which they were asked to review the statement, to debate their own role, and to establish priorities and propose actions to implement them. As part of this, the author and a colleague, who was a member of the committee on managing innovation, undertook an analysis of the policy statement of the institution as a demonstration of the use of ISM. The policy statement was first broken down into 31 specific objectives; these were then structured twice using ISM, to give an intent and a priority structure for the institution based on the statement. The demonstration was written up as a report (Janes and M'Pherson, 1984) and circulated to the members of the committee on managing innovation. As a consequence of this, the author was asked to run a series of meetings for the committee, in order to use ISM to assist the members in examining their own strategy for the committee within the policy framework of the institution.

At the first meeting, NGT was used with the participants to generate a set of objectives for the committee. At the second meeting, ISM was used to structure 36 of these objectives into an intent structure. This was followed at a third meeting by the use of ISM again, this time to set priorities amongst the objectives by creating a linear priority structure. A final meeting was then held at which the participants first drew upon the information contained in the intent and priority structures in order to write a mission statement; then, an Ideawriting session was conducted to help them to generate and categorise a list of activities which the committee should undertake in order to implement the intent and priority structures and mission statement.

This was, in fact, the first workshop that the author ran for a professional group in the U.K. The data from the NGT, ISM and Ideawriting sessions mentioned has been used elsewhere in this thesis. However, as the NGT and ISM meeting were spaced out over a period of some four months, the relevant products and interpretations of them were circulated to the committee members after each meeting. No single overall report was required by the committee. As this thesis contains a number of examples of intent and linear priority structures elsewhere, a special report on the meetings has not been written for inclusion as a supporting paper. The intent and priority structures for the committee are, however, given in Appendix 2 for information.

15. Defence Ministry: Military Reserve Force

This workshop was undertaken for a defence ministry which was planning a substantial expansion in a volunteer reserve force associated with a military service.

Seven participants took part in the workshop, including senior officers involved in manpower planning for the service together with a senior civil servant. NGT was used to assist the group in identifying factors which would contribute to achieving the proposed expansion of the reserve. ISM was then used to construct an attribute enhancement structure showing how these factors contributed to one another.

The workshop was facilitated by the author, having been designed with a colleague, an officer in the service, for whom it contributed to a wider investigation concerned with manpower planning within the reserve. As the products of the event were confidential, no details are produced here. Data on the NGT and ISM sessions have, however, been used elsewhere in this thesis. It is, perhaps, worth noting that the workshop was well received and considered by the director of manpower planning for the service, in a letter to the university, to be a most worthwhile exercise and one which his staff officers found instructive, persuasive and of great value.

7.4 DATA ON SCOPE AND TIMING

Appendix 3 contains tables of data recorded on the ISM sessions. Table A3.1a gives the data relating to intent and attribute enhancement structures. It contains details of: the number of participants; the number of elements in the final model; the number of intermediate structures examined by the group; and the total duration of the session, including the time spent by the group in discussing and amending any intermediate models and the final model but excluding any breaks. It also gives some basic information on the number of levels and cycles present in each structure. On average, in these cases, a group of six participants dealt with 25 elements in just over four hours. The group size ranged from four to ten participants, the number of elements dealt with from 17 to 36, and the total duration of the sessions from just over three hours to just under six hours.

It would be useful for workshop designers and facilitators to be able to estimate in advance the total duration of an ISM session. Assuming that each session has a clearly expressed and appropriate element set, and is well prepared and facilitated, it might seem reasonable to expect the total duration (T) to increase with both the number of elements (E) and the number of participants (P). For example, a black-box model based upon the multiple regression of T on the two variables E and P in Table A3.1a gives the equation:

$$T(\text{minutes}) = 30.5 + 17.8P + 4.35E \qquad \text{.... (1)}$$

This appears to work quite well given the limited data available. The multiple correlation coefficient is 0.92 and the standard error of estimate is 22 minutes. The estimated times calculated using equation (1) lie within + or -13% of the observed values. However, as with NGT (see Chapter 5), a number of other factors that may influence the meeting duration need to be borne in mind. These include: the knowledge of the participants and their ability to articulate their arguments; the level of controversy amongst them; the skill and style of the facilitator; and the complexity of the situation being examined. These factors are not accounted for in variables E and P in equation (1); it is thus unlikely that such a model could result in more than a rough guide to meeting duration even if considerably more data were available to refine the model.

Warfield (1976:353) suggests a formula for the time "... to conduct the transitive embedding and arrive at an initial multilevel structure (before any amendments are made)...". This is:

$$t(\text{hours}) = (1/600)e^2\sqrt{P} \qquad \ldots\ldots \; (2)$$

Warfield points out that this is a rough rule-of-thumb guide based on experience and that it is subject to considerable error. Table A3.1b shows data recorded from nine of the cases under discussion in Table A3.1a for the variables in equation (2). It gives: the time (t) spent by the group in answering questions put by the computer excluding any time spent discussing and amending the intermediate or final models; the number of elements (e) dealt with in this way; and, as before, the number of participants (P). Equation (2) presumably attempts to take into account the fact that the number of matrix entries to be completed in an ISM session increases with the square of the number of elements and makes some additional allowance for the number of participants in the group. However, attempts to use the equation on the data in Table A3.1b have given unsatisfactory results. It tends to underestimate the time required considerably, with a mean absolute error of 38% between the observed and estimated times, and an error range from +20% to -66%: for example, in the latter case, an observed time of two hours was estimated as 41 minutes using equation (2). It is considered that more data needs to be collected before it is worth pursuing these calculations further.

Table A3.2 gives data relating to six linear priority structures. On average, six participants dealt with 26 elements in just over three hours. However, there is considerable variability in the duration of the individual cases, from just under two hours to just under five hours, and estimating the time required on a basis of the number of elements and participants does not seem possible. For example, cases No. 11 and 13 are very similar with regard to both the number of participants (six each) and the number of elements (25 and 26 respectively), but are very different with regard to the total duration of the sessions. Here, the contrast in the nature of the tasks is evident and illustrates the difficulty of establishing any simple formula for meeting duration. In case No. 11 a set of highway schemes was being prioritised, whereas in case No. 13 a set of solutions to a problem situation was being prioritised by a group who had already built an attribute enhancement structure for the solutions. The latter participants were thus already very familiar with the elements and their interrelations, which may have been one reason why they were able to proceed more quickly in building a priority structure. They were also a cohesive group who normally worked together as a team.

Table A3.3 gives data regarding the composite priority structures. Here, the four cases, which each involved a series of short ISM sessions (see Chapter 8, Section 8.2.1), each took a little over three hours. Clearly, there is no relation to be discerned here between meeting duration and number of elements and participants.

7.5 SUMMARY

This chapter has focussed on providing factual summaries of the fifteen planning workshops conducted by the author with professional groups. The workshops are described in more detail in the relevant supporting papers. To give the chapter some coherence, the summaries have been grouped largely according to the type of organisation involved. Depending upon the particular situation being explored, ISM, NGT and Ideawriting have been used in various ways to generate a range of products useful for planning purposes. The particular sequence of methods used in each case is given, together with the nature of the resulting outcomes. Some background information on each workshop has also been supplied to provide an organisational setting.

In Section 7.4 the data on the scope and timing of the ISM sessions have been analysed. The duration of a session to construct an intent or attribute enhancement structure is considered, other things being equal, to be related to the number of elements and participants, but more data would be needed to validate any particular model. However, given the many other influences at work, it is unlikely that any such model could ever provide more than a rough guide to the meeting duration.

The next two chapters examine the lessons learnt from the planning workshops. Chapter 8 considers lessons for ISM, whilst Chapter 9 considers lessons for Interactive Management and systems science.

Chapter 8

LESSONS FOR INTERPRETIVE STRUCTURAL MODELLING

8.1 INTRODUCTION

This chapter discusses lessons for ISM that may be drawn particularly from the work described in Chapter 7, but which are also supported by the author's experience of giving courses on Interactive Management to student groups where ISM was used in case studies. Lessons regarding priority structures, and intent and attribute enhancement structures are discussed first, followed by consideration of the nature of the ISM process and the need to examine intermediate structures within that process. Finally, the benefits and limitations of the method are examined, including references to statements from clients and a questionnaire which are contained within the appendices.

8.2 PRIORITY STRUCTURES

8.2.1 Composite Structures

The concept of a composite priority structure has been put forward as an alternative to the more conventional linear priority structure. It was first put into practice with a group of regional managers from an industrial training board, as described in case 9 (s.p.I) in Chapter 7 and was found to be of considerable practical value. Subsequently, it was used with various university departments as described in case 2 (s.p.C), case 3 (s.p.D) and case 5 (s.p.F). In s.p.F the practical advantages of constructing a composite priority structure with a group were examined. These include: the relative ease of setting priorities among items categorised as being similar, as distinct from dissimilar items; the variety of tasks involved for the group which helps to break up the tedium of a long ISM session; and the benefits of displaying the priorities between items within categories.

The concept of a composite aligned priority structure was also introduced in s.p.F. This may be constructed from a composite priority structure and can be redrawn, if desired, as a linear priority structure. It has the advantages of being completely transitive, unlike a composite priority structure, and of retaining the category information missing from a linear priority structure.

8.2.2 Structural Classification of Composite Structures

As pointed out in Section 6.4 of s.p.F, in terms of strict definitions of a priority structure, the composite priority structure does not conform to any of the structural types: linear hierarchy, linear mixed structure, or nonlinear regular hierarchy, defined by Warfield (1980b) as the forms which priority structures can take (see Figures 8.3c,d,e, referred to later in this subsection). These three types of structure should provide a clear understanding of the relative priorities among all the element pairs present, although, even here, in the case of the nonlinear regular hierarchy, there is some ambiguity regarding the relative priorities among elements situated at the same level as each other, e.g., elements x, y, z in Figure 8.3e. Whilst the composite priority structure provides clear information about priorities between category headings and about priorities between elements within any particular category, it contains ambiguity with regard to the priorities between elements across different categories. This deficiency is remedied in the case of the composite aligned priority structure.

Given that both types of composite structure have been demonstrated to be of practical value, it is helpful to see where they fit into a classification of such structures. Warfield (1979) put forward a hierarchy of seven structural types of digraph-based structures (Figure 8.1). The composite structures do not fit readily into this diagram. However, another diagram may be constructed, incorporating similar basic building blocks, to show how the various priority structures interrelate (Figure 8.2). Examples of all the types of digraph included in this latter figure are shown in Figure 8.3. It should be noted that the composite linear mixed structure corresponds in practice to a composite priority structure with cycles such as that of Figure 3 in s.p.C. Similarly, a composite aligned linear mixed structure corresponds in practice to a composite aligned priority structure with cycles such as that shown in Figure 5 of s.p.F. Special cases of these two structural types could occur in some situations when no cycles at all are present. They would give rise respectively to a composite linear hierarchy and a composite aligned linear hierarchy. As they are somewhat unlikely to occur in practice they are mentioned for completeness but have not been inserted into Figure 8.2.

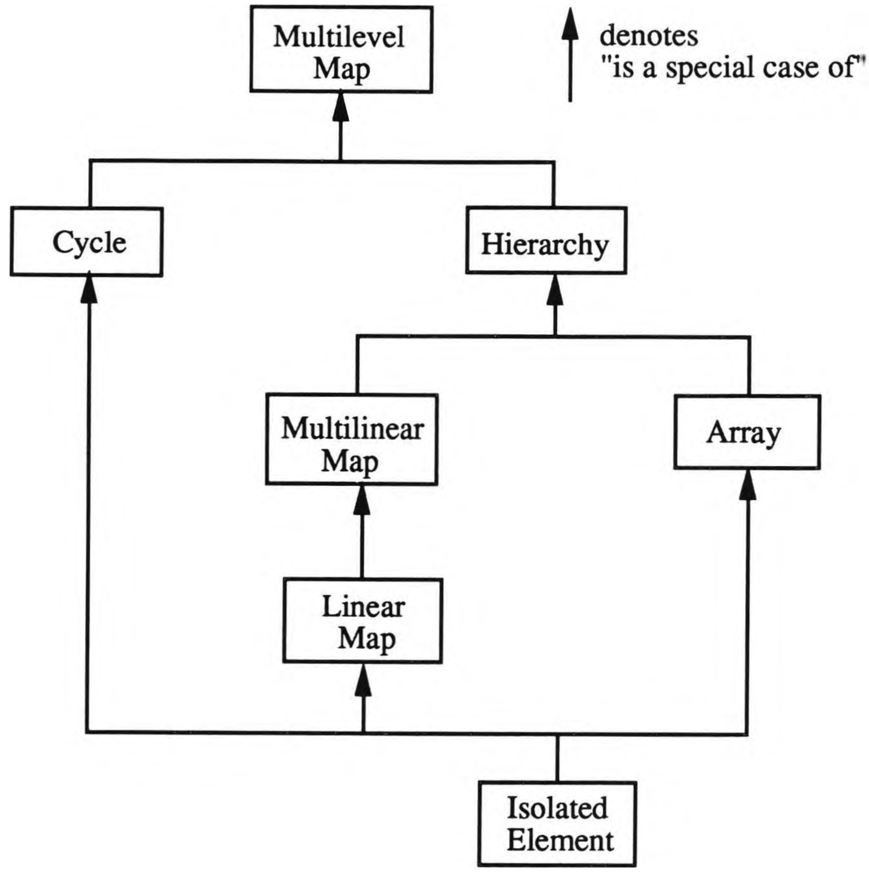


Figure 8.1 Structural types of digraph-based structures (after Warfield, 1979)

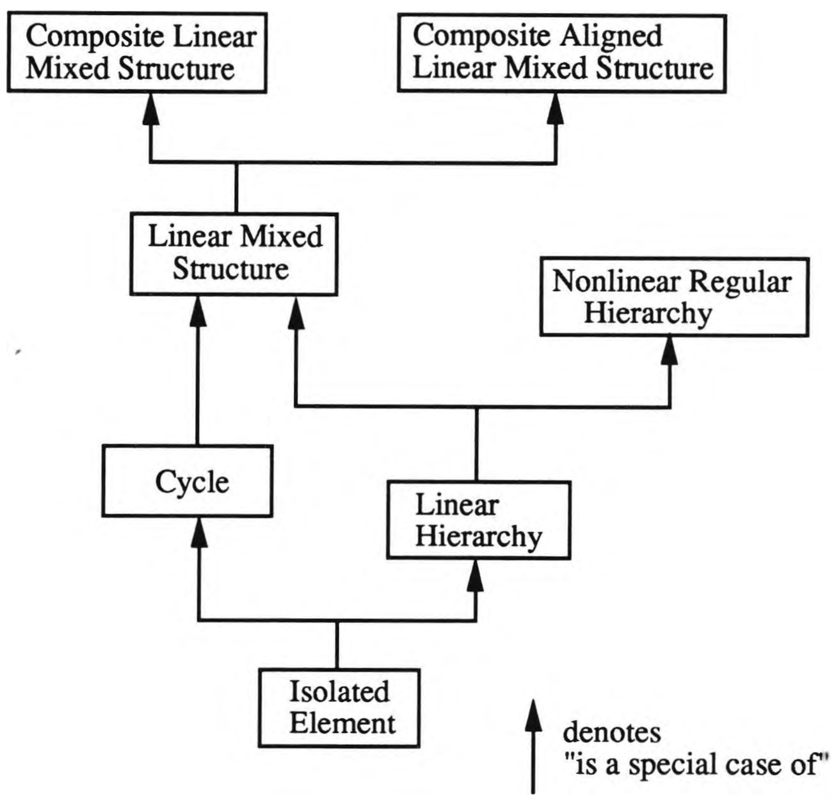
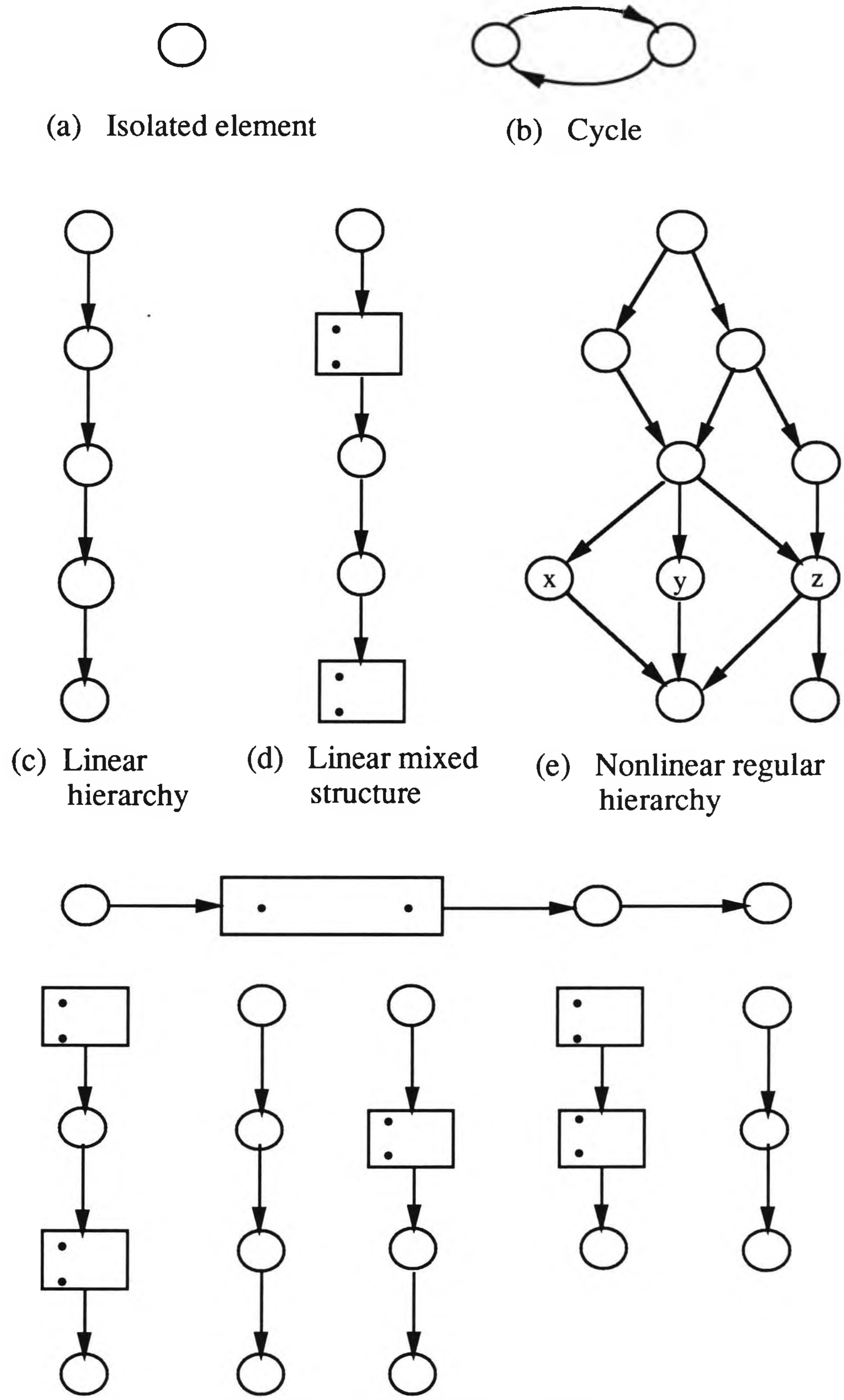


Figure 8.2 Interrelations between structural types of priority structures



(a) Isolated element

(b) Cycle

(c) Linear hierarchy

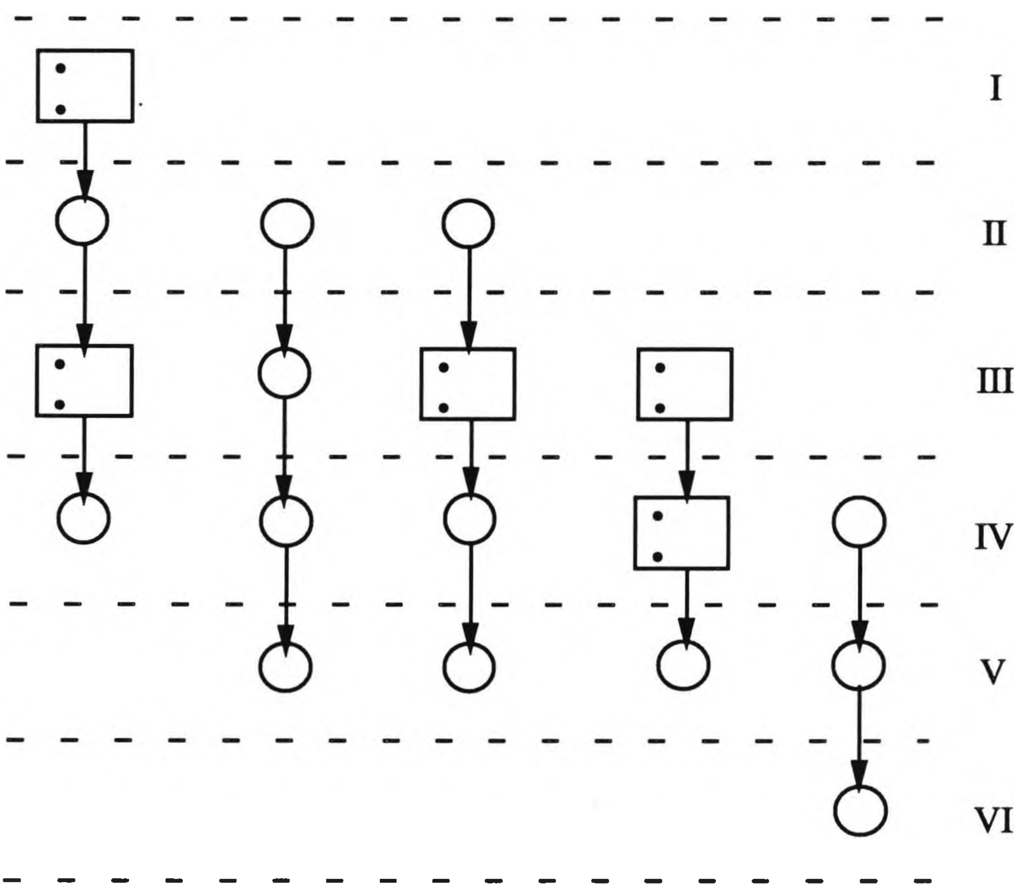
(d) Linear mixed structure

(e) Nonlinear regular hierarchy

(f) Composite linear mixed structure

Figure 8.3 Examples of structural types of priority structures referred to in Figure 8.2

(key to symbols overleaf)



(g) Composite aligned linear mixed structure

denotes an element to be prioritised

or denotes a contextual relation
e.g., "is a higher priority than"

or denotes a cycle between elements in the box,
e.g., elements of equal priority

<u>Figure 8.3(cont.)</u> Examples of structural types of priority structures referred to in Fig 8.2

8.2.3 The Need to Understand Contextual Relations and Digraph-Based Structures

The user of ISM needs to understand clearly both the logical properties that may be ascribed to different contextual relations and the properties of the various types of digraph-based structures which may result from the use of these relations. This is important in any use of ISM, but is particularly important in the case of priority structures where the possibility of confusion is perhaps greater. Supporting paper R (Janes, 1987d) illustrates the kind of confusion that may arise. It is based on a critical analysis carried out by the author following observation of the use of ISM to establish priorities.

Whilst learning about the use of ISM in the U.S.A., the author was invited to observe an ISM session being conducted on a professional basis with a group of county commissioners in a Midwest state. ISM was being used to help the commissioners set priorities between work statements of the office of management and budget, so that the county government could operate within a reduced budget for the forthcoming year.

The ISM user in this case did not understand that the asymmetric contextual relation selected, which was "is a lower priority than", had resulted in the production of a multilevel map in form of a nonlinear nonregular hierarchy, from which priorities could not be unambiguously determined. This is illustrated in Figure 8.4, an extract from a larger digraph shown in Figure 8.3 of s.p.R. Here, the relationship between elements 7 and 5 has a span of five so that the hierarchy is not regular. (The span is calculated as the difference between the number of the level at which the edge starts and the number of the level at which it finishes; for a digraph to be regular, no span of any edge in the digraph must exceed 1 (Warfield, 1980b)). The relative priorities of several pairs of elements thus cannot be clearly determined from the structure, e.g., between elements 5 and 12. In the situation above involving the commissioners, what was done would be equivalent to deleting all the arrows in Figure 8.4 and stating that elements 5 and 8 were of equal priority, which may or may not be the case. Of course, the ambiguity could be removed through discussion of the structure by the participants, resulting in a decision to position element 5 at a particular level between elements 3 and 7. However, the point is that in the situation described the user failed to appreciate, amongst other things, the shortcomings of the priority structure produced due to a lack of understanding of both the logical properties of contextual relations and the type of structures likely to result from their use. This could have had serious consequences but fortunately, in this particular case, did not.

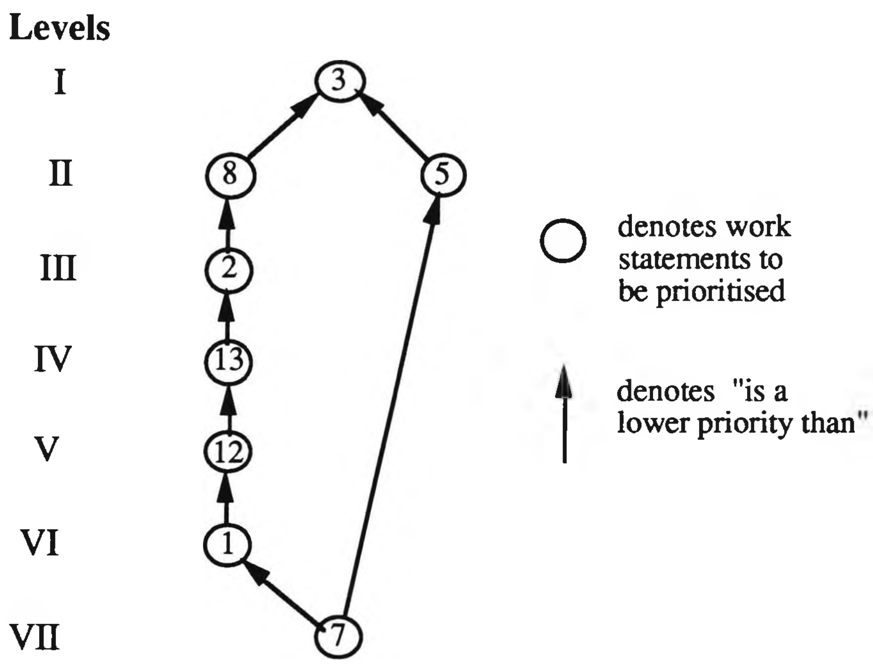


Figure 8.4 A nonlinear nonregular hierarchy

A proper understanding of the properties of contextual relations and the resulting types of digraph structures will enable the user to specify an appropriate contextual relation and to interpret the resulting digraph correctly. At least then, if an asymmetric relation is used, e.g., "is more important than", and a nonlinear nonregular hierarchy results, the user will be aware of its limitations as a priority structure.

8.2.4 Contextual Relations for Priority Structures

In the cases described, the priority structures have been based on linear mixed structures or, in the case of the composite structures, a mix of these with some simple linear hierarchies. The contextual relations selected for building such structures were designed to prevent nonlinear digraphs from forming. In the supporting papers the full details of the contextual relations used have not been discussed. This was done in order to minimise the need for unnecessary technical explanations, particularly to clients, who would have little interest in them. The exact form of contextual relation used throughout for building priority structures was one which, in fact, combined a number of the fundamental logical properties of the contextual relations discussed in Chapter 4.

A typical question put to a group as part of the priority setting process was, for example, of the form:

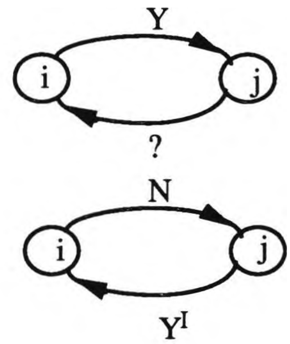
"Is element i a greater priority than, or an equal priority to, element j ?"

The participants then answered "Yes" if they considered that element i was either of greater priority than element j or was of equal priority to j. Otherwise they answered "No". This contextual relation has the logical properties of being transitive and of combining asymmetry ("is greater than") with symmetry ("is equal to"). The transitivity allows logical inferences to be made as discussed in Chapter 4. The asymmetry/symmetry property does not allow any inference to be made regarding the relationship from j to i given a "Yes" answer to the above question, but does permit a "Yes" to be inferred given a "No" answer (Figure 8.5). This latter aspect means that a "No" - "No" relationship between two elements should not occur, which prevents the formation of nonlinear structures such as that shown in Figure 8.4. The usual result is a linear mixed structure (Figure 8.3d), or possibly a linear hierarchy when no cycles are present (Figure 8.3c). The sort of problems referred to in Section 8.2.3 above with nonlinear nonregular structures should thus not arise.

Not all the priority structures referred to in the supporting papers were constructed specifically using the word "priority" in the contextual relation, although the latter were all worded to have the asymmetric/symmetric property discussed above. For example, in the cases described in supporting papers D, I, J and M the relation used was "Is more important than or is equally important to". In one situation concerning setting priorities between proposed highway schemes (s.p.K), the relation used was "Is better value for money than or equal value for money to". As discussed in case 11 in Chapter 7, this explicitly asked participants to consider the relative costs of the proposals as well as their merits as highway schemes.

8.2.5 Priority Structures and Resources

In a number of the more recent cases, it has been found helpful to distinguish within priority structures, those elements which may be achieved with the existing resources available, and those which require significant new resources.

Contextual Relation	Property	Digraphs
"is a greater priority than or equal priority to"	Asymmetric/symmetric	

i,j = elements

→ = contextual relation

Y = "Yes", denotes relation exists

N = "No", denotes relation does not exist

Y^I = a logically inferred "Yes"

? = no inference can be made

Figure 8.5 Example of a contextual relation for building a priority structure

In the cases described in supporting papers C and D, this distinction was made between objectives within composite priority structures. In two other cases (s.p.L and s.p.M), where linear priority structures were produced, the distinction enabled two further separate priority structures to be displayed, one relating to existing resources and the other to additional new resources. With regard to implementation, this helped the managers involved to identify those priority items which could be considered for immediate action and those for which further funding or human resources were required. Part of an article (Slate, 1990) written by one of these managers is attached to s.p.L; it describes how the identification of important requirements enabled the manager to argue successfully for additional resources and discusses other benefits of the ISM sessions held.

8.3 INTENT AND ATTRIBUTE ENHANCEMENT STRUCTURES

8.3.1 Identifying Levels and Clusters

In eight of the cases involving intent or attribute enhancement structures, subgroupings of interconnected elements have been identified and labelled. These form clusters or, in some cases, levels within the structures (see Table 7.1). The main purpose of such subgroupings is to help participants and others interpret the structures, particularly when large numbers of elements are involved, e.g., Figures 2 and 3 in s.p.H. In a number of cases, it has been found helpful to draw an additional figure showing the labelled cluster only, e.g., Figure 3, s.p.E.

The subgroupings have normally been identified through discussion of the relevant structure by the participants under the guidance of a facilitator. This was done after the structure had been displayed and agreed by the group. In one case (s.p.J), the set of objectives involved was classified into groups prior to building an intent structure. It was subsequently found that the intent structure could be partitioned into a number of levels broadly, though not exactly, agreeing with the groupings previously identified.

The fact that such subgroupings may be identified illustrates the way in which ISM has a natural tendency to create clusters of related elements when an intent or attribute enhancement structure is being built. This might be expected from an examination of the contextual relations used for such structures containing, as they do, phrases such as "helps to achieve" or "strongly contributes to".

8.3.2 Contrasting Intent and Priority Structures

In seven of the cases described, the sequence followed involved using ISM to build first an intent (or attribute enhancement) structure and then a priority structure. In other cases only one type of structure was produced (see Table 7.1). One technical difference between these structures concerns the type of contextual relation employed. A priority structure is constructed using a contextual relation categorised as a comparative relation, whereas intent and attribute enhancement structures are constructed using influence relations (see Chapter 4).

A second important difference of a behavioural rather than a technical nature was observed when conducting the ISM sessions. Building an intent or attribute enhancement structure is essentially a cooperative learning process amongst the participants. There is discussion involving clarification and structured argument, the purpose of which is to achieve a better understanding of how the various elements affect one another. The outcomes of such an ISM session include learning through an exchange of ideas, together with the production of an agreed map of the element interrelations which clarifies what may otherwise have remained a rather impenetrable morass of ideas. However, when building a priority structure, a different mode of participant behaviour may often be observed. The elements being prioritised will typically involve objectives or projects in which participants have vested interests as stakeholders. If individuals see projects to which they are personally committed being given a low ranking in the priority structure despite their arguments to the contrary, the ISM session may take on a more conflictual and divisive aspect. The clarification and learning may still occur, but individuals may be concerned to see that their favourite project is not considered as particularly important by their colleagues and is thus unlikely to be allocated the required resources when the priority structure is implemented. They may fully understand the arguments and logic behind the priorities and may appreciate why they are sensible priorities for the organisation concerned. However, they may also feel that the priorities set will have a significant, and possibly detrimental, impact on them personally in terms of their work and careers.

Thus setting priorities using ISM, where the priority structure may result in a significant reallocation of resources to some projects at the expense of others, may be seen as a fundamentally different kind of activity to constructing other types of ISM, such as intent or attribute enhancement structures, where the primary purpose involves clarification and learning about the interactions among a complex set of elements.

8.3.3 Using Subgraphs to Illustrate Learning

"ISM is a computer-assisted, interactive learning process whereby structural models are produced and studied. Learning takes place through group interaction, with the help of the computer, under the leadership of a skilled facilitator." Warfield (1982b:155).

The claim in this statement, that learning takes place during an ISM session, implies that the perceptions and understanding of individuals are changed through their participation in the structured discussion and argument inherent in the ISM process. S.p.F describes a case that was used to demonstrate how perceptions do change. Intent structures were constructed individually by four participants, prior to their building an intent structure as a group. The differences between these individual intent structures demonstrated that each participant had a different perception of the situation prior to the group ISM session. Consensus and disagreement subgraphs were used to illustrate what the individual structures had in common and where they differed. These subgraphs were also used to illustrate the changes in perceptions which individuals underwent in agreeing to the group intent structure.

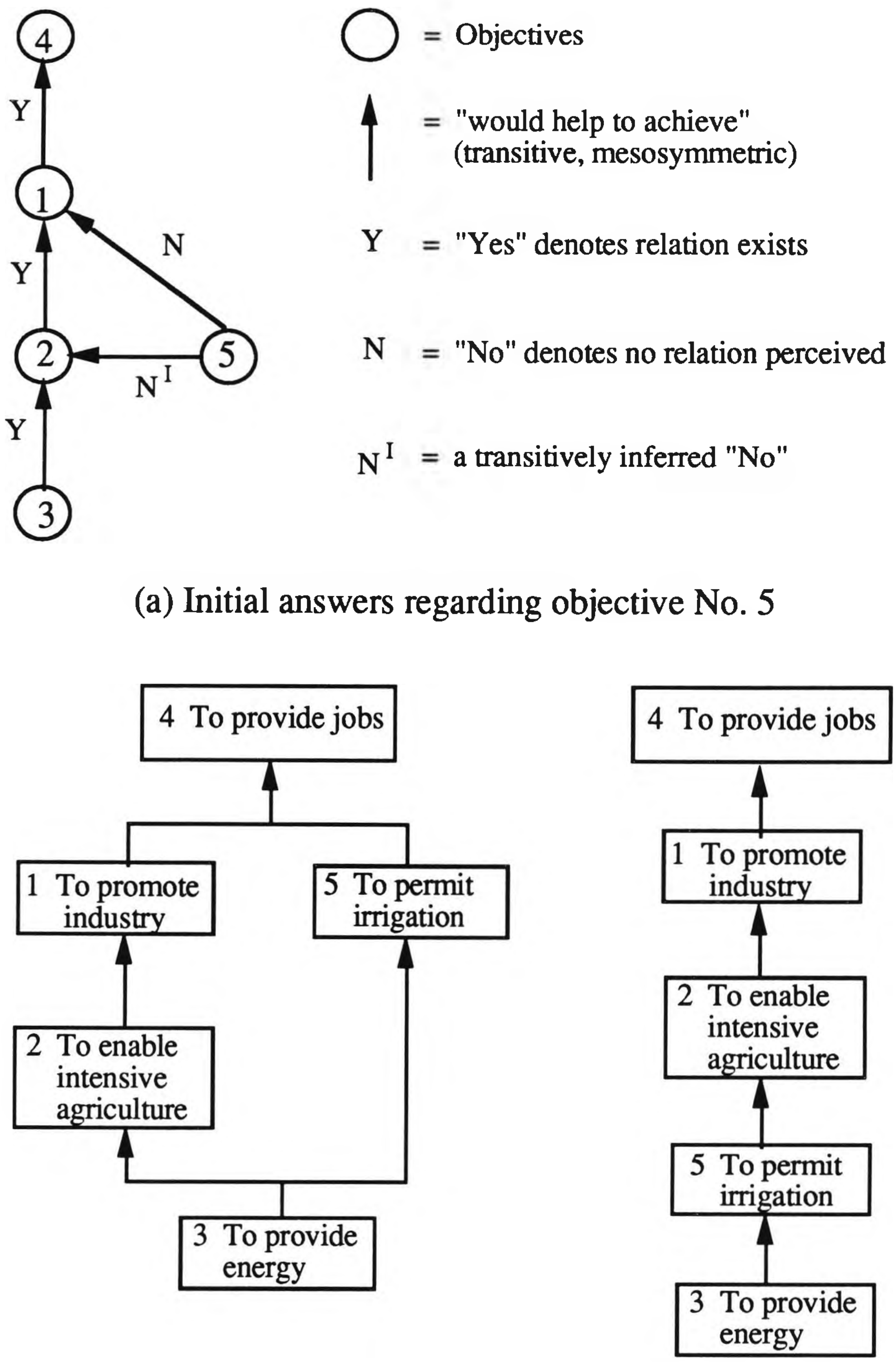
Such subgraphs provide a way of making explicit the areas of agreement and disagreement between individuals. The analysis shows the sort of differences in views which ISM helps participants to resolve and demonstrates that ISM may justifiably be called a learning process.

8.4 INTERMEDIATE STRUCTURES IN THE ISM PROCESS

8.4.1 The Need to Examine Intermediate Structures

One approach to conducting an ISM session is to deal in sequence with all the elements which it is desired to incorporate into the model without pausing to examine any intermediate structures. In this way time is not lost through extracting, displaying, discussing and amending intermediate models. The disadvantage of this approach is that any errors or misjudgements built into the model cannot be rectified until the display of the ISM towards the end of the session. Thus, earlier errors will be compounded during the model building as new elements are added. To avoid this, it is strongly recommended that opportunities are taken to enable the group to discuss and amend intermediate structures. Four reasons why such amendments may be necessary are discussed below.

First, the computer makes inferences based upon transitivity, a property which will be more clearly demonstrated by some contextual relations than others. For example, "precedes" and "is heavier than" are relations which, in the context of ISM, could be regarded as inherently transitive. However, other relations, e.g., "helps to achieve" and "strongly contributes to", are less inherently transitive, even though they may be regarded as sufficiently transitive for certain uses in ISM. With a large number of inferences being made by the computer, perhaps as many as 70-80%, it is desirable that the group has the opportunity to discuss and, if necessary, amend the structure from time to time.



(a) Initial answers regarding objective No. 5

(b) Intermediate structure (c) Amended structure

Figure 8.6 Example of the need for model amendment

Second, the group may give an answer which is inconsistent with a previous answer because they do not perceive the existence of a particular relationship between a pair of elements. Figure 8.6 gives an example of this. It shows an extract from a larger model concerned with an intent structure for a hydro-electric scheme in South East

Asia. Here, the group had already dealt with objectives Nos. 1 to 4, as shown by the "Yes" entries in Figure 8.6a, when objective 5 was introduced. The group could not, at that time, see a relationship from 5 to 1 and, as a consequence of their "No" answer to this question, a "No" was also inferred by the computer from 5 to 2 (see Chapter 4, Figure 4.1a). Subsequently, on inspection of the intermediate structure (Figure 8.6b) extracted after some more answers had been given, the group saw that a relationship from 5 to 2 and hence from 5 to 1 clearly existed. The model was thus amended to give Figure 8.6c. Had the structure not been discussed at this stage, any subsequent modelling would have built on the erroneous Figure 8.6b.

Third, since ISM is considered to be a learning process, it is to be expected that the perceptions and understanding of participants are likely to change during the course of an ISM session. The group may therefore wish to revise an answer given earlier in the process.

Fourth, ISM works on a basis of majority voting. Suppose that a group of, say, seven participants votes 4:3 in favour of a "Yes" answer to a particular question and, even though the facilitator has encouraged extensive discussion of the question, no closer agreement can be reached. If only one member of the subgroup voting "Yes" were to switch to a "No" vote, the answer and inferences consequent upon it would change. To ensure that a robust model as acceptable as possible to the whole group is built, discussion of intermediate structures, with the possibility of amendment where perceptions have changed, is desirable.

8.4.2 Activities Involved in the ISM Process

Figure 8.7 has been constructed to illustrate the activities involved in a typical ISM session. It makes allowances for the display, discussion and amendment of intermediate models during the session. (The sequence of four models shown in the boxes in the figure is adapted from Warfield (1974b).) As a result of thinking about the issue or situation being explored, participants have mental models, which are usually incomplete, of elements relevant to the situation and their interactions. Through the answers given to the questions posed, a matrix model is developed by

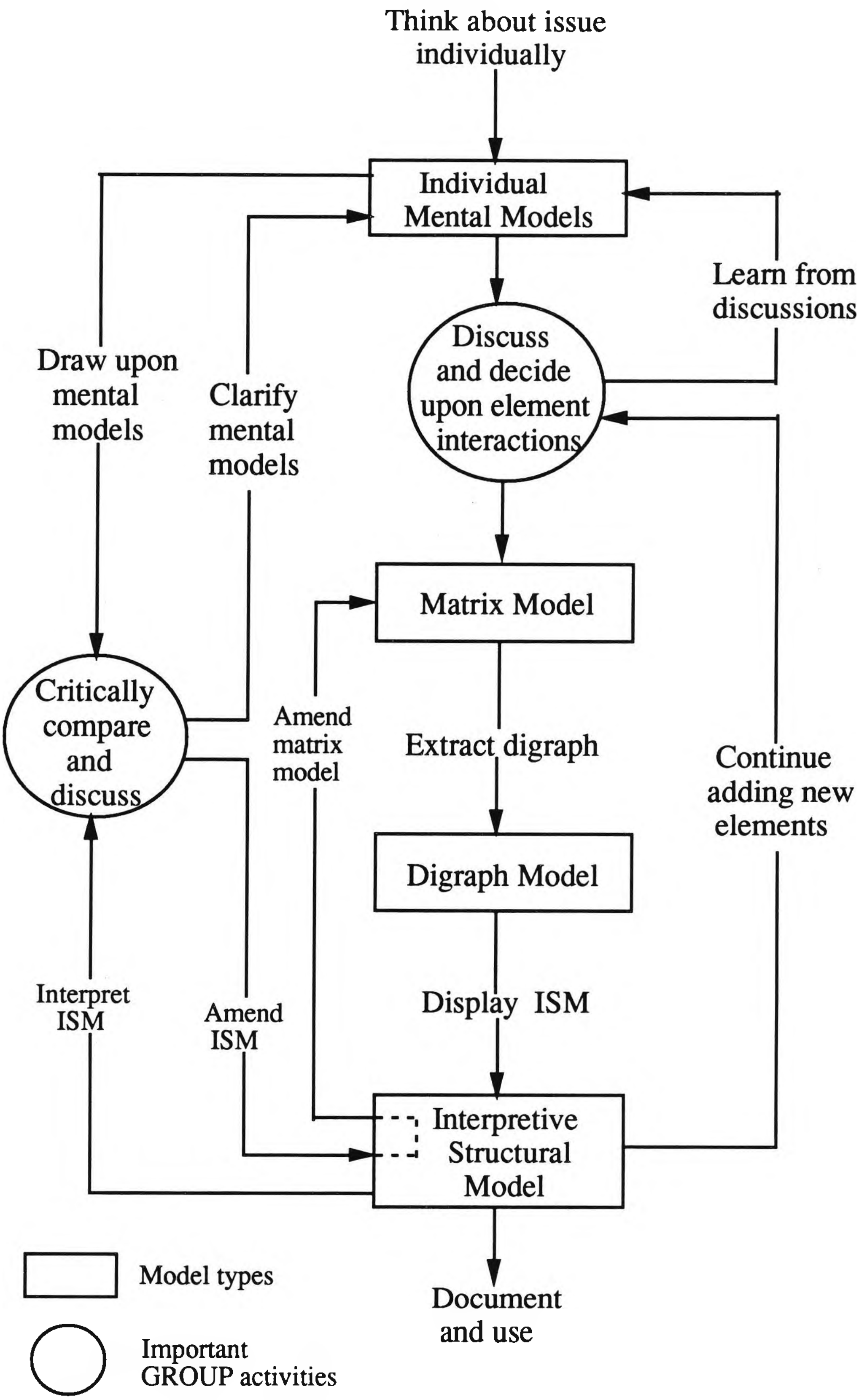


Figure 8.7 Activities involved in an ISM session

the computer. From this the computer extracts a digraph model which forms the basis for the visual display of the ISM. The ISM needs to be interpreted for the group by the facilitator. This may be done by reading systematically all the statements represented by walks on the map (Warfield, 1980a). Participants can then critically compare their mental models with the ISM and, if necessary, amendments agreed by the group can be made to the ISM. Both during the discussion that occurs when answering the questions posed by the computer, and during the interpretation and discussion of the resulting ISM, individual mental models may be clarified and changed.

The extraction and display of intermediate structures may usefully be repeated several times during a modelling session. This iterative process helps to ensure that, as the model develops, the group is adding new elements to an accepted structure. The software permits any agreed amendments to the visual display of the ISM to be entered into the computer in order to update the matrix model. In practice, the amendments are often quite small, typically involving the deletion or insertion of one or two relationships, or the change in position of one or two elements. Sometimes no changes at all are necessary. The procedure need not, in fact, take up an excessive amount of the group's time if the display of the ISM by the facilitator is done during normal breaks, e.g., for coffee and lunch. The group can then discuss the model when it reassembles.

The opportunities to discuss and amend the model can also help in behavioural terms. First, they enable the participants, who may not be familiar with ISM, to see at an early stage the form of model that they are producing with its obvious benefits. This helps to reinforce their enthusiasm. Second, the change in the nature of the group's activity introduces variety into the rather relentless series of questions posed by the computer, which is tiring particularly when dealing with a large number of elements. Third, from a systems perspective, there is also the advantage that participants are periodically reviewing the "whole", i.e., the ISM, as well as concentrating on the "parts", i.e., the elements and relations.

8.5 BENEFITS AND LIMITATIONS OF ISM

8.5.1 Benefits

Warfield (1976, 1982b), Watson (1978) and Waller (1983a) have discussed various benefits of ISM. The author's own experience of applying the method supports the following list of benefits, which may be observed when ISM is properly implemented and facilitated.

1. The group remains focussed on the issue, situation or problem; rambling discourse is minimised.

2. Ideas and thinking are clarified through focussed debate and communication.

3. Learning is promoted through discussion of different perceptions.

4. An appreciation is obtained of alternative viewpoints and arguments associated with the issue being explored.

5. Understanding is gained of the issue and the important factors involved.

6. Dominance by aggressive, high-ranking or articulate members of the group is reduced.

7. Members of the group who may be reticent are encouraged to contribute and have an opportunity to do so.

8. The method is adapted to human information processing capabilities and avoids cognitive overload.

9. Participants understand the method easily; there is no requirement for them to have any prior knowledge or familiarity with the underlying mathematics or the computer software.

10. The method provides an unambiguous means for visually displaying a complex set of interrelations between a set of elements.

11. Clear structures are produced from messy unstructured situations.

12. Both qualitative and quantitative elements may be included in the same model.

13. The model is owned by the group as a whole.

14. The model provides an effective means of communication.

15. Iteration is permitted so that the model may be amended as required during the process.

16. All pairwise comparisons between elements are considered systematically, either directly by the participants, or through logical inferencing.

17. Efficient use is made of the participants' time.

18. All decisions made by a group are recorded for future reference.

19. The method is context-free in the sense that it may be used in most multi-element situations, provided that a suitable transitive relation can be determined.

20. The products resulting from the use of the method are of real value to the client organisation.

8.5.2 Limitations

A number of potential limitations of ISM are listed below and commented upon. Again, they are based on the author's own experience of putting the method into practice, either in the cases referred to in Chapter 7 or with numerous groups of students. As with the benefits listed above, a number of them have been discussed by Watson (1978) and Warfield (1982b). They are described as "potential" limitations in the sense that many of them need not be limiting provided that due attention is paid to preparation, implementation and facilitation of the ISM process. However, where there are real limitations, it is important that the process designer and facilitator are aware of them.

In discussing these limitations, it is assumed that a user of ISM will be aware of certain obvious constraints regarding the use of the method. For example: that ISM is a tool for building qualitative rather than quantitative models; that the resultant structural models are static in terms of having stationary outputs, rather than dynamic in terms of having time varying outputs; and that in any one model only a single contextual relation can be used at a time.

1. The method assumes that the contextual relation used is rigorously transitive.

The mathematics underpinning ISM depends upon transitivity. As Warfield (1976:346) has remarked, any contextual relation used must be examined to ensure "that it is transitive, or that it is 'sufficiently transitive' that the exercise is likely to be useful". Thus whilst, for example, the contextual relation "precedes" is clearly transitive, the relation "strongly contributes to" is a less precise term and care must be taken to ensure that it is sufficiently transitive to be useful in a particular context.

2. The requirement for a "Yes" or "No" answer to each question may present choices that are too simplistic.

When using ISM, the group is required to give a "Yes" or "No" answer to each question. Where the group is not unanimous, the result of a vote is used after discussion of the particular question. Individual members of the group may, of course, not be satisfied with a particular decision even after hearing the arguments behind it and, consequently, they may feel dissatisfied with the resultant model. A true consensus may thus not always be obtained.

A second aspect regarding voting concerns the fact that some questions may be difficult to answer simply with either a "Yes" or a "No" response because one element may affect another in various ways depending on the particular circumstances.

A third aspect concerns the fact that some participants may be more knowledgeable about particular topics than others, yet all votes carry equal weights. In principle, a different weight could be assigned to each individual, either for an entire session or for particular questions (Warfield, 1982b). However, this could prove to be divisive and, if done for particular questions, difficult to manage in practice.

3. Participants may place different interpretations on the meanings of elements which will make it difficult for them to agree on how the elements interrelate.

It is essential that the element set used in an ISM session is clearly worded and that the meaning of each element is as unambiguous as possible. If this is not the case, participants will find it unduly difficult to agree on answers to questions regarding the interrelations between pairs of elements.

Although the computer software permits elements to be reworded during an ISM session, re-clarifying and editing of elements should be kept to a minimum as it can be time consuming and detracts from from the main purpose of the session. For this reason, it is important that any idea-generation method used to help participants identify an element set incorporates steps for the clarifying and editing of elements. Thus Nominal Group Technique is suitable for this purpose, whereas methods such as Ideawriting and Brainstorming (Osborn, 1957) have distinct shortcomings.

4. The order in which the elements are dealt with may influence the resulting model.

(See comments under 5 below).

5. The initial model may be only partially satisfactory.

The sequencing of elements will affect not only the order in which queries put by the computer are discussed by the group, but also which queries are discussed and which responses are inferred by the computer. In some cases the inferred answers may constitute 80% of the responses. Also, since ISM is designed as a learning process, it is only to be expected that some perceptions will change during the course of an ISM session so that earlier decisions may need to be reconsidered.

For both these reasons it is important that time is allowed for review and possible amendment of intermediate structures in order to ensure that the group is building upon an agreed base (see Section 8.4).

6. There are difficulties in dealing adequately with feedback between elements.

Feedback from one level to a lower level in a multilevel hierarchy is not permitted by the ISM algorithm. Elements that are agreed by participants mutually to affect one another are placed in a cycle at a single level. Furthermore, once a cycle has been created, the ISM software uses only one element in that cycle as a proxy element when raising queries concerning relations between the cycle and elements subsequently introduced into the process.

The facilitator can assist the group in avoiding the creation of unjustifiable cycles when using influence relations (see Chapter 4), which may result in large and inappropriate groupings of elements. This may be done: (i) by suggesting to the group that they should avoid creating cycles unless the interrelations between a pair of elements are clearly strong in both directions, i.e., a relationship in one direction does not dominate; and (ii) by discouraging the group from creating cycles that would be present only because of medium or long-term feedback effects.

Should cycles that the group finds unacceptable occur, it is possible to attempt to deal with them using ISM software that permits a cycle resolution procedure (Warfield, 1976:330-335). This allows the user to assign weights to relationships in a cycle on a scale of 1 to 9 according to the perceived strength of each relationship. The program then calculates a cycle threshold for the weights, which should enable the cycle to be resolved and result in a clearer picture of the important relationships present. A cycle of n elements requires n(n - 1) weights to be specified, e.g., 20 individual weights have to be specified for a five-element cycle. In practice this is time consuming, particularly when the weights have to be agreed by a group of participants, which is a considerable deterrent to its use.

7. Model validation in an empirical sense is not usually possible.

A model constructed using ISM is normally subjective in nature offering a well-argued interpretation of an issue as agreed by participants who possess knowledge of the issue. Although there is a body of discrete mathematics underpinning the method and its associated software, the actual diagrammatic models are essentially qualitative in nature. They are thus not amenable to validation in the empirical and quantitative sense in which attempts are made to validate mathematical or simulation models (Carson et al, 1983:43-45; Banks et al, 1988, as cited in Stevens, 1991:117-118). They have to be judged on such factors as whether the model building process increases the level of understanding among participants and whether the model users find the resultant product, i.e., the model itself, useful in practice (see Section 8.5.3). In this sense, the principle of model validation stated by Forrester (1968:3-4) seems as appropriate to a qualitative model based on ISM as it does to a mathematical simulation model: "Model validity is a relative matter. The usefulness of a mathematical simulation model should be judged in comparison with the mental image or other abstract model which would be used instead".

8. The ISM process may appear to force participants through a repetitive and rigid procedure.

The ISM process serves to keep the participant group focussed on the issue being explored and also ensures that all pairwise relations between elements are accounted for. However, the systematic and relentless stream of questions put by the computer can sometimes appear to be too rigid and constraining to participants. The result is that they may become tired and impatient and boredom may occur. It is thus vital that the facilitator is observant of the group dynamics and the level of participation of individuals (see Chapter 3). He or she is in charge of both the process and the working environment and must make every effort to ensure that interest and full participation are retained. Appropriate facilitator training is therefore essential.

9. The quality of the products depends upon the contributions the participants are able and willing to make.

A recurring theme in ISM, and in Interactive Management generally, concerns that of providing people who are directly involved in complex issues or situations with a means of dealing with those issues themselves rather than relying on external expertise (see Chapters 2 and 3). Ackoff (1981:66) has suggested that one of the implications of the participative principle (see Chapter 2) is that "... no one can plan effectively for someone else. It is better to plan for oneself, no matter how badly, than to be planned for by others, no matter how well." One assumption here is that the various stakeholders in a situation have the ability to resolve their own problems if provided with appropriate support.

It is thus important that the participant group is selected so that it has among its members those with appropriate knowledge and understanding of the particular situation being explored. Support from the facilitator, the methods and the computer can help the group to work more effectively and efficiently, but the products from any group work will ultimately be limited by the quality of the contributions of the participants. If the participants lack the necessary understanding, or are overly blinkered with respect to their particular organisational problems, or allow parochial interests of their own departments to dominate their thinking, then the resulting products may not be of much practical value.

10. The practice of ISM, in the context of Interactive Management, requires a significant level of resources.

ISM may be used by an individual, for example, someone working alone at a computer terminal to construct a model which helps to clarify his or her thinking about a problem. However, the discussion here focuses on the use of ISM with a participant group in the context of an Interactive Management support system. It is apparent that significant resources are required for such an activity, which may take place over several days. First, these involve the Interactive Management team (see Chapter 9) consisting of those carrying out the roles of consultant, facilitator and support staff, e.g., a computer operator. Second, they involve the physical resources of a decision support room, including a computer and relevant software. Furthermore, the time of the client and participants is involved. The overall commitment of people and physical resources is thus considerable and will limit the occasions on which the use of the approach is appropriate.

8.5.3 Evaluation by Clients and Participants

Attempts to assess the value of the workshops to clients and participants have been made in two respects. First, a number of statements have been supplied by clients for whom the various workshops were conducted. These statements are reproduced in Appendix 4 and confirm that the use of ISM and related methods was of real benefit to the organisations concerned.

Second, a questionnaire has been used following three of the more recent workshops (cases 2, 12 and 13 in Table 7.1) to assess the reactions of participants to the workshops. The questionnaire is reproduced in Appendix 5 and was designed at the author's request by Mr K.Hammer of the Interactive Management Unit. It contains questions relating to: the participants' reactions to the workshop methods and procedures; possible future benefits of the workshop; the decision support room environment and facilities; and the briefing information sent out. The questionnaires were conducted by individual face-to-face interviews with each of the participants at their place of work some time after the relevant workshop had taken place. Every one of the participants in the three workshops took part. As shown in Appendix 5, the results of the questionnaires are very encouraging. Participants generally indicate a high level of satisfaction with the methods and procedures used and with the working environment; they also consider the outcomes in terms of learning and documented products to be of benefit.

The main improvements suggested as a result of the questionnaire responses include:
(i) Process design. The design of any Interactive Management workshop needs careful thought to ensure, not only that it produces the desired results as a process of collective enquiry (see Chapter 9), but also to ensure that the process itself is well-paced and varied so that the commitment and enthusiasm of participants are retained without their becoming excessively tired.
(ii) Facilitator skills. These need to be of a high order as discussed in Chapter 3; thorough facilitator training is thus essential. The facilitator needs to be sensitive to the group dynamics and requirements and must manage the process so that participants: understand why they are undertaking a particular activity; know what is expected of them; and do not become so over-tired that their performance deteriorates.
(iii) Methods. Thought needs to be given to improving further the methods for idea categorisation and for writing mission/goal statements (see Chapter 9).
(iv) Briefing literature. This needs to be as clear and free of jargon as possible and efforts need to be made to see that all participants receive it in advance.

8.6 SUMMARY

This chapter has discussed the lessons for ISM arising primarily from the case studies described in Chapter 7. Section 8.2 focussed on priority structures. A new type of structure, called here a composite priority structure, has been put forward and tested in four of the cases. The relationship between this composite priority structure and other types of priority structures has been explained. The need for users of ISM to understand clearly the properties of contextual relations and digraph-based structures has been emphasised and an illustration, based on the building of a priority structure, has been given of the confusion which may arise when this understanding is absent. The way in which different resource requirements may be allocated to elements in priority structures has been demonstrated.

Section 8.3 focussed on lessons for intent and attribute enhancement structures. The way in which levels and clusters of elements in such structures may be identified has been illustrated. It has been proposed that building intent and attribute enhancement structures is a fundamentally different kind of activity for participants to building priority structures. The use of subgraphs to illustrate that learning takes place during an ISM session has been demonstrated for an intent structure. In Section 8.4 a case has been made for the need to examine intermediate structures during an ISM session. The activities involved in such a session have been explained and portrayed diagrammatically.

In Section 8.5 the benefits and limitations of ISM have been assessed. In the case of the limitations, these have each been commented upon, and it is noted that these are "potential" limitations in the sense that many need not be limiting provided that the ISM user is aware of them and pays proper attention to preparation, implementation and facilitation of the ISM process. This section also reports on attempts to assess the value of the planning workshops through the use of questionnaires with participants and statements from clients. It is concluded that the feedback obtained is generally favourable indicating a high level of satisfaction with the workshops.

Whilst this chapter has focussed specifically on lessons for ISM, Chapter 9 considers lessons for the wider context of Interactive Management and for systems science.

Chapter 9

LESSONS FOR INTERACTIVE MANAGEMENT AND SYSTEMS SCIENCE

9.1 INTRODUCTION

This chapter comprises two distinct parts. The first concerns lessons for Interactive Management (IM) which has provided the wider context in which the ISM work was undertaken. The activities involved in an IM intervention are examined along with the design of a process of collective inquiry. A method for idea categorisation, which was developed during the workshops, is formally described.

The second section concerns lessons for systems science. First, the topic of complexity is considered, including what the term means and those aspects of it that are addressed by ISM. Then, the topic of modelling is discussed, focussing particularly on qualitative modelling and the involvement of the client in the model building process.

9.2 LESSONS FOR THE METHODOLOGY OF INTERACTIVE MANAGEMENT

9.2.1 Perspectives on the Methodology of IM

In Chapter 3 the distinction was made between the way that the terms "methodology" and "method" would be used in this thesis. It was suggested that IM as a whole could be regarded as a methodology that provides a framework for constructing a process of inquiry. Within the methodology itself, a number of specific methods, such as NGT, can be used to accomplish certain aspects of that process of inquiry.

The experience of the planning workshops enables some conclusions to be drawn about the methodology of IM. Three perspectives on the methodology are shown in Figure 9.1. The first embodies the wider sequence of activities in a complete IM

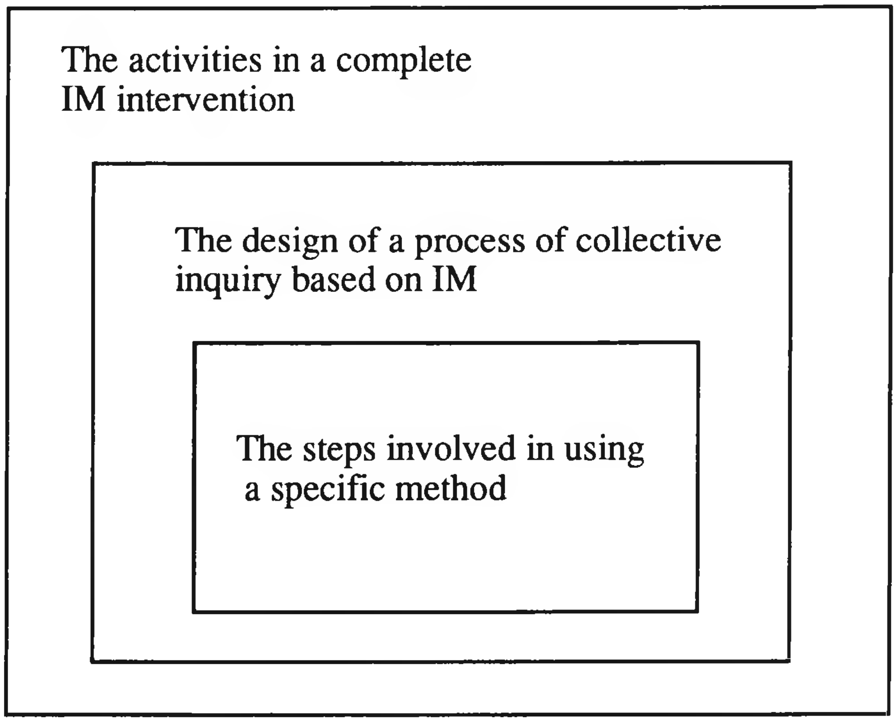


Figure 9.1 Three perspectives of the methodology of Interactive Management

intervention, from initial contact with a potential client organisation, through the planning workshop itself, to the implementation of the results. This is illustrated in Figure 9.2, which is discussed in Section 9.2.2 below. The second perspective, at a higher level of resolution, considers the design of a process of collective inquiry into an issue, based on IM. This includes, for example, how the various methods are to be sequenced during a particular planning workshop. Aspects of this are discussed further in Section 9.2.3 below. The third perspective, at a still higher level of resolution, considers the steps involved in using a specific method. This has been examined in detail for ISM, NGT and Ideawriting in Chapters 4, 5 and 6 respectively and will not be discussed further here. However, the methods developed during the workshops for idea categorisation and writing mission statements, which have been mentioned in the workshop reports (see Table 7.1), are considered in Sections 9.2.4 and 9.2.5.

9.2.2 The Activities in a Complete IM Intervention

Figure 9.2, illustrating the first perspective, shows the activities and roles involved

Stages	Activities	Roles
	Receive request to investigate a complex issue	Potential client and one of IM team
Situation assessment	Examine issue with client organisation	IM consultant with client
	Decide whether IM could provide an appropriate approach	IM consultant
	Design process of collective inquiry into the issue, based on IM	IM consultant with IM team and client
Workshop preparation	Select participant group	Client with IM consultant
	Prepare detailed workshop plan	IM consultant with IM team and client
	Inform participants about planning workshop and provide relevant documentation	Client with IM consultant
	Conduct planning workshop using methods and principles of IM	Facilitator and support staff with participant group
Group work	Distribute, immediately, the products of the group work	Support staff
Report writing	Prepare report on planning workshop with recommendations for client organisation	IM consultant with facilitator and support staff
	Implement results and recommendations	Client
Implementation	Follow up	IM team

Figure 9.2 Important activities and primary roles in an IM intervention

in an IM intervention of the type described in the cases in Chapter 7. It is not intended to be an exhaustive list but to pick out important activities and to illustrate a typical pattern of events. In practice, in particular cases, the activities, their sequence and the associated roles may show minor deviations from the figure.

Initially, an approach is made to one of the IM team from a potential client. A member of the team, called here the IM consultant, will then meet with the client, and possibly other people from the client organisation, to examine the issue, situation or problem of concern. The IM consultant then has to decide whether IM can offer an appropriate approach to the situation. If a decision is made to go ahead at this stage, a process of inquiry, based on IM, has to be designed to explore the issue. The objectives of the work have to be defined and the way in which the methods of IM can be used to achieve these objectives determined. The participant group needs to be carefully selected in accordance with the criteria discussed in Chapter 3. A detailed workshop plan has to be prepared, taking particular care to ensure that sufficient time has been allocated to enable the sequence of methods to be put into practice properly. Assuming that the client has approved the workshop plan and that payment considerations have been agreed, the participants can be informed about the arrangements and provided with any background documentation which may help them to participate in the workshop as fully and knowledgeably as possible. The facilitator, who may also be the IM consultant, with the help of support staff, can then conduct the workshop with the participants as described in the various supporting papers. As far as possible, the products of the group work resulting from the use of each method should be distributed immediately to each participant, so that they have the relevant information to contribute fully to the next stage of the workshop. Subsequently, a report is prepared for the client giving both the products of the group work and recommendations for the client organisation. The client should be given an opportunity to comment on a draft of the report. The client will normally be responsible for implementation of the results and recommendations, and may require follow-up advice from the IM team on this. Follow-up activity may also be initiated by the IM team to explore the participants' reaction to the workshop and to see if implementation does, in fact, take place.

The right hand column of Figure 9.2 refers to five primary roles associated with the activities. Three of these roles, those of IM consultant, facilitator and support staff, relate to the IM team; the other two, those of client and participant, are external roles relating to the client organisation in the context of the cases described in this thesis.

(It should be noted that, in some situations, a number of those having external roles may not be part of the client organisation, e.g., certain stakeholders). Warfield (1990:264) distinguishes nine roles. If these are also partitioned into external and IM team roles they may be grouped as follows:

External Roles	**IM Team Roles**
Top manager	Process designer
Broker	Facilitator
Participant-designer	Report manager
Stakeholder	Supporting process roles
Implementer	

Five of these roles are broadly similar to those shown in Figure 9.2, although in some instances they are given different names. For example, Warfield does not use the terms client and consultant to describe the roles of top manager and process designer respectively; the former pair might be considered common terms for such roles in a U.K. context. Particularly helpful is the notion of a broker, as distinct from a top manager (or client), who is typically employed in the client organisation, is well acquainted with the issue, and who works closely with the IM team on behalf of the organisation. In the author's own work no distinction has been made between these two roles. However, in cases Nos. 3, 4, 10, 14 and 15 described in Chapter 7, such roles were, in retrospect, easily distinguishable and, in case No. 3, recognition of this distinction would have been helpful, particularly when preparing the client report.

9.2.3 Designing a Process of Collective Enquiry

In preparing for a planning workshop, it is essential that careful thought is given to the process of inquiry that is to be undertaken during the workshop. Each of the methods, ISM, NGT and Ideawriting, may be employed in isolation but, as shown in Table 7.1, they may be combined together as an effective process of collective inquiry in a variety of ways. Designing such a process will be aided by developing, with the client or broker, a clear understanding of the aims of the workshop. Once these have been agreed, consideration can be given to the way in which the methods may be used to accomplish those aims. Judgement, based upon knowledge of the principles and methods of IM, as discussed in Chapters 2 to 6, is important here as well as experience with the use of the methods. As Warfield (1990) has suggested, five fundamental operations that can be carried out with ideas are those of generating, clarifying, structuring, interpreting and amending the ideas. The methods available have to be organised to carry out these operations in a logical sequence which will enable the group to move towards the achievement of the agreed aims of the workshop.

Table 1 in s.p.F showed the activities involved in connection with a planning workshop for a proposed Centre for Enterprise Management. The nine activities represent a complex sequence of group work and illustrate the careful thought needed in designing such a process of inquiry.

Certain specific lessons relating to the process of inquiry may be drawn from the work discussed in Chapter 7.

(i) If a model is to be constructed using ISM and the elements are not known beforehand, NGT, with its clarification and voting steps, offers an effective method for element generation; it is to be preferred for this task to methods like Ideawriting where no such opportunity for idea clarification occurs.

(ii) Chapter 8 discussed the behavioural difference between the construction of an intent and a priority structure. It may be concluded that building an intent or attribute enhancement structure before building a priority structure will enable the participants to learn from one another so that they acquire an improved understanding of the elements and their interrelations in advance of setting priorities among the same set of elements.

(iii) Ideawriting may be used to encourage participants to think about the problem situation and to exchange ideas in a structured way prior to generating an element set using NGT.

(iv) The Ideawriting product may be used as one means of checking whether the NGT product provides a suitably comprehensive set of ideas. For example, the participants can examine whether an objective set generated using NGT covers all the issues raised through the earlier use of Ideawriting. If it does not, consideration can then be given as to whether further objectives need to be added to the set.

(v) Ideawriting may be used to help initiate team building amongst the participants at the start of the planning workshop.

(vi) The wording of any trigger questions used for Ideawriting or NGT purposes needs particular care and attention (see Chapter 5). This is because they have such a significant influence on the direction in which the thinking of participants is focussed and, consequently, on the products resulting from the use of the methods.

9.2.4 Idea Categorisation

When building a composite priority structure, it is necessary to categorise the elements to be prioritised. ISM may be used to do this provided that the software available can cope with a symmetric contextual relation such as "is similar to" which will enable the elements to be grouped into a category structure (see Chapter 4). However, this can be a rather time-consuming use of ISM given the nature of the product achieved, i.e., a simple clustering of elements into sets. Also, separating items into sets is perhaps an activity where it is advantageous to have a constant overview of the whole picture as well as focussing on particular pairs of elements and their interrelations.

During the course of the planning workshops, a method was developed that enables a group to categorise quite a large set of ideas by hand relatively quickly. It was first used in case No. 9 (Table 7.1) and subsequently in cases Nos. 2, 3 and 5. The steps of the method are explained in Figure 9.3. It should be noted that, as with ISM, categorising in this way intentionally deters the participants from grouping the elements under predetermined headings, which would prejudge the categories that might otherwise emerge.

9.2.5 Mission Statements

In seven of the planning workshops a mission statement for the organisation concerned was written by the participants during the last stage of the workshop.

A method for doing this with a largish group of, say, six to ten participants is described below. It has evolved from a procedure that the author first observed

1. Each idea is listed separately on a display card, e.g., a "Post-it " note.

2. The facilitator takes the ideas one by one in turn and displays them to the group on a display board, e.g., a white board.

3. As each new idea is displayed, the group decides whether it has a perceived similarity with any other idea(s) already on the board.

4. The facilitator places ideas perceived to be similar to each other in clusters which are kept on display on the board.

5. The above procedure is continued until all the ideas have been examined by the group and placed in clusters having perceived commonality and distinction.

6. The clusters are given descriptive headings, each of which expresses a common theme displayed by the ideas in the relevant cluster.

7. All the ideas in each cluster are checked for consistency with the relevant heading and amendments are made as appropriate.

8. A record is made of each category heading and the ideas within each category.

Figure 9.3 A method for idea categorisation

being used at the Centre for Interactive Management at the University of Virginia. The participants are split into two subgroups each of which is asked to select a chairman. The subgroups are then asked to work separately on a task posed by the facilitator, for example, "Using the information produced so far in the workshop, prepare a mission statement for the XYZ Service and a set of key goals to support that mission." Each subgroup prepares its response to the task on flip chart sheets. At the end of the allotted time period, the subgroups are brought together in a plenary session and the respective mission statements and key goals are displayed. The facilitator then takes the whole group systematically through a discussion of the respective components of each product, encouraging the participants to suggest ways in which the mission statements and goals suggested by each subgroup may be combined to produce a single product. When fewer than six people are involved, the subgroups are unnecessary and the participants can work as one group; the same sort of procedure is followed but in this case only a single statement results. Examples of mission statements produced using the above method are given in the supporting papers (see Table 7.1). Appendix D of s.p.C and Appendix C of s.p.I have been included as examples of mission statements and key goals prepared separately by the subgroups involved.

The production of such statements serves several purposes. It helps the participants to encapsulate their views on a shared vision that has emerged for the organisation involved as a result of the workshop. The statement does not replace the other workshop products; rather, it serves to supplement them. Subsequently, the statement can be used to convey to interested parties the group's vision for the future of the organisation. In addition, the activity provides a way of rounding off the workshop and drawing it to an appropriate conclusion.

9.3 LESSONS FOR SYSTEMS SCIENCE

9.3.1 Dealing with Complexity

In their book entitled "Dealing With Complexity: An Introduction to the Theory and Application of Systems Science", Flood and Carson (1988:19) suggest that a typical response from a systems scientist to the question "What is systems science all about?" might be "that it is about 'dealing with complexity' ". This is a laudable ambition for what is a relatively new subject, although it should perhaps be viewed in an historical context; for example, as Phillips (1976:5), observes: "One of the perennial problems in man's intellectual history has been finding the most appropriate way to study any complex entity or system". In considering lessons for systems science, this subsection will attempt to examine those aspects of complexity that are addressed by ISM when used in the context of Interactive Management.

(i) The meaning of complexity

In attempting to explore the meaning of complexity, Flood (1987) distinguishes between two different aspects of it (Figure 9.4). The first aspect is associated with the system or situation under study. Here, complexity is considered to arise because of the presence of many parts or elements in the system with numerous interrelationships between them; this is labelled by Flood as the "systems dimension" of complexity. Within the field of systems, this aspect relates to what might be thought of as a traditional view of complexity. For example, Simon (1965: 63), writing about the architecture of complexity, states: "Roughly by a complex system I mean one made up of a large number of parts that interact in a nonsimple way." Bertalanffy (1972:25), writing about General Systems Theory, notes the looming "problem of 'organised complexity', that is, of interrelations between many but not infinitely many components". Hall (1989:25), writing about systems methodology, states: "Therefore, the number of parts, the number of types of parts, their connectivity, the number, and the number of types of relationships, *all* must be at the core of the concept of complexity."

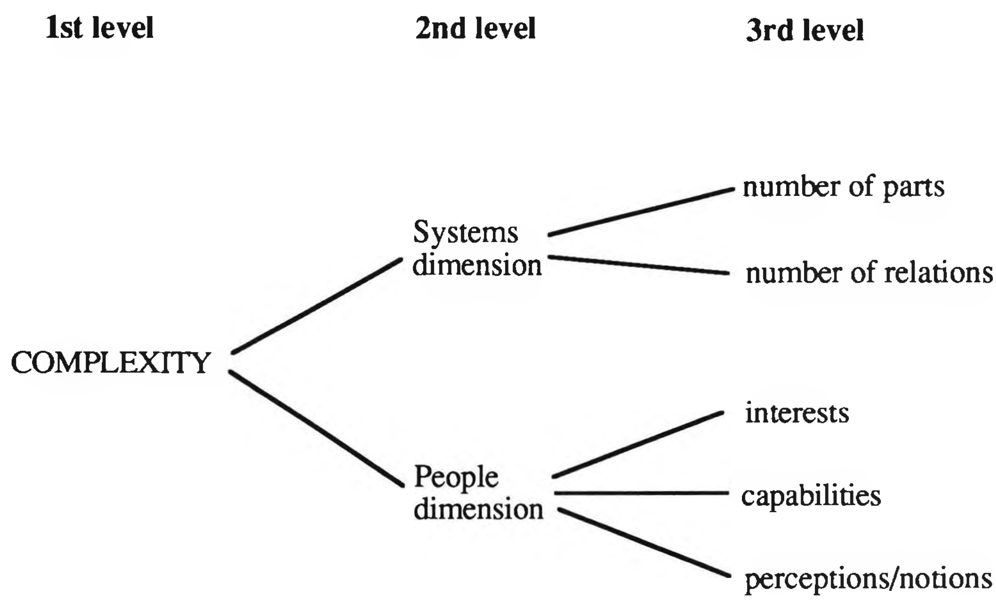


Figure 9.4 Flood's "Disassembly of complexity" (based on Flood, 1987)

The second aspect of complexity distinguished by Flood is associated with the interpretation of a system or situation by observers and is considered to depend upon their interests, capabilities, perceptions and notions; this is denoted as the "people dimension" of complexity. Flood (1988) subsequently attempts to extend the "people dimension" by splitting it into two parts. The first is described as "psychological complexity", embracing the terms already mentioned under the "people dimension", whilst the second is described as "metaphysical complexity" and relates to values and beliefs.

Warfield (1990:133) draws a distinction between "situational complexity" and "cognitive complexity". The former may be interpreted as those aspects of the situation under study that the mind is able to intercept. Cognitive complexity relates to those aspects of our understanding of the situation that make interpretation difficult.

Both Flood's and Warfield's explanations of the meaning of complexity have something in common. They are of interest in the context of Interactive Management because of the way in which they quite explicitly consider complexity to be a function of both the situation or system being explored and the way that the situation is interpreted by an observer(s).

(ii) Aspects of complexity addressed by ISM

In considering those aspects of complexity that are addressed by ISM, it will be helpful to draw upon the ideas of both Flood and Warfield referred to above. This is done in Figure 9.5, where Warfield's term "situational complexity" is used to refer to the complexity of the issue, situation or problem being explored. This is preferred to Flood's term "systems dimension" in that it may or may not be appropriate to describe the issue, situation or problem being explored as a "system". Furthermore, as the focus of Interactive Management is on work with groups of participants, it is desirable when considering the "people dimension" of complexity to distinguish explicitly between the "cognitive complexity" relating to an individual's understanding and interpretation of a situation, and the "pluralistic complexity" resulting from the fact that individuals in a group will interpret issues differently. Figure 9.5 indicates that ISM, when used in the context of Interactive Management, attempts to address all three areas of complexity: situational, cognitive and pluralistic.

Clearly, there can be little doubt that ISM, supported by NGT, attempts to address **situational complexity**. The identification of elements and explicit examination of the relations between them are a major focus of ISM and one of the things that it was designed to do.

With regard to **cognitive complexity**, it will be helpful to make use of the terms suggested by Flood in connection with his "people dimension", i.e., perceptions, notions, capabilities and interests, and to adopt his interpretation of them.

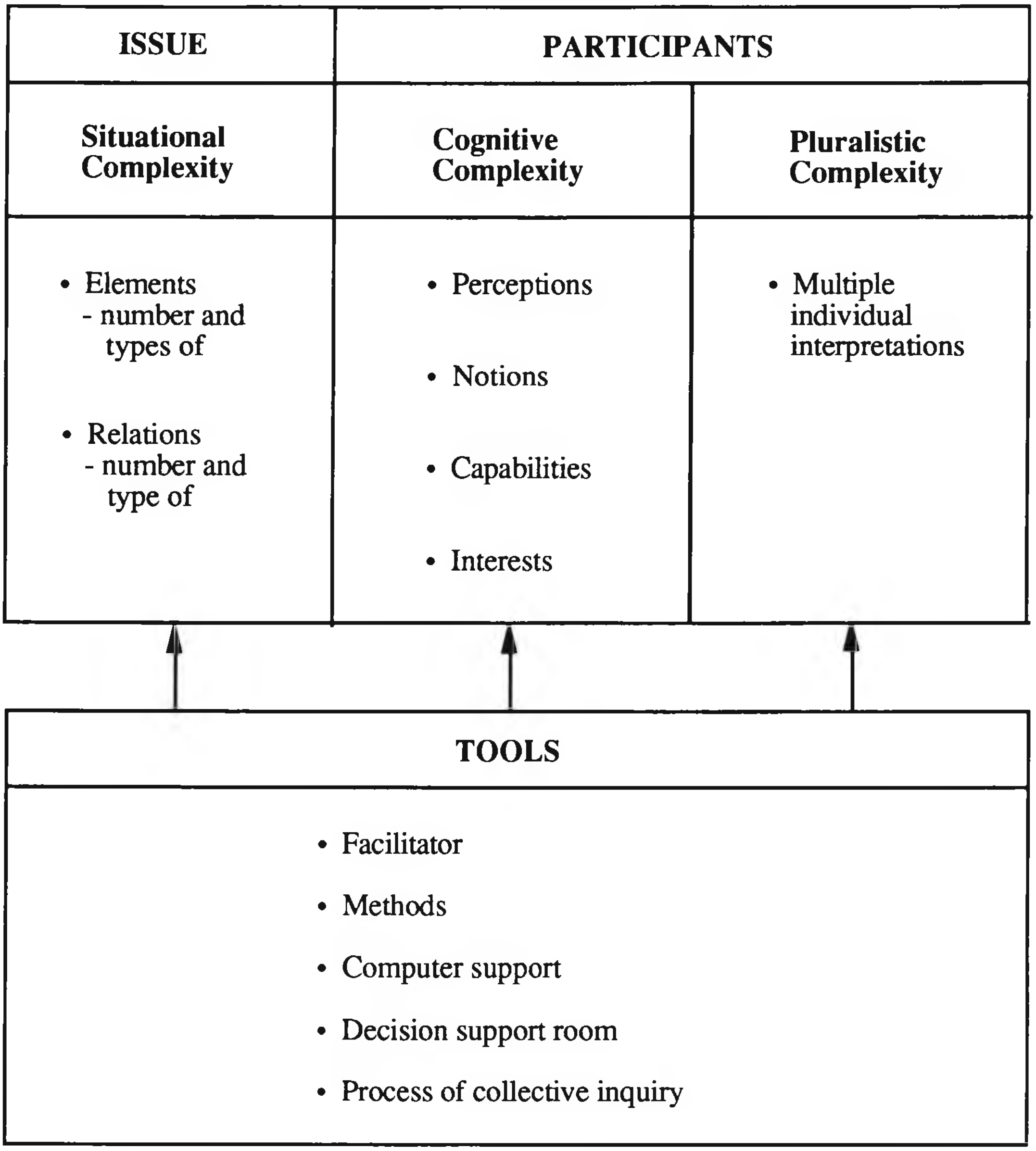


Figure 9.5 Aspects of complexity addressed by ISM when used in the context of IM

"Perception" refers to the way that we gain an appreciation of a situation in order to construct mental models. The term "notion" is related to this and refers to an individual's conception of the mental model so constructed. It is proposed here that the process of ISM helps individuals in both these respects as implied by Figure 8.7. The term "capability" refers to the fact that people will have different capabilities in dealing with complex issues. ISM addresses this in that it is designed to reduce the cognitive burden (Warfield, 1990) experienced by participants, by breaking complexity down into manageable "chunks" (Miller, 1956, as discussed in supporting paper A) and by ensuring that the forms of diagrammatic representation used have unambiguous rules of construction and interpretation. With regard to "interests", participants will have varying interests both in any particular issue as a whole and in specific aspects of it. Flood and Carson (1988:21) quote Ashby's (1973) striking illustration of this, whereby a neurophysiologist would consider the brain with its "feltwork of fibres and a soup of enzymes" as being complex, whereas a butcher might consider it as simple in that "he has to distinguish it from only about thirty other 'meats' ". The participative nature of an IM workshop, the structured debate which forms part of the methods used, and the subtle pressure on people to contribute, all help to raise the interest of participants in the situation being explored.

The third column in Figure 9.5 which is labelled **pluralistic complexity**, explicitly recognises the multiple individual interpretations of a situation which will arise as a result of individual cognitive complexity. One aim of ISM is to address this by helping participants to arrive at a "true consensus" view of an issue (Adair, 1987:68-69). This implies that: the issue has been thoroughly discussed by the participants; that communication has been open enough for members to feel that they have had an opportunity to influence decisions; and that everyone accepts that whilst one particular solution is not necessarily everyone's preferred solution, it is an acceptable way forward. The participative nature of ISM should help the individuals involved to appreciate one another's perception of a situation and to learn more about it. In so doing they may, of course, find that the situation is more complex than they had previously appreciated. Nonetheless, the improved understanding should enable those involved to address the situation in a more informed manner.

(iii) Complexity of the Interactive Management system

Figure 9.5 also serves to illustrate the complexity involved in running an IM planning workshop. The workshop designer has available a set of tools which need to be carefully integrated to make the workshop productive. These include: a variety of methods which may be combined to provide a process of collective inquiry; computers, software and peripheral displays; the equipment and layout of the decision support room; personnel including a facilitator, computer operator and other support staff. The design of the workshop requires that these tools be combined into a complex system which enables the three types of complexity associated with the issue and the participants to be addressed simultaneously. The implementation of the workshop by the facilitator is particularly demanding in that he or she has to ensure that the tools are coordinated so as to make effective and efficient use of the participants' time throughout the duration of the workshop; there will probably not be a second opportunity to get it right!

9.3.2 Modelling

In considering lessons for the discipline of systems science, the general recognition of the importance of model building within the discipline should be emphasised. For example, in their book on systems science, Flood and Carson (1988:35) write: "As the aim of this book is to investigate the means by which man can deal with complexity (which is not readily observable and certainly requires suitable simplification), models offer us precisely the sort of approach we require". Kalman (1980:4), referring to the methodology of "systems" within the context of system theory, states that: "It is safe to say that the notion of a model plays a central role.", whilst Tomlinson (1984:212) considers that "... the building of a model remains at the heart of the ORASA [Operational Research and Applied Systems Analysis] process, and is perhaps its most distinctive feature."

ISM may be considered as one of a number of modelling approaches which form part of the discipline of systems science. The lessons for ISM that were discussed in Chapter 8 may thus be considered implicitly as lessons for systems science. However, two other lessons regarding modelling are discussed below.

(i) Qualitative modelling

Supporting paper A summarised the way in which ISM uses the discrete mathematics of logic and structure (including set theory, matrix theory, graph theory, binary relations and Boolean algebra) to represent systems described in terms of elements and relations. Waller (1983b; 1983c) has referred to this kind of mathematics as a qualitative mathematics which provides an appropriate language for tackling complexity.

Consequently, ISM provides a modelling approach which does not force model builders to focus only upon highly quantifiable elements. Thus variables measurable on low order nominal and ordinal scales of measurement (Hall, 1962b; Ghiselli et al, 1981) can coexist in the model alongside elements that are measurable on higher order interval and ratio scales. For example, consider Figure 2 in supporting paper S (Hammer and Janes, 1990), which shows an extract from a larger ISM. This contains the quantitative elements "Profits falling" and "Frequent production breakdowns", together with the qualitative elements "Narrow engineering-based company culture" and "Lack of leadership from the managing director", which are (notionally) measurable on nominal or, at most, ordinal scales. In many situations, such qualitative elements may be as significant as the quantitative ones; they should not be left out of whatever analysis of the situation is undertaken simply because the modelling approach adopted is not capable of accommodating qualitative aspects.

The way in which ISM enables the user(s) to deal with difficult-to-quantify elements and quantifiable elements at the same time in the same model through the use of "qualitative mathematics" provides a distinct contrast to more conventional modelling approaches such as, for example, system dynamics (Forrester, 1971; Coyle, 1977; Wolstenholme, 1990). Here, the underlying mathematics is quantitative in nature and is based on the use of difference equations. This requires variables that are measurable on high order scales which demonstrate the properties of additivity and enable arithmetic operations to be performed.

(ii) Using Interactive Management to involve the client in model building

Chapter 6 explained how IM was integrated into a process of model building and computer software development undertaken for the Department of Health. An overview of the process was given in Section 6.4.1 and the roles of IM and Ideawriting in this were discussed in Section 6.4.2.

It is considered that the process, as summarised in Table 6.5 of Chapter 6, when implemented in context of IM, provides an effective and efficient way of involving the client organisation throughout the model building activity. In conventional modelling, e.g., in fields such as operational research and management science (Anderson et al, 1985), formal ways of involving the client in the model building activity are frequently neglected. Such involvement ensures that the eventual models constructed incorporate the variables that the client wants and that they are at the appropriate level of detail, i.e., the models represent the "real-world" situation in sufficient detail so as to be of practical use, but not in so much detail as to be incomprehensible to the user. In addition, it ensures that any resulting software is in an acceptable and usable form.

9.4 SUMMARY

The first half of this chapter has discussed lessons for Interactive Management. The subject has been considered from three perspectives and each of these has been examined in detail. First, the important activities in a complete IM intervention have been analysed and sequenced and roles have been allocated to those activities. Second, the design of a process of collective inquiry, based on the principles and methods of IM, has been discussed and specific lessons relating to this have been stated. Third, a method for idea categorisation, which was developed during the workshops, has been formally described; a method for writing mission statements has also been explained.

The second half of the chapter has discussed lessons for systems science, a subject very much concerned with ways of dealing with complexity and with modelling as an aid to this. The meaning of the term complexity has been examined and three important aspects of it have been delineated: situational, cognitive and pluralistic. It is concluded that ISM, when used within the context of IM, attempts to address each of these three aspects of complexity. The complexity of the IM system itself has also been noted. With regard to modelling, it is considered that ISM provides a qualitative mathematics which enables models containing qualitative variables to be constructed. It is also concluded that IM may be used to provide a means of involving a client organisation directly in the process of model building and software development.

Chapter 10 draws together the conclusions of this thesis.

Chapter 10

CONCLUSIONS

10.1 INTRODUCTION

This thesis is concerned with the application of ISM and related idea-generation methods, Ideawriting and NGT, within the context of Interactive Management. This chapter draws together the conclusions of the work and consists of three parts: first, consideration is given as to the extent to which the objectives stated in Chapter 1 have been achieved; second, the author's contribution to the knowledge of the subject matter is summarised; and third, suggestions are made for possible future work in this field.

10.2 ACHIEVEMENT OF OBJECTIVES

The **primary objectives** listed in Section 1.4 are each discussed below. The chapter reference(s) following each objective indicate the part of the thesis which relates to that objective.

1. To show how ISM has been extended as a method. (Chapters 7 and 8)

The concept of a new type of ISM structure, called here a composite priority structure, has been put forward and tested successfully in a number of applications. A classification scheme has been suggested for priority structures and the composite priority structure and its derivative, the composite aligned priority structure, have been fitted into this scheme. The way in which subgroupings of elements in intent or attribute enhancement structures can be identified has been demonstrated; these form levels or clusters in the structures.

2. To assess ISM critically and draw out lessons for its use. (Chapter 8)

The activities involved in the ISM process have been analysed diagrammatically and the need to examine intermediate structures within that process emphasised. The importance of a proper understanding of contextual relations and their properties has been illustrated. Use has been made of subgraphs to demonstrate the way that differences in views between participants may be resolved during an ISM session. The benefits and limitations of the method have been examined and, in the case of the latter, discussed in some detail. Evaluative feedback on a number of workshops has been obtained from both clients and participants; this confirms that those involved generally appear to have benefitted substantially.

3. To show how the range of application of ISM has been tested and extended by identifying and exploiting new areas. (Chapter 7)

As far as the author is aware, the fifteen workshops described represent the first time that ISM has been widely applied in the United Kingdom. The cases involved demonstrate the use of the method across a range of public sector organisations including university administrative and academic departments, a national industrial training board, district health authorities, a county council and an urban police force.

4. To demonstrate how ISM may be used as a management tool within the framework of Interactive Management. (Chapter 7)

The majority of the workshops were undertaken for managers and were designed to further the planning and management of the organisations concerned. The workshop summaries in Chapter 7 and the supporting papers demonstrate that benefits of both a process and a product nature have accrued to the management teams involved.

5. To assess two idea-generation methods, Ideawriting and NGT which may be used in conjunction with ISM. In addition, to show how these have been applied and, in the case of Ideawriting, extended. (Chapters 5 and 6)

The steps of both methods have been explained and illustrated, and their use in conjunction with ISM has been described. Data on the number of ideas generated and the duration of the methods has been collected and analysed. The way that Ideawriting may be extended to include formal steps for idea categorisation and editing has been explained. An improved measure for the relative diversity of opinion among participants in an NGT session has been proposed. The benefits and limitations of the two methods have been examined and compared.

6. To draw out lessons for Interactive Management and systems science.(Chapter 9)

With regard to Interactive Management, the activities involved in an intervention have been analysed and lessons have been drawn for the design of a process of inquiry based upon Interactive Management. Formal methods for idea categorisation and the writing of mission statements have been described.

With regard to systems science, lessons have focussed upon two areas concerned with complexity and modelling. In the case of complexity, the aspects of it that ISM attempts to tackle have been delineated: these are situational, cognitive and pluralistic complexity. In the case of modelling, ISM may be considered as providing a valuable qualitative modelling language. Furthermore, the way in which Ideawriting and the framework of Interactive Management may be used to involve a client organisation directly in the process of model building and computer software development has been demonstrated with applications in the Health Service. (It is noted that the lessons relating to ISM referred to above may also be regarded as lessons for systems science.)

Two **secondary objectives** were also stated which were intended to support the primary objectives. These are discussed below.

7. To explain the framework of Interactive Management and show how it has been used to establish a decision support room at City University. (Chapters 2 and 3)

Important contributions to the development of Interactive Management have been examined including, particularly, those of Warfield and Christakis. Areas of related work have also been discussed. Five components that can make group work more productive have been considered in some detail; these are: the participant group, the facilitator, the methods, the computer support and the decision support room. The way in which the latter two have been implemented at City University has been explained, including the evolution of the computer support and the design of the decision support room.

8. To explain the principles underpinning ISM as a modelling tool and to outline the operation of the ISM software developed at City University. (Chapter 4)

The principles of ISM have been explained including the process of model construction. The importance of contextual relations and their logical properties in the use of ISM has been emphasised. An overview has been given of the development and operation of the software, ISM-PC, written for a personal computer.

10.3 CONTRIBUTION TO KNOWLEDGE

The author's contribution to the subject is contained in the above discussion concerning the way in which the objectives set out at the start of the thesis have been achieved. This contribution is explicitly drawn out below and is divided into two areas.

The first area concerns **ISM**, which may be thought of as one modelling approach within the discipline of systems science. The contribution to this area may thus be considered directly as a contribution to systems science and is as follows.

- Creating and testing the composite priority structure and also the composite aligned priority structure.

- Devising a classification scheme for priority structures that incorporates the above two composite structures.

- Systematic use of levels and clusters to create subgroupings of elements in ISM structures.

- Demonstrating, through the use of individually constructed subgraphs, the way in which ISM helps to resolve differences in views among participants.

- Diagrammatic analysis of the activities involved in the process of ISM.

- Showing how the practice of ISM can be improved by the extraction of intermediate structures during the process.

- Demonstrating how ISM priority and intent structures may be used by managers to assist with resource allocation.

- Illustrating the pitfalls of attempting to use ISM without a proper understanding of contextual relations.

- Explaining the principles of ISM and clarifying the nature of contextual relations and their logical properties.

- Supervising the development of ISM software for a personal computer.

- Assessment of the benefits and limitations of ISM, and of Ideawriting and NGT, including an evaluation by participants and clients.

- Analysis of data collected during ISM, Ideawriting and NGT sessions.

- Assessing those aspects of complexity that are addressed by ISM.

The second area concerns the contribution to **Interactive Management,** listed below, which has provided a context for the ISM work that has been undertaken. In the sense that Interactive Management may be considered as one of a number of systems methodologies, this contribution may also be considered as a contribution to the discipline of systems science, taking a broad view of the discipline as one that embraces systems concepts, modelling tools, techniques and methodologies.

- Extending the range of real-world applications of Interactive Management and ISM through their use with a wide range of British public-sector organisations.

- Analysing the activities and roles involved in an Interactive Management intervention and drawing lessons for the design of such interventions.

- Use of Ideawriting, NGT and ISM in an integrated sequence.

- Extending the method of Ideawriting to include steps for categorisation and editing of ideas.

- Proposing an improved measure for the relative diversity of opinion among participants in an NGT session.

- Creating, and formally describing, a new method for categorising a set of elements such as those generated using NGT.

- Use of Ideawriting and the concepts of Interactive Management to involve a client organisation directly in model building and computer software development..

- Clarifying the five components for productive group work and the interrelations between them.

- Design and implementation of a decision support room for Interactive Management work in a UK context.

10.4 FUTURE WORK

Two possible areas for further work in this field are outlined below.

First, the computer support for Interactive Management could be improved and extended in a number of ways. With regard to the ISM software, this could include improvements to the inferencing procedure and the provision of a graphics capability. Better integration between the existing ISM, graphics and word processing software packages would also be of benefit. Portability of the computer support and the other components of the decision support environment also needs to be explored, as potential clients often ask if workshops can be conducted on their own premises; currently, this is not easily accomplished. With regard to Interactive Management as a whole, user-friendly software needs to be developed to support the other methods of Interactive Management, i.e., options field, options profile and tradeoff analysis. In addition, developments in decision support systems could also be explored to determine any relevant lessons for computer support in Interactive Management.

A second area for further work concerns extending the application of the methods. Whilst the author has used the options field and options profile methods successfully with various student groups working on case studies, opportunities to use this design approach with professional groups dealing with real-world issues in organisations have not yet arisen. In addition, it would be interesting to extend the applications to include the private sector and to compare the results with those obtained so far from work with public sector organisations. The use of post-workshop interviews and questionnaires has proved beneficial; this should be continued on a systematic basis to evaluate any future workshops, methods used and the extent to which implementation occurs.

Epilogue

This epilogue is intended to round off the thesis. Its purpose is to discuss certain wider issues relating to the research topic and, as a result of the experience of the work undertaken, to reflect further on a number of points raised in the Prologue. Four issues are considered: the range of organisations involved in the workshops; the use of the term "consensus" to describe the methods; problems of coping with changes in mental models; and power imbalances among participants.

First, the range of organisations involved in the planning workshops is considered. The fifteen workshops, together with the computer modelling contracts for the Department of Health, were carried out for organisations most of which form part of the public sector. Leaving aside the first workshop, which was undertaken at the University of Virginia, the organisations involved in the fourteen workshops conducted in the United Kingdom were not actively recruited; rather, they arose through requests made to the author from the clients involved who had heard about Interactive Management through a variety of sources. In a number of cases, workshops were requested by managers who had attended postgraduate courses on Interactive Management and ISM given by the author and who wanted to use the approach in planning for their own organisations, e.g., the workshops undertaken for district health authority speech therapy services. Several cases arose through requests from colleagues to carry out work within the author's own department or with other sections of the university or with outside organisations, e.g., the workshops conducted for the Department of Systems Science, for the Accommodation and Conference Service and for the Institution of Mechanical Engineers respectively. Yet other work arose through requests from people for whom the author had carried out previous work, e.g., the last two Engineering Industry Training Board workshops and the contracts for the Department of Health. Thus the sample of organisations was self-selecting rather than being designed as a research study. Had the sample been so designed, a wider range of organisational types would have been desirable; for example, a cross section of private sector concerns involved in activities such as manufacturing or service provision could have been considered. It should, however, be born in mind that such planning workshops are expensive to run in terms of manpower and facilities and that the income generated was used to finance, in part, the salaries of some of the personnel involved in mounting them. There was thus not a free hand to pick and choose organisations at will. Potential clients had to believe that such a planning workshop would be productive, to be able to obtain the time commitment of the participants involved and, in most cases, to be willing to pay for the work to be carried out.

It is instructive to consider the reasons why the Interactive Management approach might have appealed to the particular organisations involved in the workshops. In part, these reasons relate to the assumptions underlying Interactive Management which were stated in the Prologue. First, public sector service organisations correspond broadly to a bureaucratic model where formal rules and procedures are accepted; they also often place importance on team work. They might thus be expected to look favourably on collective inquiry involving participation through the use of formal group methods. Second, the backgrounds of the participants in the workshops were such that most of them might be expected to be sympathetic both to the notion of taking a rational approach to complex problems and decision making and to the notion of a computer inferring answers through the use of logic. For example, six of the cases involved engineers or engineering managers, whilst most of the other cases involved a fair proportion of people with some technical or scientific training. Third, unlike private sector concerns, public sector service organisations do not usually have clear quantitative measures of performance, e.g., profit, sales level, return on capital employed. Demands for greater accountability and improved management practice mean that public sector organisations increasingly find that they are obliged to set objectives and priorities; these are activities in which ISM can play a significant role Thus whilst the workshops have tested ISM reasonably thoroughly, it is acknowledged that the particular sample of organisations involved might, for the reasons stated above, have found the Interactive Management approach particularly attractive. More studies need to be conducted to establish its acceptability and effectiveness in other types of organisational cultures in the United Kingdom.

Second, the use of the term "consensus" to describe the methods of Interactive Management is examined. Warfield (1990: 199) states that "... because [the methods] embody attributes that support consensus or near-consensus, they were designated as 'Consensus Methodologies' ...". In practice, the word "consensus" is used to signify a number of important characteristics concerning the participative nature of the methods. These are: that the meetings involved are conducted in an open fashion, whereby all participants have an opportunity to contribute through structured discussion of the issue being explored; that the ideas of participants are acknowledged by the group so that members feel that their views have been listened to and that they have had a fair chance of influencing decisions; that individuals can formally indicate their judgements, e.g., by voting; and that participants accept that whilst everyone may not be in complete agreement with all aspects of the products resulting from the use of the methods, they accept the outcome as a way forward. Thus it should not be inferred that the methods necessarily achieve consensus in the literal sense of unanimity, viz., being of one mind. Checkland and Scholes (1990: 29-30) offer a useful distinction between the concepts of consensus-seeking and accommodation-seeking with regard to SSM (soft systems methodology). They argue that consensus-seeking is "... the occasional special case of seeking accommodations in which the conflicts endemic in human affairs are still there, but are subsumed in an accommodation which different parties are prepared to 'go along with'." This notion has relevance to Interactive Management. Thus it might be more appropriate to think of the methods as helping participants to reach accommodations among different interests rather than as seeking a consensus in the sense of unanimity, in that the members of the group are prepared to accept the outcome even though disagreements on certain aspects may still be present.

Third, problems of coping with changes in mental models which occur during the ISM process are considered. Since ISM is designed as a learning process, it is to be expected that the mental models of participants will change as the process proceeds. (Here, "learning" refers to gaining knowledge or understanding of whatever issue is being explored). The assumption is made that individuals come to an ISM session with mental models of the issue that are, at most, imprecise and loosely formed. Having been involved in, say, an NGT session to generate the element set, they are likely to have perceived some connections between some of the elements; however, it would seem most improbable that anyone would start the ISM session with a well-formed mental picture of all the possible element interrelations.

The learning that occurs may involve gaining a better understanding of: the relations between pairs of elements; the way that subgroups of elements form clusters or levels; and the wider perspective of the ISM structure as a whole. Particularly important in this context is the understanding gained of the different perceptions that other individuals have of the interrelations between elements. It is assumed that participants come to an ISM session in order to tackle a complex issue with a willingness to engage in a process of collective inquiry involving openness and participation. ISM attempts to create equal opportunity for participants to influence decisions and provides a democratic voting procedure to assist with this. However, problems may arise where individuals are unable to agree. It may be that, even though questions have been thoroughly debated and the facilitator has ensured that participants have had ample opportunity to state their views, the position of certain elements in, say, a priority structure is unsatisfactory to one or more members of the group. This may result in feelings of frustration where individuals find it difficult to come to terms with group decisions that they do not like regarding the interrelations among the elements in question. It should not, therefore, be assumed that on all occasions there is a convergence of mental models to the extent that everyone is in complete agreement with the products of the sessions. A more realistic aim is to attempt to reach an accommodation (see discussion above), whereby people are prepared to accept the outcome even though they disagree with certain features of it but where the sense of group achievement outweighs any possible individual frustration.

Another aspect of changes in mental models occurring during the ISM process concerns the situation where perceptions alter because of learning as the model building proceeds and, as a consequence, participants wish to revise an earlier decision. A display of intermediate ISM structures during the course of the session provides an opportunity to review the structure as a whole with the group and to consider any possible amendments and their consequences. The business of displaying, interpreting and critically discussing intermediate structures so as to provide an opportunity to clarify mental models and to amend the ISM structure itself was discussed in some detail in Section 8.4.

Fourth, the question of the extent to which the Interactive Management approach addresses power imbalances among participants is discussed. Fundamental to the approach is the assumption that people are willing to work together on matters of common interest through an open exchange of ideas in order to tackle complex issues. Any client who understands what Interactive Management involves, and who then makes the commitment of time and resources required for such an activity, is unlikely to practise a highly autocratic style of management. He or she is more probably going to be sympathetic to the concept of participative management and the view that colleagues, subordinates and other stakeholders can cooperate in making a significant contribution to the issue being explored. It has been emphasised that the methods of Interactive Management attempt to provide equal opportunity for all participants to make contributions. Thus, Ideawriting, Nominal Group Technique and ISM have been designed so as to reduce the dominance of group members who may be high-ranking, aggressive or particularly articulate and to encourage contributions from members who may be reticent. In addition, none of the component parts of the products of the group's work is attributable to any one individual, so the products are owned by the group as whole. However, to assume that power differences are, in some way, completely eliminated or even suspended would be to take a rather naive view. For example, certain individuals may be better informed, more articulate or more persuasive than others. Furthermore, when it comes to implementation, if those holding the reins of power are not committed to the products, they are unlikely to be implemented.

The Interactive Management approach does not contain formal procedures for analysing who holds what kind of power. Of course, members of the Interactive Management team may, through observation, become aware of such power differences; part of the facilitator's task is to see that these are not allowed to dominate the proceedings. There is a growing interest in the role of power in methodologies. For example, when describing developments in SSM, Checkland and Scholes (1990) explain how "political system" analysis forms part of the stream of cultural enquiry embodied within the methodology. This analysis includes an examination of how power is expressed in a problem situation using the metaphor "commodity". Such commodities of power include, for example, role-based or intellectual authority, access to information, charisma, and membership of particular committees or groups. An interesting topic for further research in Interactive Management would be to investigate which participants hold what kind of power, and the extent to which power is expressed and used to influence both outcomes and implementation.

References

Ackoff, R.L. (1979). The future of operational research is past. Journal of the Operational Research Society , 30(2), 93-104.

Ackoff, R.L. (1981). Creating the Corporate Future. New York: Wiley.

Adair, J. (1987). Effective Teambuilding. London: Pan Books.

Anderson, D.R., Sweeney, D.J. and Williams, T.A. (1985). An Introduction to Management Science: Quantitative Approaches to Decision Making. Minnesota: West Publishing Co. (Fourth Edition).

Argyris, C. and Schon, D. (1978). Organisational Learning. Reading, Massachusetts: Addison-Wesley.

Ashby, R.W. (1973). Some peculiarities of complex systems. Cybernetic Medicine, 9(2), 1-7.

Ayiku, M.N.B. (1986). Towards implementing the Menon Report: a systems approach using ISM. Systems Research, 3(4), 215-224.

Banks, J., Captain, D.G. and Captain, S.P.S. (1988). Modelling process, validation, and verification of complex simulation: a survey. Proceedings of Conference on Methodology and Validation, Orlando, Florida, Jan., 1988. Simulation Series, 19(1), 13-18.

Bellinger, P.W. (1987). "Applications for interpretive structural modelling in Hertfordshire County Council". Project report for the Postgraduate Diploma Course for Senior Managers in the Highways and Transportation Industry. City University, London. 32pp.

Bertalanffy, L. von (1972). The history and status of general systems theory. In Trends in General Systems Theory, ed. G.J.Klir. New York: Wiley. 21-41.

Broome, B.J. and Keever, D.B. (1986). "Facilitating group communication: the interactive management approach". Paper presented at the annual convention of the Speech Communication Association, Chicago, November, 1986.

Carson, E.R., Cobelli, C. and Finkelstein, L. (1983). The Mathematical Modeling of Metabolic and Endocrine Systems: Model Formulation, Identification and Validation. New York: Wiley.

Centre for Interactive Management (1985). "Training the interactive management facilitator". Unpublished notes, Centre for Interactive Management, George Mason University, Virginia. 3pp.

Checkland, P.B. (1972). Towards a systems-based methodology for real-world problem solving. Journal of Systems Engineering, 3(2), 87-116.

Checkland, P.B. (1978). The origins and nature of "hard" systems thinking. Journal of Applied Systems Analysis, 5(2), 99-110.

Checkland, P.B. (1979). The shape of the systems movement. Journal of Applied Systems Analysis, 6, 129-135.

Checkland, P.B. (1981). Systems Thinking, Systems Practice. Chichester: Wiley.

Checkland, P.B. (1983). O.R. and the systems movement: mappings and conflicts. Journal of the Operational Research Society, 34(8), 661-675.

Checkland, P.B. (1987). Images of systems and the systems image. Newsletter of the International Federation for Systems Research, No. 16, Winter 1987/88, 1-3.

Checkland, P.B. (1989). Soft systems methodology. Chap.4 in Rational Analysis for a Problematic World: Problem Structuring Methods for Complexity, Uncertainty and Conflict, ed. J.Rosenhead. Chichester: Wiley. 71-100.

Checkland, P.B. and Scholes, J. (1990). Soft Systems Methodology in Action. Chichester: Wiley.

Christakis, A.N. (1982). Personal communication.

Christakis, A.N. (1983a). "Participative technology assessment". Keynote speech at the Technology Assessment Symposium of the Food and Drug Administration, USA, Sept., 22-23, 1983.

Christakis, A.N. (1983b). "Planning, design, and implementation: the sigma five strategy". Paper presented at the Cairo Conference on Planning and Implementation Strategies for Alleviating Congestion in Cairo. Cairo, April 17, 1983.

Christakis, A.N. (1984). Management of complexity: the interactive approach. Continuing the Process. Newsletter, Graduate School, U.S. Department of Agriculture, Washington, D.C., 1(4), 1-2.

Christakis, A.N. (1985a). The national forum on nonindustrial private forest lands. Systems Research, 2(3), 189-199.

Christakis, A.N. (1985b). High technology participative design: the space-based laser. In Proceedings 1985 International Conference of the Society for General Systems Research, 2, 925-933.

Christakis, A.N. (1985c). "Definition of an interactive management facilitator". Unpublished notes, Centre for Interactive Management, George Mason University, Virginia, USA.

Christakis, A.N. and Keever, D.B. (1984). "Management's quest for new solutions". Unpublished manuscript, Centre for Interactive Management, George Mason University, Virginia. 22pp.

Cleveland, H. (1973). The decision makers. The Center Magazine, VI(5), 9-18.

Coyle, R.G. (1977). Management System Dynamics. Chichester: Wiley.

Cromer, I. and Broome, B.J. (1988). "Building consensus in a cultural context: an interactive approach to strategic planning for tribal self-sufficiency." Paper presented at the 32nd Annual Meeting of the International Society for General Systems Research, St. Louis, Missouri, May, 1988.

Dalkey, N. and Helmer, O. (1963). An experimental application of the Dephi Method to the use of experts. Management Science (9)3, 458.

Delbecq, A.L., Van de Ven, A.H and Gustafson, D.H. (1975). Group Techniques for Program Planning: A Guide to Nominal Group and Delphi Processes. Glenview, Illinois: Scott, Foresman and Co.

Delp, P., Thesen, A., Motiwalla, J. and Neelakantan, S. (1977). Systems Tools for Project Planning. Indiana University, Bloomington, Indiana: International Development Institute, PASITAM.

Eden, C. (1989). Using cognitive mapping for strategic options development and analysis (SODA). In Rational Analysis for a Problematic World, ed. J.Rosenhead. Chichester: Wiley. 21-42.

Eden, C., Jones, S. and Sims, D. (1983). Messing About in Problems. Oxford: Pergamon Press.

Flood, R.L. (1987). Complexity: a definition by construction of a conceptual framework. Systems Research, 4(3), 177-185.

Flood, R.L. (1988). Situational complexity, systems modelling and methodology. Transactions of the Institute of Measurement and Control, 10(3), 122-129.

Flood, R.L. and Carson, E.R. (1988). Dealing With Complexity: An Introduction to the Theory and Application of Systems Science. New York: Plenum Press.

Flood, R.L. and Jackson, M.C. (1991). Creative Problem Solving: Total Systems Intervention. Chichester: Wiley.

Forrester, J.W. (1961). Industrial Dynamics. Cambridge, Massachusetts: M.I.T. Press.

Forrester, J.W. (1968). Principles of Systems. Cambridge, Massachusetts: Wright-Allen Press.

Forrester, J.W. (1971). World Dynamics. Cambridge, Massachusetts: Wright-Allen Press.

Friend, J.K. (1989). The strategic choice approach. In Rational Analysis for a Problematic World, ed. J.Rosenhead. Chichester: Wiley. 121-157.

Friend, J.K. and Hickling, A. (1987). Planning Under Pressure: The Strategic Choice Approach. Oxford: Pergamon Press.

Galbraith, J. (1979). Organisation Design. New York: Addison-Wesley.

Geschka, H., Schaude, G.R., and Schlicksupp, H. (1973). Modern techniques for solving problems. Chem.Eng. (N.Y), 80(18), 91- 97.

Ghiselli, E.E., Campbell, J.P. and Zedeck, S. (1981). Describing individual differences. Chap.2 in Measurement Theory for the Behavioral Sciences. San Francisco: W.H.Freeman.

Gill, S.L. and Delbecq, A.L. (1982). Nominal group technique (NGT). Chap.8 in Group Planning and Problem-Solving Methods in Engineering Management, ed. S.A.Olsen. New York: Wiley. 271- 287.

Hall, A.D. (1962a). A Methodology for Systems Engineering. New York: Van Nostrand.

Hall, A.D. (1962b). The role of measurement. Chap. 8 in A Methodology for Systems Engineering . New York: Van Nostrand. 244-251.

Hall, A.D. (1989). Metasystems Methodology: A New Synthesis and Unification. Oxford: Pergamon Press.

Hammer, K. and Janes, F.R. (1990). Interactive management. OR Insight 3(1), 11-13.

Handy, C.B. (1985). On the workings of groups. Chap. 6 in Understanding Organisations. London: Penguin.

Hitchins, D.K., Janes, F.R., Jeffery, R. and Hammer, K. (1989). "Designing a Centre for Enterprise Management." Paper presented at the IEE Management and Design Division Discussion Meeting on Systems Engineering and its Interrelationships with Academic/Industrial Collaboration. University of Strathclyde, July 6, 1989. 22 pp.

Hitchins, D.K. (1992). Putting Systems to Work. Chichester: Wiley.

House, R.W. (1982). Considerations for transferring technologies internationally. Engineering Management International, 1, 151-161.

Jackson, M.C. (1990). Beyond a system of systems methodologies. Journal of the Operational Research Society, 41(8), 657-668.

Jackson, M.C. and Keys, P. (1984). Towards a system of systems methodologies. Journal of the Operational Research Society, 35(6), 473-486.

Janes, F.R. (1983). Planning for the future of engineering education. Research Report, Centre for Interactive Management, School of Engineering and Applied Science, University of Virginia, Charlottesville, Virginia. 40pp.

Janes, F.R. (1985a). "Proposals for a decision support room." Unpublished document. Department of Systems Science, City University, London. 6pp.

Janes, F.R., (1985b). Planning for the Training Development Division of the Engineering Industry Training Board. Technical Report No. DSS/FRJ/242, Dept. of Systems Science, City University, London. 18pp.

Janes, F.R. (1987a). Applications of interactive management in planning for engineering education. In Problems of Constancy and Change. 31st Annual Meeting of the International Society for General Systems Research, Budapest, June, 1987. Vol.1, 520-525.

Janes, F.R. (1987b). Products, services and priorities for the Engineering Industry Training Board. Technical Report No. DSS/FRJ/248, Dept. of Systems Science, City University, London. 24pp.

Janes, F.R. (1987c). Setting priorities for highway schemes in Hertfordshire using interpretive structural modelling. Technical Report No. DSS/FRJ/246, Dept. of Systems Science, City University, London. 7pp.

Janes, F.R. (1987d). Using a subordinate relation in an ISM. Chap. 8 in Group Techniques for Idea Building. by C.M.Moore. Newbury Park, California: Sage Publications.

Janes, F.R. (1988). Interpretive structural modelling: a methodology for structuring complex issues. Transactions of the Institute of Measurement and Control. 10(3). 145-154.

Janes, F.R. (1991). The use of interactive management in designing a Centre for Enterprise Management: intent and priority structures. Research Memorandum No. DSS/FRJ/270, Dept. of Systems Science, City University, London. 26pp.

Janes, F.R. (1992). Planning for an industrial training board team: an application of Interactive Management. In Information Technology and Society: Theory. Uses. Impacts. ed. J.L.Alves. Proceedings Int. Symp. on Communication Meaning and Knowledge vs. Information Technology, Lisbon, Sept., 1989. Lisbon: APDC and SPF (Associacao Portuguesa para o Desenvolvimento das Comunicacoes and Sociedade Portuguesa de Filosofia). 367-374.

Janes, F.R., Hammer, K. and Jeffery, R. (1989). Issues, objectives and priorities for the Department of Civil Engineering of City University, London. Technical Report No. DSS/FRJ-KH-RJJ/263, Dept. of Systems Science, City University, London. 25pp.

Janes, F.R. and Jeffery, R. (1989). Objectives and priorities for the Accommodation and Conference Service of City University, London. Technical Report No. DSS/FRJ-RJJ/257, Dept. of Systems Science, City University, London. 33pp.

Janes, F.R. and Jowitt, R. (1989). Applications of interactive management in planning for a university department. In Systems Prospects: The Next Ten Years of Systems Research, eds. R.L.Flood, M.C.Jackson and P.Keys. New York: Plenum Press. 243-250.

Janes, F.R. and M'Pherson, P.K. (1984). Interpretive structural model of the I.Mech.E. policy statement. Research Memorandum No. DSS/FRJ-PKM/240, Dept. of Systems Science, City University, London. 15pp.

Janes, F.R. and M'Pherson, P.K. (1985). Planning exercise for the Management Support Department of the Metropolitan Police. Technical Report No. DSS/FRJ-PKM/241, Dept. of Systems Science, City University, London. 25pp.

Jeffery, R.J. (1987) "Interpretive structural modelling for the IBM personal computer". Final-year project for the BSc degree in Systems and Management. City University, London. 114pp.

Jeffery, R.J. and Janes, F.R. (1988a). "Interpretive structural modelling: ISM-PC software for IBM PC/AT/XT". Program and user manual. Department of Systems Science, City University, London. 56pp.

Jeffery, R.J. and Janes, F.R. (1988b). Planning for the Short Course Unit of City University, London. Technical Report No. DSS/FRJ-RJJ/252, Dept. of Systems Science, City University, London. 23pp.

Jeffery, R.J. and Janes, F.R. (1988c). Requirements and priorities for a community speech therapy service in West Lambeth Health Authority. Technical Report No. DSS/RJJ-FRJ/252, Dept. of Systems Science, City University, London. 18pp.

Jeffery, R.J. and Janes, F.R. (1989). The use of interpretive structural modelling in planning for a community speech therapy service. Proceedings 33rd Annual Meeting of the International Society for the Systems Sciences, ed. P.Ledington, Edinburgh, July, 1989. 2, 314-319.

Jeffery, R.J., Janes, F.R. and Hammer, K.A. (1989). Priorities for a community-based speech therapy service for people with learning difficulties in Hounslow and Spelthorne District Health Authority. Technical Report No. DSS/RJJ-FRJ-KH/259, Dept. of Systems Science, City University, London. 23pp.

Jenkins, G.M. (1969). The systems approach. Journal of Systems Engineering, 1(1), 3-49.

Jenkins, G.M. (1983). Reflections on management science. Journal of Applied Systems Analysis, 10, 15-40.

Kalman, R.E. (1980). A system-theoretic critique of dynamic economic models. International Journal of Policy Analysis and Information Systems. 4 (1), 3-22.

Keever, D.B. (1985). Design for improving university/industry cooperative research projects. Proceedings 1985 Annual Meeting of the Society for General Systems Research, May, 1985. Seaside, California: Intersystems Publications.

McDonald, R.B. (1982). "A tradeoff evaluation procedure." Unpublished manuscript, Centre for Interactive Management, University of Virginia, Charlottesville, VA. 17pp.

Mackensie, E. (1972). An operations room for fast decisions. International Management, Jan., 1972.

Mackett, D., Christakis, A.N. and Christakis, M.P. (1983). Designing and installing an interactive management system for the South-West Fisheries Centre. Proceedings of the Third Symposium on Coastal and Ocean Management, ASCE/San Diego, California, June 1-4, 1983. 518-537.

Mackett, D.J. (1985). Strategic planning for research and management of the albacore tuna fishery. Systems Research, 2(3), 201-210.

Miller, G.A. (1956). The magical number seven, plus or minus two: some limits on our capacity for processing information. Psychol. Rev., 63(2), 81-97.

Moore, C.M. (1987). Group Techniques for Idea Building. Newbury Park, California: Sage Publications.

Moss, R. (1985). Designing for reduced operating costs (DROC). Health Service Estate, No. 56, June, 1985, 23-28.

M'Pherson, P.K. (1980). Systems engineering: an approach to whole-system design. The Radio and Electronic Engineer, 50(11/12), 545-558.

M'Pherson, P.K. (1981). A framework for systems engineering design. The Radio and Electronic Engineer, 51(2), 59-93.

Napier, R.W. and Gershenfeld, M.K. (1973). Groups: Theory and Experience. Boston: Houghton Mifflin Company.

Olsen, S.A. (ed). (1982). Group Planning and Problem-Solving Methods in Engineering Management. New York: Wiley.

Osborn, A.F. (1957). Applied Imagination. New York: Charles Scribner's and Sons.

Phillips, D.C. (1976). Holistic Thought in Social Science. Stanford, California: Stanford University Press.

Rhodes, H. (1990). "Objectives and priorities for the Accommodation and Conference Service: a progress report". Unpublished report, City University, London. 9pp.

Rickards, T. (1974). Problem Solving Through Creative Analysis. Epping, Essex: Gower Press.

Roberts, N., Andersen, D.F., Deal, R.M., Garet, M.S. and Shaffer, W.A. (1983). Introduction to Computer Simulation: A System Dynamics Modelling Approach. London: Addison-Wesley. Chaps. 3 and 4.

Roberts, P.C. and Janes, F.R. (1987). The use of quantitative computer models to determine operating costs of alternative hospital designs. Commissioned Technical Report for the DHSS - Research Contract W87/SD/1010A. No. DSS/PCR-FRJ/247, Dept. of Systems Science, City University, London. 23pp.

Roberts, P.C., and Janes, F.R. (1989). Designing for reduced operating costs - modelling the linen services function. Health Service Estate. No. 66, May, 1989, 35-37.

Roberts, P.C., Janes, F.R., Hammer, K.A. and Pope, C.M. (1990). Development and application of computer modelling to assess operating costs of alternative hospital designs. Model 2: catering services. Commissioned Technical Report for the DoH - Research Contract W87/IS/1010A No. DSS/PCR-FRJ-CMP/262, Dept. of Systems Science, City University, London, 48pp.

Roberts, P.C., Janes, F.R. and Pope, C.M. (1988). Development and application of computer modelling to assess operating costs of alternative hospital designs. Model 1: linen services. Commissioned Technical Report for the DoH - Research Contract W87/IS/1010A. No. DSS/PCR-FRJ-CMP/251, Dept. of Systems Science, City University, London. 24pp.

Roberts, P.C., Moss, R. and Janes, F.R. (1988). Designing for reduced operating costs: the design of out-patient departments. Health Service Estate. No. 62, April, 1988, 35-40.

Sage, A.P. (1977). Methodology for Large Scale Systems. New York: McGraw-Hill.

Simon, H.A, (1960). The New Science of Management Decision. New York: Harper and Row.

Simon, H.A. (1965). The architecture of complexity. General Systems Yearbook, 10, 63-76.

Slate, D. (1990). Restructuring the system. Therapy Weekly, ,1 March, 1990, 16(13), p12.

Spooner, P. (1972). Decision room strategies and corporate destiny. Business Administration, July, 1972.

Steiner, I.D. (1972). Group Process and Productivity. New York: Academic Press.

Stevens, C.G.J. (1991). "A decision making information system for labour resource allocations: integration of logic and time-based large-scale project computer simulations". PhD thesis, City University, London.

Tomlinson, R. (1984). Rethinking the process of systems analysis and operational research: from practice to precept - and back again. Chap. 13 in Rethinking the Process of Operational Research and Systems Analysis, eds. R.Tomlinson and I.Kiss. Oxford: Pergamon Press. 205-221.

Wainwright, G.R. (1987). Meetings and Committee Procedure. London: Hodder and Stoughton.

Waller, R.J. (1979). Comparing and combining structural models of complex systems. IEEE Trans. Syst. Man Cybern., SMC-9(9), 580-586.

Waller, R.J. (1980). Contextual relations and mathematical relations in interpretive structural modelling. IEEE Trans. Syst. Man Cybern., SMC-10 (3), 143-145.

Waller, R.J. (1983a). Complexity and the boundaries of human policy making. Int. J. Gen. Systems, 9, 1-11.

Waller, R.J. (1983b). Knowledge for producing useful knowledge. In Producing Useful Knowledge for Organisations, ed. R.H.Kilman et al. New York: Praeger.

Waller, R.J. (1983c). "Complexity, humans, and the importance of structure". Chap. 1 of an unpublished manuscript. School of Business, University of Northern Iowa, Cedar Falls, Iowa.

Warfield, J.N. (1973a). An Assault on Complexity. Battelle Monograph No. 3. Columbus, Ohio: Battelle Memorial Institute.

Warfield, J.N. (1973b). Intent Structures. IEEE Trans. Sys. Man. Cybern., SMC-3(2), 133-140.

Warfield, J.N. (1974a). Structuring Complex Systems. Battelle Monograph No.4. Columbus, Ohio: Battelle Memorial Institute.

Warfield, J.N. (1974b). Towards interpretation of complex structural models. IEEE Trans. Syst. Man Cyber., SMC-4(5), 405-417.

Warfield, J.N. (1976). Societal Systems: Planning, Policy and Complexity. New York: Wiley. (Reprinted, Salinas, California: Intersystems, 1989).

Warfield, J.N. (1979). Some principles of knowledge organisation. IEEE Trans. Sys. Man Cybern., SMC-9 (6), 317-325.

Warfield, J.N. (1980a). Complementary relations and map reading. IEEE Trans. Sys. Man Cybern., SMC-10(6), 285-291.

Warfield, J.N. (1980b). Priority structures. IEEE Trans. Sys. Man Cybern., SMC-10 (10), 642-645.

Warfield, J.N. (1981). "Current thinking and practice concerning decision situation rooms". Unpublished manuscript, Centre for Interactive Management, University of Virginia, Charlottesville, VA. 7pp.

Warfield, J.N. (1982a). Organisations and systems learning. General Systems, 27, 5-74.

Warfield, J.N. (1982b). Interpretive structural modelling (ISM). Chap. 5 in Group Planning and Problem-Solving Methods in Engineering Management, ed. S.A.Olsen. New York: Wiley, 155-201.

Warfield, J.N. (1983). "The process alternative". An address to the Governor's Commission on Virginia's Future, Richmond, Virginia, February 3, 1983. Unpublished.

Warfield, J.N. (1984a). Principles of interactive management. Proceedings International Conference on Cybernetics and Society. New York: IEEE, January, 1984, 746-750.

Warfield, J.N. (1984b). Progress in interactive management. Proceedings 6th International Congress on World Organisation for General Systems and Cybernetics, AFCET: Paris, France, Sept., 1984. 29-35.

Warfield, J.N. (1990). A Science of Generic Design: Managing Complexity Through Systems Design. Salinas, California: Intersystems Publications.

Warfield, J.N., Geschka, H. and Hamilton, R. (1975). Methods of Idea Management. Approaches to Problem Solving, No.4. Columbus, Ohio: The Academy for Contemporary Problems.

Warfield, J.N. and Kearney, C. (eds.) (1989). Annotated Bibliography of Publications. Institute for Advanced Study in the Integrative Sciences, George Mason University, Virginia, USA.

Watson, R.H. (1978). Interpretive structural modelling - a useful tool for technology assessment. Technological Forecasting and Social Change, 11, 165-185.

Webster's New Collegiate Dictionary (1973). S.v. "method" and "methodology". Springfield, Massachusetts: G. and C. Merriam.

Wolstenholme, E.F. (ed.) (1989). Proceedings of symposium on applying systems dynamics, London. Dec., 1988. Transactions of the Institute of Measurement and Control, 11(4), 170-216.

Wolstenholme, E.F. (1990). System Enquiry: A System Dynamics Approach. Chichester: Wiley.

Wood, W.C. and Christakis, A.N. (1984). A methodology for conducting futures-oriented workshops. Technological Forecasting and Social Change, 26, 281-297.

Appendix 1

STATEMENTS BY COLLABORATORS

The University Ordinance for the Degree of Doctor of Philosophy states that:

"Joint work may be submitted as a thesis or published papers provided it is accompanied by a statement countersigned by the collaborator or collaborators indicating clearly the candidates share of the work."

This Appendix contains statements by the relevant collaborators.

Statement agreed by collaborator: K Hammer

Three items of work co-authored by Mr Hammer are referred to below.

1. Technical Report DSS/FRJ-KH-RJJ/263

Mr Janes was responsible for designing the Interactive Management workshop, for facilitating the methods used with the group during the workshop, and for the content of the resulting report. Mr Hammer contributed as a team member: in discussing the design of the workshop and the content of the report, in providing support during the workshop, and in the technical production of the report.

2. Technical Report DSS/RJJ-FRJ-KH/259

Mr Hammer contributed as a team member as stated for the report under (1) above.

3. OR Insight paper, Vol.3, No.1, Jan.-March 1990

The first draft of this paper was produced by Mr Hammer. The case study (including Figures 1 and 2) used to illustrate the use of Interactive Management in the paper was conducted by Mr Janes with a student group. The case was part of a course being given by Mr Janes on Interactive Management. Mr Janes commented on the draft of the paper and, as a result, various changes were made.

25th February 1992 K. Hammer

K Hammer

Statement agreed by collaborator: Mr. R. J. Jeffery

The joint work referred to below constituted part of Mr. Jeffery's training as facilitator and consultant in Interactive Management whilst working for Mr. Janes during 1987-89.

In the case of joint work where the name F. R. Janes precedes that of R. J. Jeffery, Mr. Janes was responsible for designing the Interactive Management workshops, for facilitating the methods used with the relevant groups during the workshops, and for the content of the resulting reports. Mr. Jeffery contributed as a team member in discussing the design of the workshops and the content of the reports, in providing computer support during the workshops, and in technical production of the reports.

In the case of joint work where the name R. J. Jeffery precedes that of F. R. Janes, the design of the Interactive Management workshops was done jointly by Mr. Janes and Mr. Jeffery. Mr. Jeffery facilitated the workshops under the guidance of Mr. Janes and produced initial drafts of the resulting reports in the established 'house' style of the Interactive Management Unit. These were commented upon and revised by Mr. Janes. Mr. Jeffery undertook technical production of the reports.

F. R. Janes FRJanes

R. J. Jeffery

27th July 1989
RJJ/FRJ

30 Bishopdale Drive
Collingham
Yorkshire
LS22 5LP

Applications of Interactive Management in
Planning for a University Department
F R Janes and R Jowitt

This paper was written by Mr.Janes. He added my name as an author,because we had discussed the problems I was having generating a team spirit in the Dept. He felt that I had made a contribution. He was,in my opinion,very generous. The intellectual drive and the hard work was all his.

I found the method worked. I was able to use the results and conclusions for the next 4 years. I hope that the University continues to use the methods developed by Mr.Janes. The way we were able to generate Objectives,Priorities and come up with a Mission Statement(accepted by all)was a wonderful demonstration of the technique. I wish he could be allowed to use it in my present organisation!

Ray Jowitt (Head of Dept,Systems Science 1985-90)

Ray Jowitt 3/12/90

STATEMENT BY THE COLLABORATOR (Prof. P.K. M'Pherson)

with reference to:

"Planning Exercise for the Management Support Department of the Metropolitan Police"

I confirm that the concept and implementation of the above three-day workshop was designed and organized by Mr. F.R.Janes. The role of expert facilitator during the interactive sessions was also performed by Mr. Janes. The final report on the workshop with the above title was written by Mr. Janes.

The methodology underlying the workshop followed Mr Janes' procedure as developed from sources of Interpretative Structural Modelling.

My contributions fell into three categories:

1 Administrative: to cost the effort required for the workshop, and to provide the preliminary introduction.

2 Technical support: some assistance was provided to help with the classification and structuring of objectives and entities as they arose during the course of the workshop - this enabled analysis to be accelerated.

3 Presentational: to support Mr Janes during the final presentation of the results to senior staff of the Metropolitan Police.

P.K. M'Pherson

7 April 1992

Statement Agreed by Collaborator: Prof. P.C. Roberts

This statement refers to contracts undertaken for the Health Building Directorate of the Department of Health to develop models and software of hospital linen and catering services.

Mr F.R. Janes was principal investigator and project manager for the contracts. He was responsible for introducing Ideawriting, signed digraphs and the concepts of Interactive Management as an integral part of the modelling and software development process, as described in his thesis. He coordinated the work of the City University team throughout the project and organized and chaired all working meetings of the consultative group appointed by the Department of Health.

With regard to the Technical Report entitled Model 1: Linen Services (DSS/PCR-FRJ-CMP/251), a first draft of this was prepared by Professor Roberts with contributions on validation and user trials from Dr. C.M. Pope, who was responsible for much of the computer software development. Mr Janes coordinated the assembly of the report, and made comments on the various sections which resulted in many amendments to the report.

With regard to the Health Service Estate paper on Modelling the Linen Services Function (HSE No. 66, May 1989), this was prepared by Professor Roberts with amendments suggested by Mr Janes and is based on the above report.

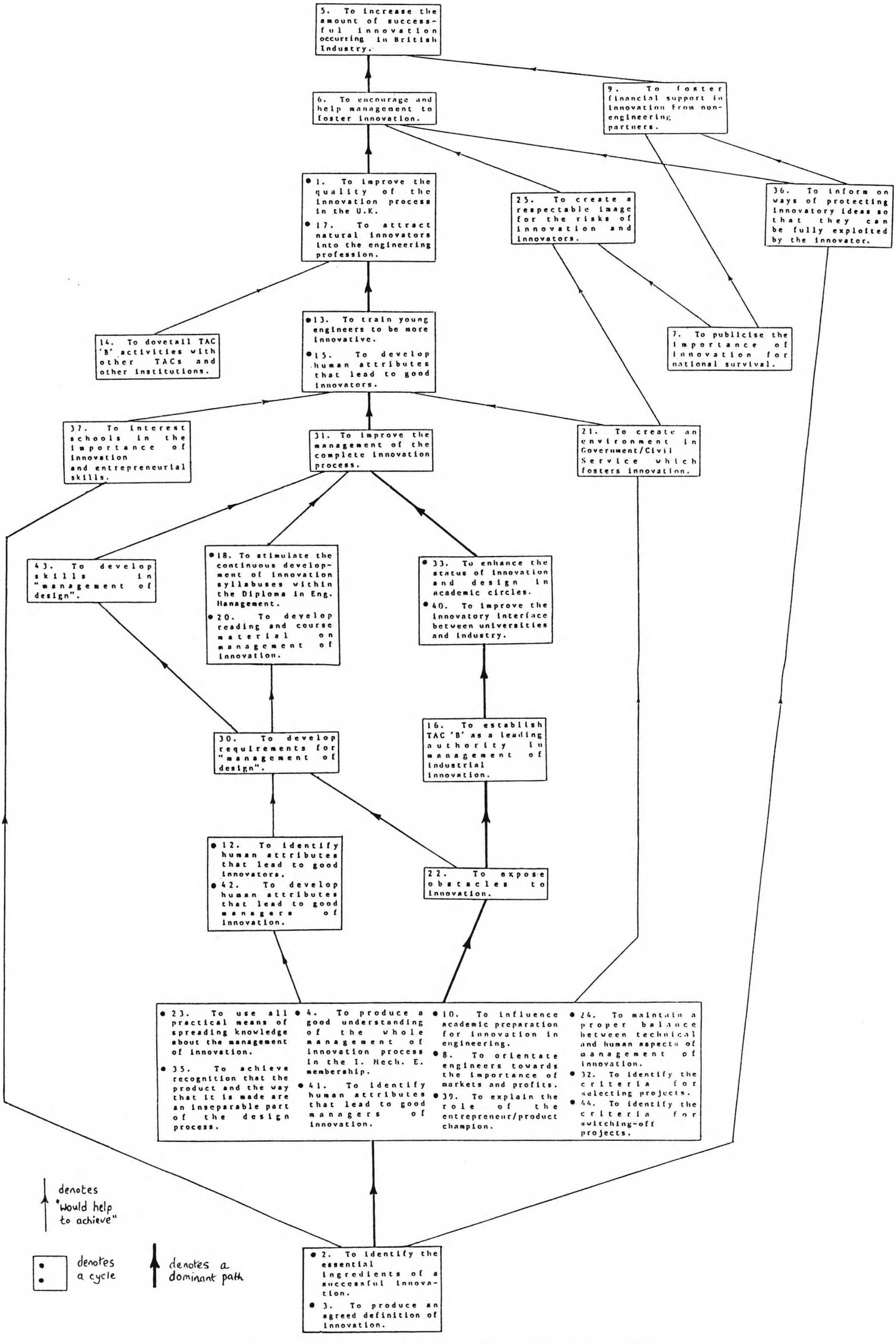
P C Roberts

25th February 1992
Professor P.C. Roberts
Project Director

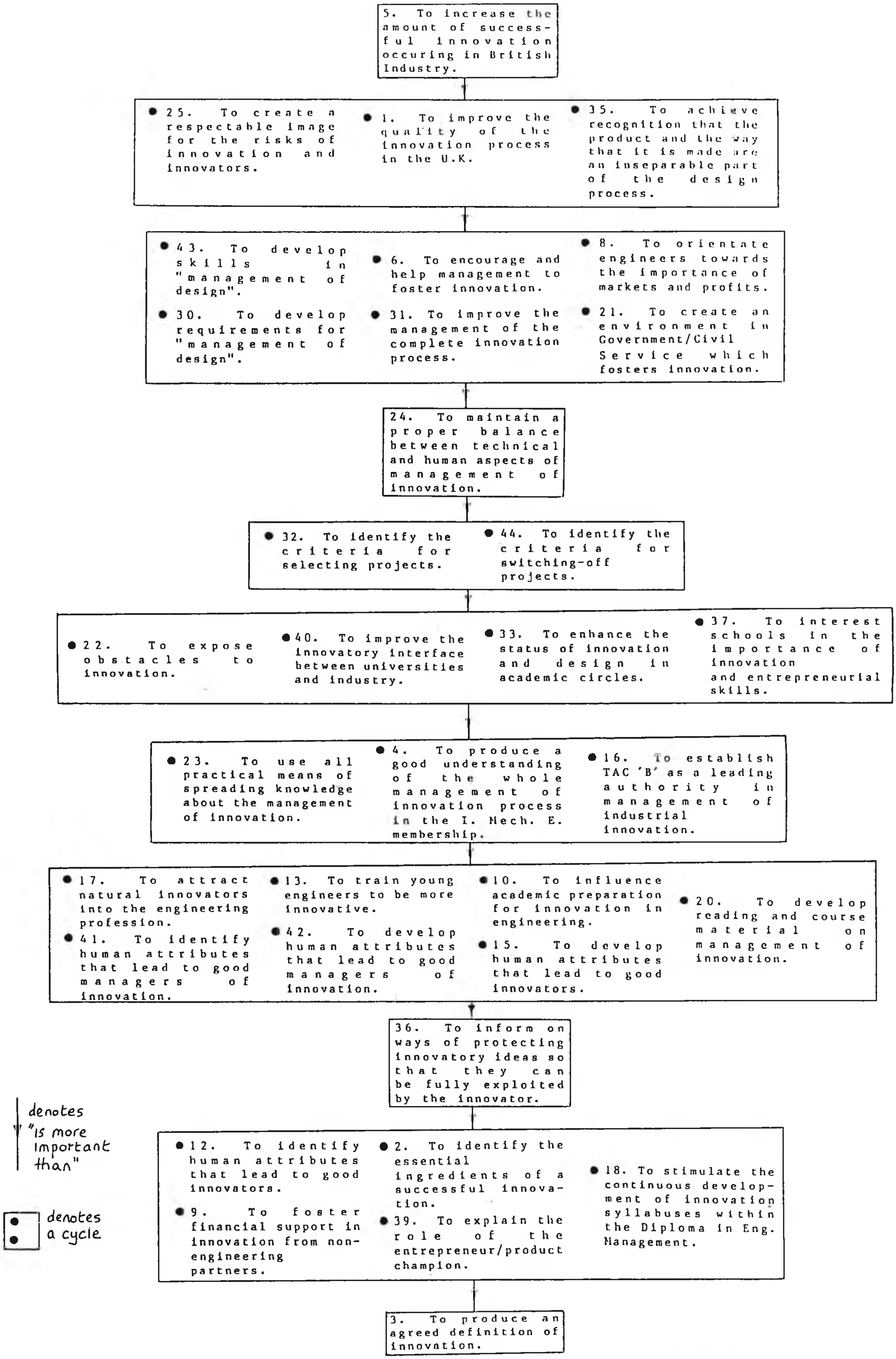
Appendix 2

PROFESSIONAL INSTITUTION TECHNICAL ACTIVITY COMMITTEE: INTENT AND PRIORITY STRUCTURES

Case No. 14 in Section 7.3 of Chapter 7 describes a planning workshop undertaken for the Technical Activity Committee of a Professional Institution. For reasons explained in the case description the relevant intent and priority structures are reproduced in this Appendix.



Intent Structure: IMechE Tac 'B'



Priority Structure: IMechE Tac 'B'

Appendix 3

DATA ON ISM SESSIONS

This Appendix contains data on the duration of the ISM sessions, the number of participants involved and the number of elements in the models. It also gives some other parameters concerning the models. The data are discussed in Chapter 7, Section 7.4.

Case Number	Supporting Paper	Planning Workshop	Participants (P)	Elements (E) in model	Intermediate structures	Total duration (T) of ISM session	Levels	Cycles
			Number			h min	Number	
1	B	University Dept. of Systems Science	8	19	2	4 40	8	1
4	E	University Short Course Unit	6	26	2	4 40	9	0
5	F	University Centre for Enterprise Managemen	4	21	2	3 10	13	1
6	G	University Engineering Education	6	23	1	3 30	7	9
7	A	Training Board: Fellowship Programme	4	30	2	3 45	12	5
8	H	Training Board: Development Team	9	28	2	4 45	12	6
10	J	Police Force: Management Support Dept.	10	32	2	5 55	11	5
12	L	Health Authority: Speech Therapy Service	5	21	No data	No data	11	4
13	M	Health Authority: Speech Therapy Service	6	21	2	4 0	10	3
14	-	Professional Institution: Technical Activity Committee	4	36	1	4 25	10	7
15	-	Defence Ministry: Military Reserve Force	6	17	1	3 20	8	0
		Average	6	25	-	4 13	10	4

Table A 3.1a Data on ISM sessions: intent and attribute enhancement structures

Case Number	Participants (P)	Elements (e)	Duration (t)	
	Number		h	min
1	8	19	3	30
4	6	13	2	0
5	4	16	2	5
6	6	23	2	40
7	4	16	1	55
8	9	25	3	30
10	10	32	4	50
13	6	21	3	20
14	4	35	3	25

Table A3.1b Data on ISM sessions (see Section 7.4 for interpretation of P, e and t)

Case Number	Supporting Paper	Planning Workshop	Participants	Elements in model	Intermediate structures	Total duration of ISM session	Levels	Cycles
			Number			h min	Number	
1	B	University Dept. of Systems Science	8	21	2	2 25	10	7
10	J	Police Force: Management Support Dept.	10	32	1	3 0	11	8
11	K	County Council: Highway Schemes	6	25	2	4 45	12	5
12	L	Health Authority: Speech Therapy Service	5	20	0	1 50	12	7
13	M	Health Authority: Speech Therapy Service	6	26	1	2 50	16	8
14	-	Professional Institution: Technical Activity Committee	3	34	1	4 30	11	7
		Average	6	26	-	3 13	12	7

Table A 3.2 Data on ISM sessions: linear priority structures

Case Number	Supporting Paper	Planning Workshop	Participants(P)	Elements (including categories)	Categories	Elements in largest category	Cycles	Total duration of ISM session
			Number					h min
2	C	University Accommodation and Conference Service	8	46	8	8	11	3 5
3	D	University Dept. of Civil Engineering	5	30	4	8	11	3 25*
5	F	University Centre for Enterprise Management	4	48	9	6	9	3 15
9	I	Training Board: Regional Managers	8	38	6	11	5	3 5
		Average	6	41	7	8	9	3 13

* Includes time spent on initial attempt to construct a linear priority structure (see s.p. D, Section 5.2)

Table A 3.3 Data on ISM sessions: composite priority structures

Appendix 4

STATEMENTS FROM CLIENTS

Section 8.5.3 of Chapter 8 discusses evaluation of the planning workshops by clients and participants. This Appendix contains statements which have been supplied by clients for whom the various workshops were conducted.

CITY University

MEMORANDUM

From I Stockdale/J Tibble
Accommodation Office

To Ross Janes
Systems Science Dept

Copy

18th February 1991

Re: Interactive Management Unit planning workshop for the Accommodation and Conference Service held 23/24 January 1989

Further to your letter of 26 November 1990, I hope you will find the following comments on the above workshop of use.

Effectiveness:

The workshop provided the first opportunity for hitherto separate offices to meet formally and consider their points of common interest, concern and responsibility. The meeting benefited from being held on neutral ground with an independent person to guide it through the ideas generated.

Methods used:

Staff leading the workshop engendered a cooperative rather than competitive air, helping to create a corporate spirit and a feeling that the mission statement was achieved by the group rather than imposed upon it. The group comprised of individuals with varying views as to the nature, policies and direction of the service and the many ideas aired were given value through the techniques used. The use of the computer and visual display, and the fact that all points raised were written on the white board, helped people to feel that every contribution was important and played a part in producing the mission statement. The ranking of goals meant that the group re-evalued its thinking constantly. As a consequence the group thought about its policies rather than simply accepted well held opinions, and the goals identified were held personally on behalf of the service rather than as a result of dictation by the head of service.

Use of product:

The workshop helped us to identify the service to ourselves before launching it to the University. It set group priorities which cut across parochial office goals. It was invaluable in seeing how staff reacted to each other and to the opinions aired and helped in assessing future group dynamics. In addition, it highlighted how personalities play a large part in the operation of the service, and that weight and consideration should be given to this when making staff appointments. The workshop set the tone for Managers Meetings which have continued two or three times a term since January 1989 and policies have continued to evolve democratically with consensus. The service produced a progress report on priorities arising from the workshop in September 1990 and is considering further work with the Interactive Management Unit at some point this academic year, hopefully with a residential component.

Centre for Continuing Education

CITY University

Northampton Square
London EC1V 0HB

Telephone 071-253 4399
Fax 071-250 0837

Short Course Unit Planning Workshop

Mr F.R. Janes is a colleague of mine at City University. The Centre for Continuing Education here has had the pleasure of working collaboratively with him in numerous capacities since 1988. His contributions to work of this Centre have been valued greatly and I would like to record my appreciation of one example in particular.

In 1988, this Centre obtained PICKUP* funding for the initiation and development of a Short Course Unit (SCU). The aim of this Unit was, initially, to provide administrative support for academic departments who wished to develop programmes of full-cost short courses for professionals. Although this aim sounds relatively simple, it soon became clear at the planning stage that it was fraught with difficulties - mainly concerning its strategies for financial support once the PICKUP funding ceased.

In order to clarify our thinking we consulted Mr Janes to help identify and structure the objectives of the Short Course Unit by means of a planning workshop.

A group of six members of City University staff involved in the area of short courses met on two occasions in the Decision Support Laboratory of the Department of Systems Science to identify and structure the objectives of the Unit.

The programme of meetings involved participants, firstly in developing an appropriate set of objectives for the Unit and secondly in examining how these objectives might be interrelated. The methods of computer-aided interactive management were used for these purposes with the staff of the Interactive Management Unit acting as facilitators throughout. The group was led by Mr Janes through a series of processes specifically designed to promote the efficient generation and structuring of ideas.

Later, a Priority Structure was produced for 15 of the objectives which formed the basis of future planning.

The planning workshop and products resulting from it provided a clear picture on the role and functions of the SCU, and provided information for subsequent resource allocation and development.

*PICKUP is a DES initiative, and is an acronym for professional Industrial and Commercial Updating.

As a planning exercise this was extremely valuable and had an added advantage in that the methods used by Mr Janes involved the staff of the SCU in determining the direction of their future activities. As such it was highly motivating and deserves the highest recommendation.

Yours sincerely,

Stella Parker

Dr Stella Parker
Head of the Centre for Continuing Education

25/2/92

REF:SP24.2D

Sarum House
6, Watermint Quay
Craven Walk
London N16 6DD

Monday, November 19, 1990
Ross Janes
Department of Systems Science
City University
Northampton Square
London EC1V 0HB

Dear Ross,

Interactive Management

We spoke the other day about interactive management.

I have found the techniques and methods which you employ in interactive management to be surprisingly effective. Starting up a Centre for Enterprise Management from within a university department was a new experience for me and one I looked forward to. How to interact with other members of staff in the department, to persuade them to join the venture, was not obvious, especially since—while I might have more business experience than they, it was they who understood the university "ropes".

The Interactive Management sessions which you set up were something of a revelation to me. Like many in industry, I was highly sceptical of the term and of the notion "facilitator"; it seemed to me to smack of jargon and to lack substance. I was also outnumbered in the sessions three-to-one, and was concerned lest my views and aims were swamped. These were the attitudes which I brought to the sessions.

The event was enjoyable. We discussed the Issue; we undertook a session using Nominal Group Technique; we progressed to Interpretive Structural Modelling. And my understanding of the roles and objectives of the Centre for Enterprise Management (CEM) were not so much swamped as enlarged. Facilitating became obviously necessary and useful, although I could see that not everyone would make a good facilitator. At the end of the last session, we had an agreed plan and organization, the whole having taken less time overall than I would have thought possible.

To me, the magic of Interactive Management as I experienced it during those sessions, was the subliminal group dynamics. Over a period of time, the various views of the participants converged without any of the individuals conceding ground, feeling put upon, or registering upset. Time, as I have since learnt during practices of my own, is important. The process seems to be taking a long time when in operation, but that feeling of duration is important—it is necessary for viewpoints to evolve. And the degree of achievement at the end is well worth the effort, since it is highly unlikely that the participants would have achieved a tiny part of the progress made by the group over the same period—let alone have developed a group committed through participation to the result.

Like Victor Kiam, I was so impressed I bought the idea. As you know, I have taken up the notion of Interactive Management myself—there can, perhaps, be no greater tribute to my total conversion from sceptic to advocate in one easy lesson!

Best regards

Derek Hitchins

Engineering
Training
Authority

41 Clarendon Road
Watford
Herts WD1 1HS
Tel (0923) 38441

Fax (0923) 56086

The Engineering Training Authority is dedicated to supporting British industry in developing an engineering manufacturing workforce which is equipped and trained to the highest international standards

8 May 1991

Mr R Janes
Senior Lecturer
Department of Systems Science
City University
Northampton Square
London EC1V OHB

Dear Ross,

Many thanks for your letter - please pass on my congratulations to Fred as Head of Department.

Things have moved a long way since the exercise in 1985 - most of the work of EITB is being assumed by the Engineering Training Authority, and so strictly speaking any reference to the Board should be in the past tense.

You may wish to use the following comments:-

a) The exercise tacitly set the boundaries around the area being discussed, and thus clarified the objectives of the team.

b) The identification of the trigger question involved the whole group in the identification of the purpose of the department - and brought out the fact that this was perhaps more complex at the group level than it appeared at the "topic specific" individual level. It showed that the individuals needed to be more aware of the totality of the situation.

c) The exercise was most successful in ensuring all the team contributed (and were seen by their peers to contribute) to the identification of the team's focus and the planning to achieve it. In addition the mechanisms to achieve group consensus were very visible. Colleagues were conscious of the interplay of opinions and facts and did not feel excluded from the process; consequently there was a high degree of commitment to the outcomes.

d) As Team Manager the exercise gave me an insight into the attitudes and concepts of my colleagues. The common sharing of a novel experience, which was so productive, provided a very firm foundation for the building of a team.

cntd/......

The Engineering Training Authority is a company limited by guarantee registered in England Number 2324869 Registered Charity Number 1000328 **Registered office:** Link House Radlett Road Watford Herts WD2 4JX

cntd/...... 8 May 1991

Engineering Training Authority

e) No matter how well based on theory and others the exercise could not have worked without your sympathetic and sensitive "facilitating". The paper you sent me is an almost "clinical" report of the events in 1985. I would hope that your thesis deals thoroughly with the human abilities necessary to make the mechanism work.

On a related topic, your letter prompted me to consider how the processes we used might lend themselves to a rather difficult problem. Briefly, we in the Authority and many other organisations, are "Industry Lead Bodies" for our respective sectors of industry. As such we are preparing Occupational Standards (which will form the basis of National Vocational Qualifications). The preferred process is called Functional Analysis and requires the desegregation of functions - a "top down" approach. If you have time it might be worth a brief meeting to go into more detail.

Finally may I wish you every success with your thesis.

With best wishes.

Yours sincerely,

Gill P. Thomas

f. M N Johnson

ENGINEERING INDUSTRY TRAINING BOARD

54 Clarendon Road
Watford
Hertfordshire
WD1 1LB

Telecom Gold
74:ETB001

Telex
265451
MONREF G
Ref. ETB001

Telephone
0923 38441

Fax
0923 243025

EITB

GFB/SSH

7 January 1991

Mr Ross Janes
Department of Systems Science
City University
Northampton Square
London
EC1V 0HB

Dear Ross

Thank you for your recent letter and I apologise for not replying sooner.

I am sorry that we were not able to go ahead with the workshop but the reasons were one of "timing constraints" related to the rate at which changes are taking place here.

The previous workshop in 1987 was extremely successful and many of the priorities identified then are in many ways still very relevant today and still referred to by those Managers who attended.

The workshop enabled a number of people, those directly involved such as the Regional Managers and others in Corporate Planning, to become involved in the planning process. The achievement of consensus by statistical means (if I can put it that way) and the immediacy of the decision process using computers were an important factor in the success of the workshop.

The report is still referred to three years or more after the event which says a lot for the quality of the material and the commitment of those who took part.

Yours sincerely,

Sue Hales

pp G F Ball
General Manager, Regional Operations

Planning Exercise for the Management Support Department of the Metropolitan Police Force

The three day planning exercise undertaken for the Management Support Department of the Metropolitan Police Force in 1985 under the direction of Mr Janes was most helpful to me as the Assistant Commissioner in charge of the newly-formed Department.

The exercise enabled a number of people, including senior staff who would be involved in running the Department, to make a significant contribution directly to the planning process. The methods used were effective in helping participants to work together in order to generate and structure objectives and to set priorities for the Department. The report resulting from the event provided a valuable document which contributed to the planning and organisation of the Department.

C B J SUTTON LLB QPM
Director
Police Requirements Support Unit
Formerly Assistant Commissioner
Metropolitan Police

Transportation
Director of Transportation
Nigel G Knott CEng FICE FIHT

Hertfordshire
COUNTY COUNCIL

Mr. R. Janes
Senior Lecturer
City University
Northampton Square
London EC1V OHB

Goldings
North Road
Hertford SG14 2PY
Fax : 0992 556029

Telephone: 0992-556040
My ref : C/PWB/MB
Your ref :
Date : 22 April 1991

Dear Ross

SETTING PRIORITIES FOR HIGHWAY SCHEMES
INTERPRETIVE STRUCTURAL MODELLING

Thank you for your letter of 5th April 1991 and it was good to hear from you again. I confirm that the County Council are happy for you to use the 1987 report in your PhD Thesis.

Turning to the value of the exercise, I believe the changed priorities introduced by ISM were logical and addressed the issue of value for money being raised by County Councillors at that time. However the members of the council were reluctant to accept an arrangement where "expert officers" established guideline priorities, without a factually based reasoning being explicitly established. To progress therefore we either had to assemble a cross party group of elected members to go through the ISM exercise again, or continue to search for an objective prioritising method.

David Tweedale, who is now responsible for this work, has devised a system based on congestion, accidents, and building density which seems to be gaining some support, but as always if the politicians do not like the final ranking they attack the method.

To summarise therefore the ISM trial proved an interesting exercise, assisting the County Council in the development of a prioritising system which is ongoing. I hope this brief note is of assistance.

Yours sincerely

P.W. Bellinger
Head of Design Services

COMMUNITY HEALTH SERVICES

Community Unit,
WEMBLEY HOSPITAL,
Fairview Avenue,
Wembley, Middlesex,
HAO 4UH

Tel: 081 903 1323 x 3261

Ross Janes,
Department of Systems Science,
CITY UNIVERSITY,
Northampton Square,
London, EC1V OHB

14th May 1991

Dear Ross,

I am writing in response to your request for my feedback on the effectiveness of the I.S.M. workshop.

As a Manager I found the Interpretive Structural Modelling process extremely helpful in identifying problems, service needs and setting objectives on a time scale in order to meet those needs. From my point of view perhaps our experience at the I.S.M. workshops was somewhat different to the experience people may have coming into this situation cold. As you will remember in the report you refer to, I actually lead the NGT session which formed the basis for the work on the I.S.M. workshop so I felt more ownership of the project and also felt that I had shared much of the burden of most of the work by, in fact, dealing with this first stage myself.

The workshop certainly helped to plan for the future of a service and although I was not with Hounslow and Spelthorne Health Authority long enough to see the plans we based on this completed, the areas I did follow through on were most successful. An important by-product of the workshop was the sense of teamness generated in the members and joint commitment to a series of common goals. As the Manager of a much larger team now - i.e. 42 as opposed to 7 - I would support the use of I.S.M.in the determination of solutions and prioritisation of structures with regard to other service issues. However, the draw-back at the moment of such a process is that it requires time to follow through on the products of the workshop and in the last eighteen months it has not been possible to find this time as no statistical phases appear to exist in the NHS at present.

As you will also be aware, I felt committed enough to the I.S.M.process to want to purchase the system for myself. Unfortunately the funds disappeared from which to do this. Should the constant changing environment within the NHS reach a temporary standstill, I would be delighted to embark on another project using this process again. I can only give you my full support in any future work of this nature.

If there is any other way in which we can help with regard to providing feedback for your PhD, I would be delighted to do so.

I am sorry that there has been such a delay in responding to your urgent request.

Yours sincerely,

Belinda Cowell

Belinda Cowell,
District Speech Therapy Manager

ET21/408/MO'S/1

Department of Health

Euston Tower 286 Euston Road London NW1 3DN

Telephone 01-388 1188 ext 336/3377
GTN 2597

Ross Janes
Department of Systems Science
City University
Northampton Square
EC1V OHB

Your reference

Our reference

Date 21 December 1990

Dear Ross

DROC SYSTEMS MODELLING

The DROC (Designing for Reduced Operating Costs) Systems Modelling of linen and catering services in NHS hospitals has involved two separate consultative groups, and included design and operational professionals from the NHS and Department of Health. The adoption of the principles of Interactive Management in running the various meetings of the groups, including the use of Idea-writing in the model building stages of computer software development, has been highly beneficial. It has helped to involve participants closely in the relevant models. This has contributed significantly to the successful development of both the LINEN and CATER software, which are being tested and applied in the NHS. Reported benefits include use in planning hospital services, budgetary management and staff training.

Yours sincerely

Tony Noakes

TONY NOAKES

Superintending Architect

Appendix 5

SUMMARY OF RESULTS OF QUESTIONNAIRE FOR PARTICIPANTS (see Section 8.5.3, Chapter 8)

A questionnaire was used following three of the later workshops (cases 2, 12 and 13 in Table 7.1, Chapter 7) to assess the reactions of participants. It was designed by Mr K.Hammer of the Interactive Management Unit (IMU) at the author's request and was amended in minor ways after the first use. It is reproduced at the end of this Appendix.

The questionnaires were completed through individual face-to-face interviews conducted by a member of the IMU with each of the participants. The interviews were undertaken at the participants' place of work between one and eight months after the workshops occurred. Every one of the 19 participants in the three workshops took part. The workshops did not all involve the use of the same methods (see Table 7.1) and so the comments on the responses refer to the particular case or cases as appropriate.

Q1. Do you consider that the IMU's briefing literature described what you eventually experienced?

Responses ranged from "Fully" to "Not clearly enough" but the briefing literature was, on the whole, fairly well regarded.

Q2. What were your anticipations of this event?

This question elicited the full range of responses from "eagerness", to "it will be a waste of time" from one participant. Responses were generally positive with "curiosity" being the commonest reply.

Q3. What were your reactions at the end of each session?

<u>Ideawriting</u>. Responses were all positive, being balanced between "impressed" and "pleased".

<u>Nominal Group Technique</u>. The majority response was "pleased", with a number of "impressed" and "neutral" replies. Several participants also noted that it was interesting, revealing or tiring.

<u>Idea Categorisation</u>. Responses were balanced between "pleased" and "neutral". One participant felt that it had been dominated by one individual.

<u>Interpretive Structural Modelling</u>. The largest response was "impressed" with a

number noting "pleased". Additional comments included: thought provoking, hard work, repetitive and tiring.

Mission Statement/Goals. Responses were, on balance, positive but did span the whole range from "impressed" to "disappointed". Of the three participants making the latter assessment, one noted that he did not like splitting into subgroups, another thought that more time was needed, whilst the third felt that the same mission statement could have been written at the beginning of the workshop.

Q4. Were you satisfied with the room and facilities?

Here, responses were an almost unanimous "yes", but with two remarks about the need for better ventilation in the decision support room.

Q5. Was the catering: excessive; adequate; insufficient; not to your taste?

This was almost unanimously responded to with "adequate".

Q6. Were the explanations and efforts of the facilitators to your liking?

The majority response was "very good", with a number of "quite good" answers and one "adequate". (Two different facilitators were involved in the three workshops. One gained a consistently high rating; the other received some critical comments regarding his explanation of the process of the workshop to the group and his facilitation of the mission/goals stage.)

Q7. Did you feel frustrated by the proceedings at any time?

Whilst some participants answered "no" to this question, a majority answered "yes". The reasons for this latter answer were varied. A number felt frustrated with other participants at some time during the workshop, e.g., for having different perspectives or being long-winded. Some were tired by the end of the workshop and found trying to write a mission/goals statement difficult. This also relates to the comments under Q6 above.

Q8. Did you at any time feel distracted by the observers or by the equipment?

Overwhelmingly, the response here was "not at all". One participant was occasionally distracted by the noise of a computer keyboard being used.

Q9. How much do you feel you have learnt about the situation under examination?

The responses were balanced between "a considerable amount" and "some useful additions", with two replies of "a little". Certain participants also stated that they felt they had learnt a lot about the other participants or that the process clarified things they probably knew but hadn't thought about properly before.

Q10. Do you believe that the process allowed and encouraged everyone to give of their best thoughts and ideas?

A large majority responded "yes" with several "yes, except for ..." answers. The exceptions concerned: encouraging quieter group members to contribute more, being tired, and feeling pressurised into making decisions.

Q11. Having seen the printed products of the sessions, how much use do you think they will be to you in future work?

With associates. The majority response was "considerable" with some replies of "on the right occasions". Two respondents answered "none".

With superiors. Here responses were evenly divided between "considerable", "on the right occasions" and "a little". There were no "none" replies.

In your own work. One group responded almost unanimously with "considerable", whilst the other two groups replied with "on the right occasions".

Q12. Do you believe that you and most of the other participants will be able to cooperate better in future?

The majority reply here was "yes", with other answers being spread across the responses "with most of us", "probably a little better", and "I do not think it will help me". In these latter cases a number of participants pointed out that they thought their group members were already cooperating well in any case. One client noted that the ISM structures would be helpful to new staff.

Q13. Do you now believe you will be better able to state your problems to associates at work who were not participants?

The majority response was "yes, I can state them more clearly", with several "I think so answers". One participant noted that this had already happened, whilst another felt that she had no difficulty in doing this prior to the workshop.

Q14. Do you feel a full partner in a group which jointly owns and supports the documented ideas and decisions produced?

The overwhelming response here was "yes, I do". A few replies were "yes, but not very strongly". One participant responding with the latter view felt that her area of responsibility was on the periphery of the main work of her department. The one person responding "I do, but I doubt if all do" also added that he thought the ideas and decisions had the weight of group consensus behind them.

Q15. Do you feel that sometimes the simple majority voting rule denied the correct emphasis being placed on the opinions of the few who are most involved and best informed on that issue?

The majority of participants answered "occasionally" to this question, whilst the rest replied "not at all". None responded "often".

Q16. Did you feel tired or did your enthusiasm flag?

Here the responses varied very much between the groups. The vast majority of one group (case 2, Table 7.1) answered "no", with two members feeling tired towards the end of the workshop. The other two groups unanimously answered "yes", with many commenting that they felt tired towards the end. It should be noted that these latter two groups used ISM to construct both an intent structure and a linear priority structure, whereas the former group (case 2) used ISM in the much more varied activity of building a composite priority structure (see Chapter 8). However, the intensity of the thinking required was noted by members involved in both activities.

Q17. How useful do you think the whole experience will be to you in the future when dealing with problems which affect several other people?

The majority response was "gave me a few good ideas". In each case the client for the group answered "considerably". Only one participant responded with "a little" and none with "not much".

Q18. Overall, do you consider the time spent on this exercise worthwhile?

The responses to this question were all positive. The majority of participants felt that the workshop would have taken longer by any other method and that the time spent was "quite profitable". Others thought that it had been "useful".

Interactive Management : Post-Experience Questionnaire

Name of Consultancy: ....

Name of participant: ....

Name of questioner: .... Date: ....

---

1. Do you consider that the IMU's briefing literature described what you eventually experienced?

   Fully; Fairly well; Just adequately; Not clearly enough; Not at all well;

2. What were your anticipations of this event?

   Eagerness; hopeful; curiosity; misgiving; It will be a waste of time;

3. What were your reactions at the end of each session?

	I.W.	***N.G.T.***	***Categorisation***	***I.S.M.***	***Mission/Goals***
Disappointed					
Neutral					
Pleased					
Impressed					

4. Were you satisfied with the room and facilities as to:-

	Yes.	***Could be improved.***	***Poor.***
Comfort			
Peace and quiet			
Clarity of displays and charts			
Isolation from distractions			

5. Was the catering:

   Excessive; Adequate; Insufficient; Not to your taste;

6. Were the explanations and efforts of the facilitators to your liking?

   Very good; Quite good; Adequate; Need improvement;

7. Did you feel frustrated by the proceedings at any time? ***No;***

If yes, then at which stages; ....

....

8. Did you at any time feel distracted by the observers or the equipment?

Not at all; ***Occasionally;*** ***Several times,*** ***when*** ......

....

9. How much do you feel you have learnt about the situation under examination?

A considerable amount; ***Some useful additions;*** ***A little;*** ***Nothing new;***

10. Do you believe that the process allowed and encouraged everyone to give off their best thoughts and ideas?

Yes; ***Yes, except for;*** ....

.... ***No;***

11. Having seen the printed products of the sessions how much use do you think they will be to you in future work?

	Considerable.	On the right occassions.	A little.	None.
a) With associates				
b) With superiors				
c) In your own work				

12. Do you believe that you and most of the other participants will be able to cooperate better in future?

Yes; ***With most of us;*** ***Probably a little better;*** ***I do not think it will help me;***

13. Do you believe you will be better able to state your problems to work associates who were not participants?

Yes, I can state them more clearly; ***I think so;*** ***It is unlikely to be of help;***

14. Do you feel a full partner in a group which jointly "owns and supports" the documented ideas and decisions produced?

Yes I do; I do, but I doubt if all do;
Yes, but not very strongly; Not at all;

15. Did you feel that sometimes the simple majority voting rule denied the correct emphasis being placed on the opinions of the few who are most involved and informed on that issue?

Not at all; Occasionally; Often;

16. Did you feel tired or did your enthusiasm flag at any stage?

Yes; No.

17. How useful do you think the whole experience will be to you in the future when dealing with problems which affect several other people?

Considerably; Gave me a few good ideas; A little;
Not much;

18. Overall, do you consider the time you spent on this exercise worthwhile?

Would have taken a lot longer by any other method;
Quite profitable; Useful; Neutral, no gain no loss;
It was a waste of time;

Ref: FRJ/intmanqst.frj/sab

Supporting Papers

This section of the thesis contains the supporting papers A to S as listed in full in the Table of Contents.

A selection of appendices associated with supporting papers C, D, I and Q has been included, either to serve as illustrative examples or because they have been specifically mentioned in the text of the thesis. Appendices associated with other supporting papers have been omitted.

SUPPORTING PAPER A

Janes, F.R. (1988). Interpretive structural modelling: a methodology for structuring complex issues. Transactions of the Institute of Measurement and Control, 10(3), 145-154.

Interpretive structural modelling: a methodology for structuring complex issues

by F. R. Janes, BTech, MSc, CEng, MIEE, MInstMC

This paper discusses the nature of Interpretive Structural Modelling (ISM) as methodology for dealing with complex issues. Aspects of managing complexity relating particularly to the use of ISM with a group of participants are explored. These include the interrelations between the issue, group and methodology, and between content, context, process and product. Languages for modelling structure are briefly examined, and ISM is presented as a computer-assisted modelling approach incorporating words, graphics and mathematics. The steps of using ISM in practice are considered in the context of group work. Each step is elaborated upon and important features discussed. The use of Nominal Group Technique as an idea-generation method which may be used in conjunction with ISM is outlined. An example of an application is given concerning the structuring of a set of objectives to produce an Intent Structure.

Keywords: Complexity, structure, modelling, digraph, process, group work.

1. Introduction

In creating ISM, J. N. Warfield (1973a; 1974a; and 1976) has developed a powerful methodology for structuring complex issues. Drawing upon discrete or finite mathematics, Warfield has produced a mathematical language applicable to many complex issues, provided that they can be analysed in terms of sets of elements and relations. From the viewpoint of the user, the structural models produced are communicated as a combination of words and digraphs with the mathematics being hidden in a computer program.

ISM is particularly useful for working with participants in a group in which structured debate can help the participants to reach a consensus view. The role of a trained facilitator is important here in drawing out different viewpoints and in guiding the group through the steps of the methodology. In this sense ISM attempts to deal with what Flood (1988, in this issue) has labelled 'psychological complexity in that it takes into account the different interests and perceptions of the participants. In terms of the classification scheme put forward by Jackson (1988, in this issue) ISM may, for the same reason, be considered as 'pluralistic'.

Section 2 of this paper deals with a number of aspects of managing complexity in the context of working with groups. Section 3 examines three languages for modelling structure – words, diagrams and mathematics – and discusses how these are used in ISM. Section 4 deals with ISM as a process and considers the steps involved in building a structural model. In section 5 an application is considered, in this case building an Intent Structure relating to a postgraduate course in Systems Management.

Senior Lecturer, Dept of Systems Science, City University, London.

2. Aspects of managing complexity

While ISM may be used by an individual to explore the interrelations between the elements of a complex issue, it has been designed so as to be particularly well suited for group work. In this section a number of aspects of managing complexity will be examined relating particularly to the use of methodologies for group work.

a. Issue, team and tools

In order to investigate a complex issue, it is often both necessary and desirable to assemble a group of people of diverse backgrounds who can work together as a team. The team may include the following four categories of people. First, *specialists*, with content knowledge relevant to the different aspects of the situation. Second, *stakeholders*, who may be affected in some way by the outcome of the investigation. Third, *modellers*, in this case structural modellers, who can work with the participants in structuring the issue. Fourth, a *facilitator*, who can take the participants through the steps of whatever formal group processes are adopted. There may be overlap between these categories, as shown in Fig. 1.

The methodological tools adopted to enable the team to explore the issue may be many and varied. Warfield (1976 (ch 1)) has described the interactions between the issue, team and methodology as 'the fundamental triangle of societal problem solving'.

As shown in Fig. 2, the interactions between the three elements themselves give rise to a complex situation that needs careful management. Interaction 1, between the team and the issue, indicates that a group must be assembled that has appropriate involvement of stakeholders and knowledge specific to the issue in order to explore it properly. Furthermore, the participants will have different perceptions of the situation. Interaction 2, between the tools and the issue, indicates that a large range of methodological tools may be available to the team, and the appropriate ones for the issue at hand must be selected. Interaction 3, between the team and the tools, concerns the fact that even if the appropriate tools exist for the issue, the team may not be aware of them or may not understand how to use them.

(b) Group work

Once methodologies have been selected and a team of people assembled to explore an issue, the workings of a group may be greatly enhanced through a facilitator (Warfield, 1982a) with the necessary technical and behavioural skills. ISM may well be used in conjunction with an idea-generation methodology such as Nominal Group Technique (see section 4(4)). The facilitator needs technical skills in the sense of understanding the process steps of such methodologies and in being aware of the appropriate uses and limitations of the methodologies. He also needs to be familiar with the use of any associated computer software, for example, an ISM program. In addition, the facilitator also needs behavioural skills in management of the group dynamics. He should thus have certain personal skills in dealing with people and should have some experience of group work. Taking a group through the steps of one or more methodologies, keeping the participants focused on the issue and moving the whole process towards a satisfactory conclusion is thus another aspect of managing complexity.

(c) Mental limitations

An important feature of complexity concerns the interrelations between the multiple elements in the issue being explored. An individual attempting to deal with this complexity encounters mental limitations (Warfield, 1976 (ch 3)). Miller (1956) thought that the span of immediate recall was in the region of 7 ± 2 'chunks' of information, while Simon (1974) concluded that the 'chunk capacity of the short-term memory' was in the range of 5 to 7. A system having only three variables, each of which has a two-way interrelation with every other variable, may be considered in terms of 9 chunks of information (Waller, 1982). In principle, this exceeds the limits of the ability of our short-term memory to deal with it (Fig 3).

Any methodology for dealing with complex issues must, therefore, be able to break complexity down into manageable chunks of information so that the human mind can deal with it. ISM tries to do this, by enabling an individual or group to focus on the interrelations between two elements in an issue at a time, without losing sight of the properties of the whole.

(d) Content, context, process and product

Investigation of an issue or problem by a group will be aided if due attention is paid to content, context and process (Warfield, 1982b; 1984). *Content* consists of information related to the issue, particularly knowledge that the individual members of the group have about a situation and their differing perceptions of the issue or problem. Content does not exist in isolation but will depend upon an *issue context* including, for example, the particular situation and people involved in it (Fig 4). *Process* involves activities, in particular the steps of the methodology(ies) through which the group progresses when, for example, generating and structuring ideas. This process will be carried out in a *process context* consisting of the facilitator and supporting environment (physical and human) in which the group works. The outputs of the process may be regarded as the *products* resulting from the work – eg structural models – and the *learning* which takes place among the participants during the sessions.

From the above it will be seen that investigating a complex issue may place a considerable requirement upon those conducting the inquiry. A relevant group has to be assembled, methodologies must be selected, the group must be managed and attention paid to both process and contexts as well as to content and products. This will all help to ensure that appropriate products are produced and that beneficial learning takes place among the participants.

3. Languages for modelling structure

In the context of ISM, the term *structure* is used to denote the particular set of elements identified as being of interest in a problem or issue and the pattern of interrelations between them. Three modelling languages of particular importance in representing the structure of complex systems are: words; diagrams; and mathematics. In this section they are briefly examined together with their role in ISM.

(a) Modelling languages

Words may be used to construct a linguistic model of structure subject to the rules of grammar and semantics relevant to the particular natural language. They provide a most elaborate method of representing and communicating the structure of a system symbolically (Mihram, 1972).

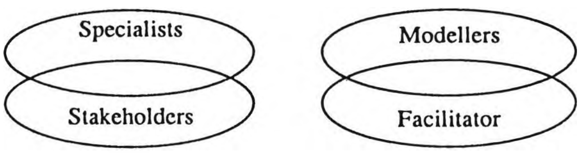


Fig 1 Overlap between categories

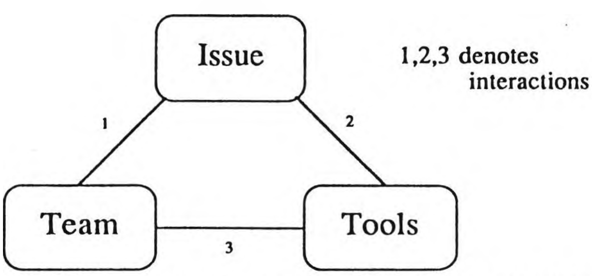


Fig 2 Issue, team and tools (adapted from Warfield (1976))

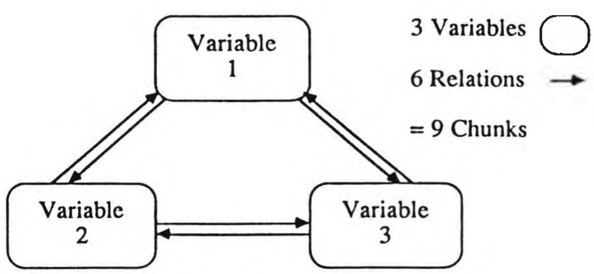


Fig 3 Chunks of information

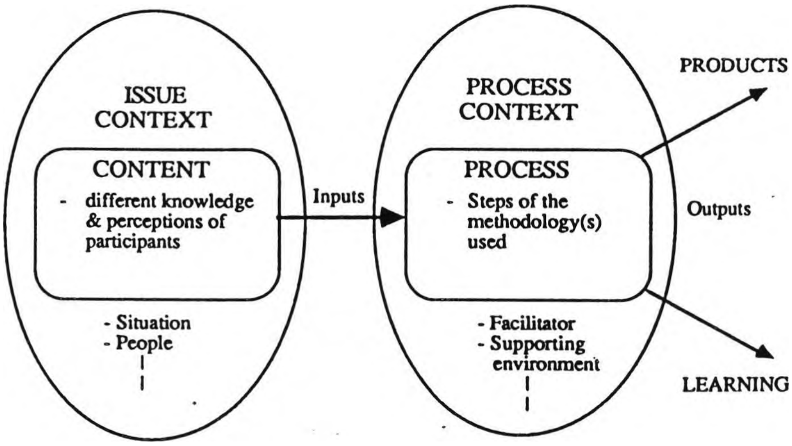


Fig 4 Content, context, process and product

Diagrams offer a pictorial representation and, like words, largely provide qualitative models. However, diagrams make full use of the parallel information-processing capacity of the visual system and thus provide a very powerful means of communication. This contrasts with linguistic models which have their origins in the spoken word and, even though they may be read with the eye, are essentially a serial way of conveying information evolved to be compatible with the ear: a serial information-processing machine.

Mathematics makes it possible for symbolic models to be constructed which are manipulated entirely by a mathematical formalism such as calculus or algebra. This allows quantitative representation and a great deal of manipulation to be undertaken. However, such models are limited, as a means of communication, to those who understand the particular mathematical language.

In developing ISM, Warfield (1976) has combined words with digraphs, a specific form of diagram, in order to provide an easy means of representing and communicating complex structural models. The construction of such models by a user group may involve considerable mathematical manipulation, but this can be entirely hidden from the user in a computer program. ISM uses the discrete mathematics of logic and structure (including binary relations, set theory, matrix theory, graph theory and Boolean algebra) which is particularly suitable for representing systems described in terms of elements and relations.

(b) Interpretive structural models

Directed graphs or digraphs are well suited to represent complex structures diagrammatically. In ISM the vertices of the digraphs represent the elements of the issue or problem being studied, while the edges are directed and denote a specific relation between the elements. For example:

Elements	Relation
1. Factors in running a successful business	– strongly contributes to
2. Objectives of an organisation	– would help to achieve
3. Planned county road schemes	– is better value for money than

Fig 5 shows a section of a typical digraph for example 2 above, in which the circles represent the objectives and

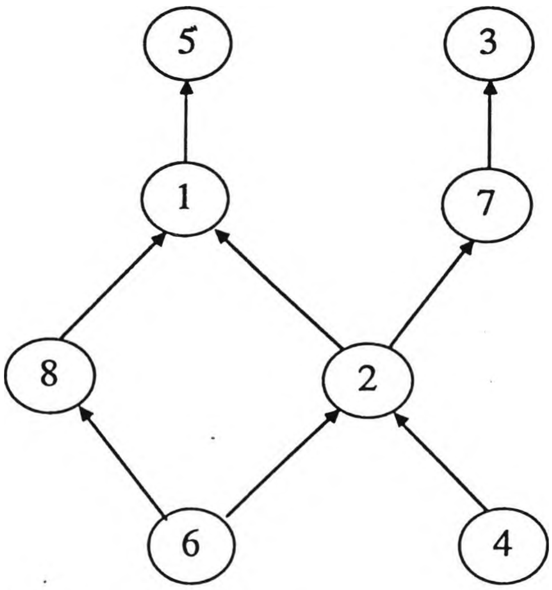


Fig 5 Example of a digraph

the arrow represents the phrase 'would help to achieve'. Inserting the wording of the elements in place of the numbered circles give a well defined structural model based on words and digraphs which is easily communicated. An example of this is shown in Fig. 12.

Warfield (1982b) has described ISM as 'a computer-assisted learning process that enables an individual or a group user to develop a structure or map showing interrelations among previously determined elements according to a selected contextual relationship'. The process of ISM forces the user to select the elements of importance in the issue being explored and to state explicitly the interrelations between them according to a specific contextual relation. The resultant ISM is a user-created visual model showing elements and relations as a multilevel digraph. The user may be an individual or a group, and the process may be done manually, which can be laborious, or with a computer equipped with ISM software. However, the full potential of the methodology is best realised in a group context with a computer.

Waller (1983) has described ISM as context free in that it can be used in any complex situation, irrespective of the content of the situation, provided that a set of elements can be identified and an appropriate contextual relation defined. Furthermore, the elements may be qualitative or quantitative, permitting items to be included which are not measurable on anything other than ordinal scales of measurement. In this sense ISM is much more flexible than many conventional quantitative modelling approaches which require variables to be measurable on ratio scales. ISM thus offers a qualitative modelling language for structuring complexity and enables a group of users to map their thinking on an issue by building an agreed structural model.

4. The Interpretive Structural Modelling process

Building an Interpretive Structural Model involves a number of activities, and these are summarised in this section. The exact sequence of steps will vary from situation to situation, but the process shown in Fig 6 is typical of the full sequence when ISM is used to explore a complex issue with a participant group using a computer.

(1) *Identifying issue to be studied.* It is necessary to identify fairly clearly the particular issue which is to be explored using ISM. An organisation may, for example, be concerned about the inadequacies of its strategic planning. It may see ISM as a methodology which can be used to involve managers in examining the interrelations between a set of organisational objectives in order to set priorities or assist in organisational design.

(2) *Deciding on type of ISM to be constructed.* At this stage it is usually important to decide on the type of structure which is to be produced during the ISM session. This will help to determine the form in which the elements are to be generated, if they are not already known, and the likely wording of the contextual relation which will be used to interrelate the elements.

Warfield (1982a) has classified the structures resulting from the application of ISM into five types. An *Intent Structure* shows the interrelations between a set of objectives. A typical contextual relation for such a structure might be 'would help to achieve'. Such structures have a number of uses (Warfield, 1973b) including clarifying thinking, explaining what an organisation or project is trying to accomplish, and providing a basis for taking action. A *Priority Structure* can be constructed when it is required to rank a number of elements in order of priority. The elements might, for example, be a list of planned local authority projects. An associated contextual relation might then be: 'is more important than'; or 'is better value for money than'. Such structures are clearly of use in allocating limited resources. An *Attribute Enhancement Structure* shows the interrelations between a set of factors, problems or opportunities. A contextual relation 'strongly contributes to' might be used, for example, to explore the interrelations between a set of problems facing a manufacturing company. The remaining two types of ISM are *Process Structures* which usually involve some kind of sequencing of a set of activities and *Mathematical Dependence Structures* which may be used to map the interrelations between a set of quantifiable elements.

(3) *Selecting participant group and facilitator.* In section 2(a) the categories of people who might form a team for an ISM session were considered. The selection of particular individuals will depend on the situation. Clearly, it is essential that participants have the necessary content knowledge relevant to the issue. If the ISM is being done for an organisation, the involvement of stakeholders, including decision makers, will help to ensure commitment to the outcomes, e g, in the case of Priority or Intent Structures.

One important consideration is group size. The group of participants responding to the questions put by the computer should be limited to a maximum of around eight people. As the group size increases much above this number, the quality of debate deteriorates. Since each member can converse with every other, the number of possible communications between different individuals in a group of n people is $n(n-1)$. An increase in the group size from six to ten participants thus results in the number of possible communications trebling from 30 to 90 (Fig 7). Individual participation, involvement in the process, and interest consequently tend to decline.

As discussed in section 2(b), the process facilitator plays an important role and he needs to have the necessary technical and behavioural skills to guide the group during the ISM session. It is highly desirable that the facilitator be familiar with building structural models and he may be assisted both by other modellers and a computer operator if the resources permit.

1. Identify issue to be studied
2. Decide on type of ISM to be constructed
3. Select participant group and facilitator
4. Generate the element set
5. Complete matrix of element interactions
6. Display the ISM
7. Discuss structure and amend if necessary

Fig 6 Process of interpretive structural modelling

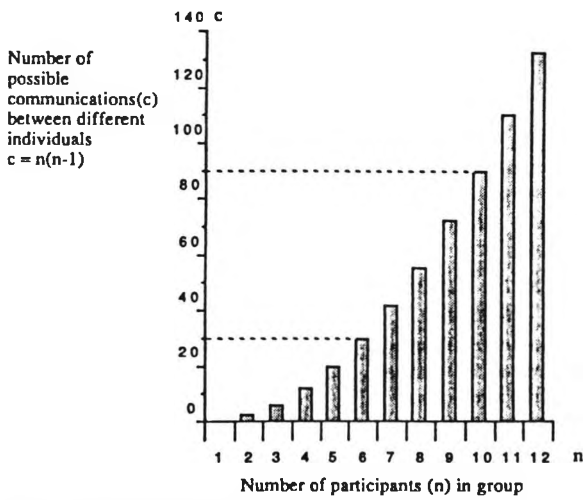


Fig 7 Possible communications between different participants

(4) *Generating the element set.* In some cases the set of elements to be structured may already be defined. For example, they may be a set of county highway schemes which have to be prioritised because the financial resources to carry them all out are not available. However, in many cases it will be desirable and necessary for the participant group to generate the elements. For example, when developing an Intent Structure for a department in an organisation, the managers involved may first have to generate the objectives to be structured. Similarly when, say, using ISM to explore how the factors influencing the effective implementation of a major construction project contribute to one another, the participants will probably have to generate the factors in the first place.

The use of structured idea-generation methods is one way in which a group can produce the necessary set of elements. Nominal Group Technique (NGT) invented by Delbecq *et al* (1975) is a process that has been found to work particularly well in conjunction with ISM (Janes, 1987; Moore, 1987; and Wood and Christakis, 1984). Warfield (1982b) has described NGT as 'an efficient method for *generating* ideas in groups, for *clarifying* the generated ideas, for *editing* the generated ideas, and for developing a preliminary *ranking* of the set of ideas'. The process may be described in terms of five basic steps:

(i) clarification of a trigger question;
(ii) silent generation of ideas in writing by each participant;
(iii) round-robin recording of the ideas on a flip-chart;
(iv) serial discussion of each idea for clarification and editing; and
(v) voting to obtain a preliminary ranking of the ideas in terms of importance.

Step (iii) ensures that all ideas are recorded and step (iv) enables a full discussion of the ideas generated in order to clarify and edit them. The process is thus fairly exhaustive and ensures that all participants have a clear understanding of, and opportunity to express value judgements on, the ideas produced.

(5) *Completing a matrix of element interactions.* At this stage the ISM software can be used. The set of elements to be structured is entered into the computer and the group is asked to respond to a series of questions put by the computer of the form:

> 'Is the Wilton Road Dual Carriageway better value for money than the Chester Abbots Bypass, taking into account all the benefits and capital costs?'

In this example a Priority Structure is being developed for a set of highway improvement schemes using a contextual relation 'is better value for money than', qualified with a phrase related to benefits and capital costs. In the case of an Intent Structure, a typical form of question is:

> '*Would* the objective of improving the quality of products *help to achieve* the objective of reversing the decline in profits?'

Here, an Intent Structure is being developed for a set of organisational objectives in a manufacturing company using the contextual relation 'would help to achieve'.

In either case the group discusses the question under the guidance of the facilitator and a 'Yes' or a 'No' answer is agreed upon after a vote has been taken by the participants. When the group votes for a 'Yes' a '1' is entered in the appropriate cell of a matrix in the computer. A 'No' vote results in a '0' being entered. The binary matrix being constructed represents a binary relation of a set on itself. As the process proceeds, the computer makes logical inferences, based upon the answers already given, which speeds up the process and leads to the construction of a reachability matrix (Warfield, 1976 (ch 9)). An example is shown in Fig 8.

The '1' entries signify that a relation exists between a pair of elements, for example, cell ($e3$, $e1$). A '0' entry signifies that no significant relation exists, for example, cell ($e2$, $e4$).

The mathematics underpinning ISM always assumes that the contextual relation used is transitive, which permits transitive logical inferences to be made by the computer. It is thus important that care is taken in selecting the contextual relation to ensure that it has this property of transitivity. An example is shown in Fig 9a for the contextual relation 'is a higher priority than'. Since project A is a higher priority than project B, and B is a higher priority than C, then it can be transitively inferred that A is a higher priority than C.

In some cases the relation used may also have other logical properties, such as asymmetry which allows asymmetric inferences to be made. An example is shown in Fig 9b for the relation 'precedes'. Since step A precedes step B, it can be asymmetrically inferred that step B cannot precede step A. The total number of inferred answers in an ISM session will vary from one situation to another, but may typically be of the order of 70%. This represents a considerable time saving when dealing with, say, 20 elements and hence a 20 × 20 matrix with 400 cells to fill in.

(6) *Displaying the ISM.* When all necessary questions have been answered by the group and a reachability matrix constructed, the computer can extract a multi-level digraph from the matrix. Fig 5 gave an example of such a digraph, in that case a hierarchical digraph containing no cycles. A multi-level digraph with cycles is shown in Fig 10. The theory underlying the process of extracting such digraphs from reachability matrices involves extensive use of discrete mathematics. For further information on

	e1	e2	e3	e4
e1	1	1	0	1
e2	0	1	0	0
e3	1	1	1	1
e4	1	1	0	1

e1, e2, e3, e4 denote elements

matrix entries : 1 = 'yes'
0 = 'no'

Fig 8 Example of a simple reachability matrix

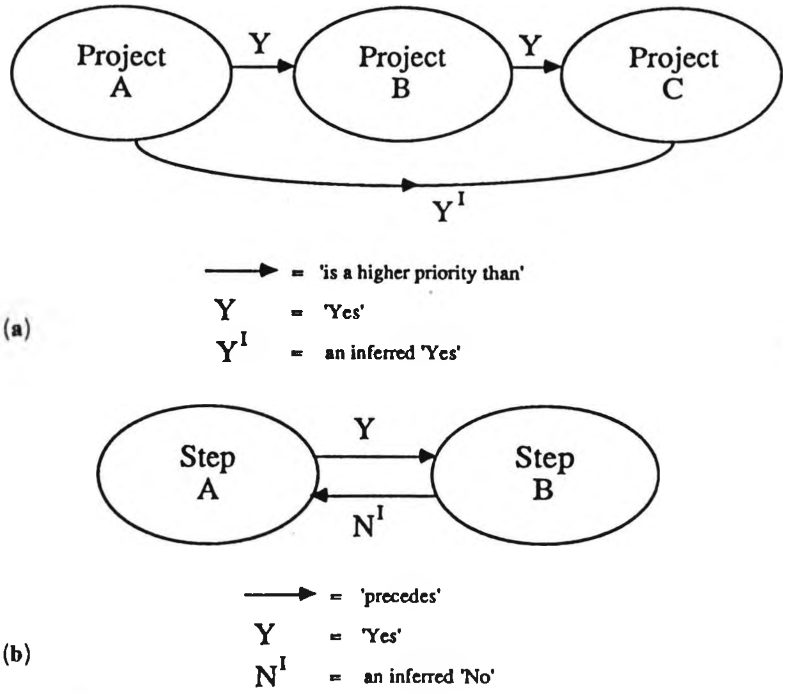


Fig 9 (a) Example of a transitive logical inference. (b) Example of an asymmetric logical inference

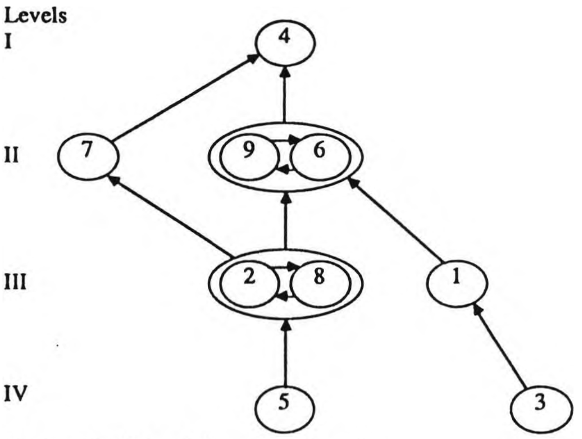


Fig 10 Multi-level digraph with cycles

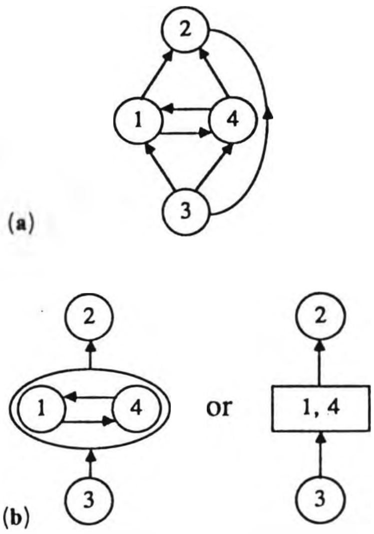


Fig 11 (a) Digraph corresponding to matrix of Fig 8. (b) Minimum-edge digraph for Fig 11a

this the reader is referred to Warfield (1973c), or Warfield (1976 (ch 10)).. However, to demonstrate the concept, it may be seen by inspection that the multi-level digraph in Fig 11a corresponds to the simple four-element matrix in Fig 8. This may be redrawn with transitive relations deleted to give the minimum-edge digraph in Fig 11b.

The ISM may now be displayed to the group. This involves substituting the full elements in words for the numbered circles in the digraph. Section 5 gives an example of such an ISM. It is desirable that the display be in a flexible form at this stage to enable the group to discuss and amend it, if necessary. This can be done by, for example, writing each element on a separate 'Post-it' sticker or index card and displaying the structure on a large whiteboard.

(7) *Discussing and amending the structure.* At this stage, the session facilitator, or another member of the modelling team, should take the group through a discussion of the ISM. The purpose of this is to explain the structure to the participants so that they understand clearly how to interpret it, and to allow them to express their views on it. Participants may suggest that amendments are made to the structure. These are normally fairly minor, typically involving, say, the movement of an element to a new position or the deletion of a relation. The facilitator should be careful to explain any proposed changes to the group and to encourage discussion of them. He may find it helpful to refer back to the record of 'Yes' and 'No' answers given by the group to the questions put by the computer. Changes should only be made if there is a reasonably strong desire

among a majority of the participants to do so, since the structure has been synthesised through a systematic process of discussion and argument. However, changing elements and relations at this stage is not in any way a negation of the structure. The ISM process is a learning process, and people's perceptions may change during the session as the result of argument or new information emerging. They may thus wish to revise a decision made earlier in the session. Agreed amendments may be fed into the computer and the ISM updated. The model can then be expanded at a later stage if necessary.

It is often useful to give the group an opportunity to discuss the model at an intermediate stage after, say, the first 8–10 elements have been structured. If they are new to the process, this gives them a feel for the kind of model being produced. It also allows minor corrections to be made by the group at an early stage, if desired, and ensures an agreed foundation on which to build.

In some cases, a large number of elements have to be structured in a limited time. It may then be desirable to select a representative subset of, say, 20 for structuring rigorously in a computer-assisted ISM session and to place the remainder into the ISM by hand. This works particularly well with Priority Structures (Moore, 1987).

5. Application of ISM

Warfield (1982a) lists a wide range of situations in which ISM has been applied covering all five types of structure described in section 4(2) of this paper. The majority of these are Intent and Priority Structures which appear to be particularly effective uses of ISM. This has certainly been the author's own experience in using ISM professionally within a range of UK organisations, including the Metropolitan Police, Hertfordshire County Council, the Engineering Industry Training Board, the Institution of Mechanical Engineers, the Royal Navy and City University. In this section an example is given of an application of ISM.

(a) Building an Intent Structure for a postgraduate course

The particular application discussed concerns a postgraduate course in Systems Management developed jointly between industry and a university. The course has been designed for able young engineers working in industry who, as their careers progress, find themselves responsible both for other engineers and complex manufacturing operations. It is thus about systems management in the broad sense of managing complex systems of men and machines in a rapidly changing technological environment. The course involves intensive periods of study at the university concerned and a major project in the student's own company. All students on the course are sponsored by their own organisations.

As part of the design process for the course, an Intent Structure was constructed. Nominal Group Technique was used to generate the elements for the ISM following the steps described in section 4(4) of this paper. Eight participants were involved, including five senior engineering managers representing the industrial steering committee responsible for the course and three academics representing the university department involved. The NGT trigger question used to focus the generation of ideas was:

> 'What does industry perceive that the students should achieve during the twelve months of the Systems Management course?'

The resulting ideas were essentially a set of objectives expressed in terms of what the students should achieve during the course. After completion of the NGT, during which the initial objectives were clarified, edited and ranked for importance, it was agreed that 30 of them would be structured in the subsequent ISM session.

In this case the contextual relation used to examine interrelations between the objectives was the phrase 'would strongly contribute to'. The ISM process thus required participants to respond to a series of questions put by the computer of the form:

> '*Would* development of an enhanced communication ability *strongly contribute* to the development of self-confidence and leadership qualities?'

As the process proceeded, the computer built up an ISM 'map' portraying the group's perceptions of the interrelations between the elements. The map was extracted from the computer, displayed and discussed several times during the four-hour ISM session. Fig 12 shows the completed 30-element map as an Intent Structure.

(b) Interpretation of the Intent Structure

The boxes in the map contain the objectives with the original NGT numbering scheme. The arrows between the boxes represent the relation 'would strongly contribute to'. The Intent Structure thus shows what strongly contributes to what.

Paths. A sequence of objectives connected by arrows is known as a path on the map. For example, the path $26 \rightarrow 4 \rightarrow 1$ is explicitly shown. This may be interpreted as a statement that objective 26 strongly contributes to objective 4 and that 4 contributes to 1. However, the transitive nature of the map means that 26 may contribute directly to any elements which it reaches via a path of one or more arrows – eg objectives 4, 1, 39, 14, 10, 16, etc. A similar interpretation may be made regarding the interrelations between the other objectives on the map.

Cycles. There are a number of cycles on the map indicated by the black asterisks. Consider, for example, the cycle between 37 and 8. This implies both that 37 contributes to 8 and that 8 contributes to 37.

Levels. The Intent Structure may be partitioned into three broad levels as indicated on the right-hand side of the map. The lowest level consists of objectives largely concerned with 'Concept Formation and Attitude Change'. The second level contains the 'Enabling Skills' objectives related to systems design, computing, communication and leadership. The third level has been labelled 'Output Characteristics', being concerned with the abilities and characteristics of the student after completion of the course, together with the student's impact on his or her own company.

Sub-groups. Many of the objectives fall fairly clearly into sub-groups as shown in the digraph of Fig 13. Five main sub-groups are identified which are concerned with:

- the systems approach;
- systems design skills;
- computer-related skills;
- leadership qualities; and
- own-company impact.

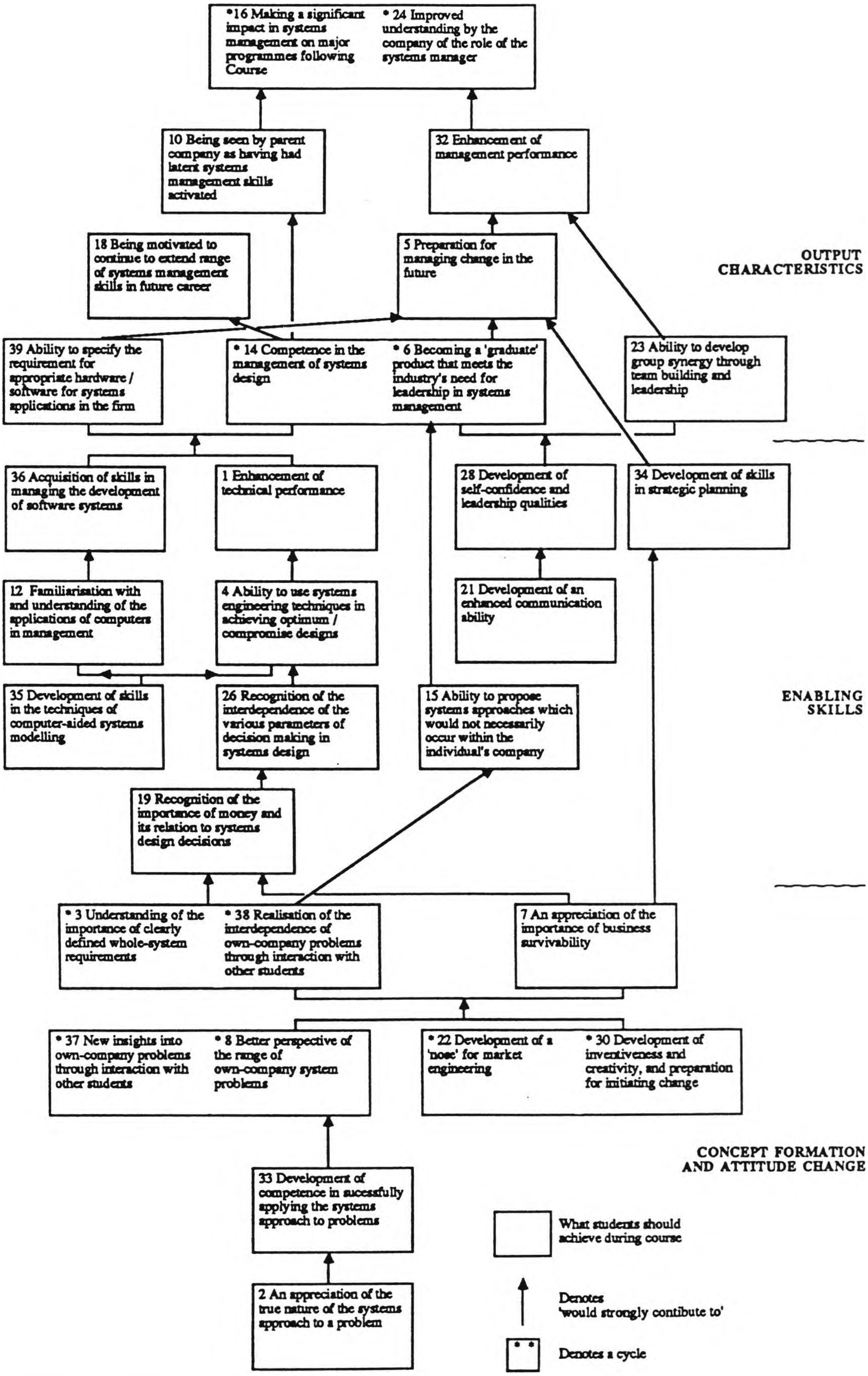


Fig 12 ISM intent structure for students on systems management course

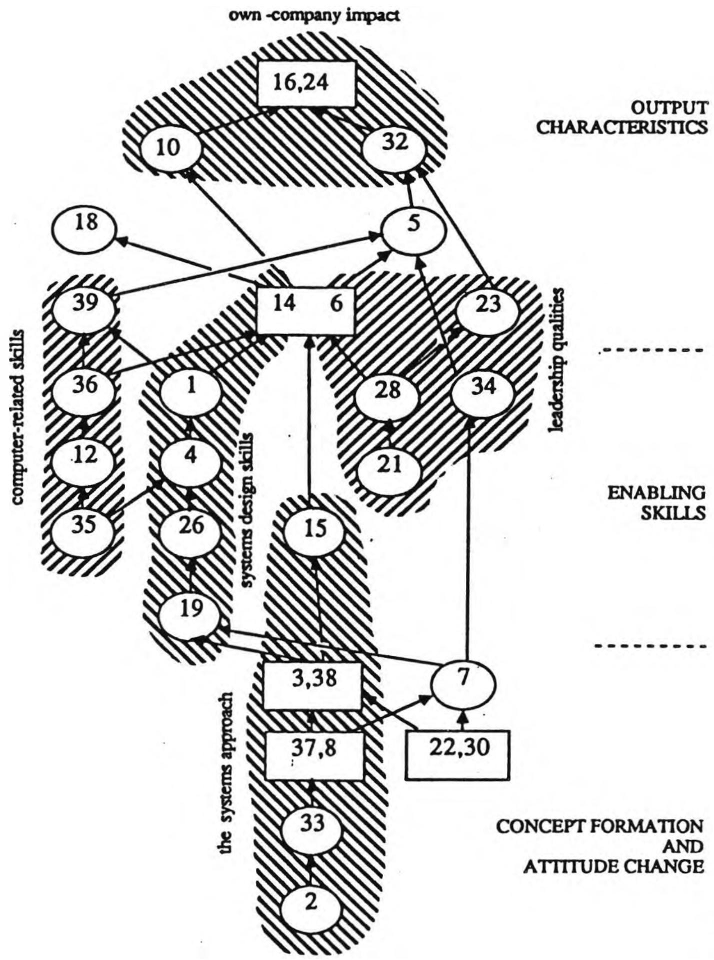


Fig 13 Major sub-groups and levels in structure

(c) Uses of the Intent Structure

The construction of such an Intent Structure helped in the following ways:

- Making explicit the multiple objectives of the course and their implications for its design and management.
- Clarifying thinking through asking participants to think through the complex interactions between the objectives systematically.
- Team building and generation of some planning momentum.
- As a way of explaining the purpose of the course to those involved and to any relevant outside agencies.
- As a basis for course planning. The levels and sub-groups which emerge from the structure and the inter-relations between the objectives provide useful information for this purpose.
- Assisting with syllabus design and scheduling.
- As a way of assessing and reporting progress. Many objectives may be followed at the same time and effort may be switched between them.
- As a base from which to change objectives as new ideas are developed or as circumstances change.

6. Conclusions

ISM combines three modelling languages: words; digraphs; and discrete mathematics, to offer a methodology for structuring complex issues. It readily incorporates elements measured on ordinal scales of measurement and thus provides a modelling approach which permits qualitative factors to be retained as an integral part of the model. In this it differs significantly from many traditional modelling approaches which can only cope with quantifiable variables.

In this paper ISM has been described in the context of working with a group of participants having access to ISM software on a computer. The steps of ISM have been described as a process taking place within a process context. The inputs to the process are the different knowledge and perceptions of the issue owned by the participants. This content knowledge will itself exist within an issue context. The process yields outputs in the form of products and learning by the participants. The role of a facilitator when using such a methodology is important in guiding the group through the steps of the process and keeping them focused on the issue so as to ensure the most productive use of their time.

A number of benefits accrue from the use of ISM. These include focused debate, clarification of thinking, group learning and team building. In addition, there is an emphasis on clarifying terms and clear specification of relations so that the user-created visual models are easily understood.

ISM may be used on its own when the elements of the issue are already known. Where this is not the case, Nominal Group Technique may be introduced as one step in the ISM process to assist the participants in generating and clarifying the elements to be structured. When used together, NGT and ISM provide a powerful methodology for structuring complex issues. The application examined deals with an Intent Structure for a postgraduate course. However, the methodology is applicable in many situations in which a participant group wishes to gain a better understanding of a complex issue.

Acknowledgements

The author is grateful to the following people: J. N. Warfield, A. N. Christakis and R. J. Waller for sharing their ideas in discussions on ISM; P. K. M'Pherson for contributions to the application discussed; and R. J. Jeffery for assistance with the figures in the paper.

References

Delbecq, A. L. *et al.* 1975. *Group techniques for program planning*, Scott, Foresman and Company, Glenview, Illinois, USA.

Flood, R. L. 1988. 'Situational complexity, systems modelling and methodology', *Trans Inst Meas & Cont*, **10** (3), 122–129.

Jackson, M. C. 1988. 'Systems methodologies as complementary tools for managing situational complexity', *Trans Inst Meas & Cont*, **10** (3), 155–160.

Janes, F. R. 1987. 'Applications of interactive management in planning for engineering education'. In: *Problems of constancy and change, Vol 1*, 31st Ann Meet Int Soc for Gen Syst Res, Budapest, June, 520–525.

Mihram, G. A. 1972. 'The modelling process'. *IEEE Trans on Syst, Man and Cybern*, **SMC 2** (5), 621–629.

Miller, G. A. 1956. 'The magical number seven, plus or minus two: some limits on our capacity for processing information', *Psych Rev*, **63** (2), 81–97.

Moore, C. M. 1987. *Group techniques for idea building*. Sage Publications, London.

Simon, H. A. 1974. 'How big is a chunk?', *Science*, **183** (8), 482–488.

Waller, R. J. 1982. 'Complexity and the boundaries of human policy making', *Int J Gen Syst*, **9**, 1–11.

Waller, R. J. 1983. 'Knowledge for producing useful knowledge'. In: Kilman, R. H. *et al* (eds), *Producing useful knowledge for organisations: Vols I and II*, Praeger, New York, USA.

Warfield, J. N. 1973a. *An assault on complexity*, Battelle Monograph No 3, Battelle Memorial Institute, Columbus, Ohio, USA.

Warfield, J. N. 1973b. 'Intent structures'. *IEEE Trans on Syst, Man and Cybern*, **SMC 3** (2), 133–140.

Warfield, J. N. 1973c. 'Binary matrices in systems modelling', *IEEE Trans Syst, Man and Cybern*, **SMC 3** (5), 441–449.

Warfield, J. N. 1974a. *Structuring complex systems*, Battelle Monograph No 4, Battelle Memorial Institute, Columbus, Ohio, USA.

Warfield, J. N. 1974b. 'Developing subsystems matrices in structural modelling', *IEEE Trans Syst, Man and Cybern*, **SMC 4** (1), 18–24.

Warfield, J. N. 1976. *Societal systems: planning, policy and complexity*, John Wiley & Sons Inc, New York, USA.

Warfield, J. N. 1982a. 'Interpretive structural modelling'. In: Olsen, S. A. (ed), *Group planning and problem solving methods in engineering management*, John Wiley and Sons, Inc, New York, USA.

Warfield, J. N. 1982b. 'Organisations and systems learning', *Gen Syst*, **27**, 5–74.

Warfield, J. N. 1984. 'Principles of interactive management', *Proc Int Conf on Cybern and Soc*, IEEE, New York, USA,

Wood, W. C. and Christakis, A. N. 1984. 'A methodology for conducting futures-orientated workshops', *Technol Forecasting and Social Change*, **26**, 281–297.

SUPPORTING PAPER B

Janes, F.R. and Jowitt, R. (1989). Applications of interactive management in planning for a university department. In Systems Prospects: The Next Ten Years of Systems Research. eds. R.L.Flood, M.C.Jackson and P.Keys. New York: Plenum Press. 243-250.

Applications of Interactive Management in Planning for a University Department

F R Janes and R Jowitt

In: Systems Prospects : the Next Ten Years of Systems Research edited by R.L. Flood, M.C. Jackson and P. Keys. New York: Plenum Press, 1989, pp 243-250.

Department of Systems Science

City University

Northampton Square

London EC1V 0HB

England

SUMMARY

This paper reports on the application of the methods of Interactive Management in planning for the future of the Department of Systems Science at City University, London. The methods were used by the academic staff to produce and structure objectives for the department over the next five years. Initially, Nominal Group Technique was used to generate, clarify, edit and obtain a preliminary ranking of a set of objectives. Two Interpretive Structural Modelling sessions were then held to develop both an Intent Structure and a Priority Structure for the department based upon these objectives. Finally, a mission statement in the form of a set of key goals was produced. The paper describes the group processes and the resulting products, and considers their implementation and uses as a management tool. Reflections of a participant upon the methods are also discussed. It is concluded that this approach has been of benefit to the department in developing both the research and teaching aspects of its subjects. In addition, the process of discussion and compromise which the methods of Interactive Management imply, has led to the identification of agreed priorities thus enabling a more effective allocation of resources.

1. BACKGROUND TO THE STUDY

Management theory (Koontz et al., 1984) suggests that management is the act of getting things done through the activity of human organizations. Some of the concepts involved in this process are as follows.

Setting Objectives. Unless the organization is quite clear what targets it is aiming for and why it is aiming for them, there will be misunderstanding and muddle.

Planning. This involves working out the details of how the organization is going to achieve both the long and short term objectives, within the constraints of the available human, financial and material resources, and providing those resources.

Organizing. The successful delivery of plans requires good organization. The organization must be built up, coordinated and guided so that the various elements and levels in the organizational structure work together, are informed and achieve their designated objectives.

Leading. The manager cannot accomplish everything on his own; he has to work through other people. They have to accept willingly the requests and discipline of the manager. They have to be motivated, directed and controlled.

Deciding. The manager is in a position of responsibility and has to make decisions. He has to decide what action to take, how things are to be done and consider the resource implications. The success of the enterprise depends on the quality of the decision making.

It is assumed that these concepts are basic requirements for the effective management of a university department.

The retirement of Professor Philip M'Pherson as a founder member and head of the Department of Systems Science at City University marked a significant milestone in its history and development. The appointment of a new head of department presented an opportunity to rethink the direction of both teaching and research. The use of the methods of Interactive Management (Warfield, 1982, 1984), already being used and developed in the department, is one way through which the knowledge, expertise and experience of members of the academic staff were integrated to produce a well-defined set of objectives. The results in the form of key goals and priorities have been used over the past eighteen months to aid decision making. The clarification, learning, argument, sharing of views and open discussion inherent in the process of Interactive Management have all played a very important part in team building during this period.

2. THE METHODS USED

Academic staff of the department met on three occasions in December 1986 at the request of the new head, Ray Jowitt, in order to develop goals and objectives and to set priorities for the department. The methods of Interactive Management were used throughout with a facilitator leading the group through a series of processes designed to promote the efficient generation and structuring of ideas.

On day one an idea-generation method, Nominal Group Technique, was used to help participants in generating a set of objectives for the department. On day two a subset of these objectives was structured using

Interpretive Structural Modelling (ISM) to produce an Intent Structure, which shows how the objectives interrelate with one another. On day three a subset of 21 of the objectives was structured, again using ISM, to produce a Priority Structure taking the assumption of limited resources as the key criterion. Finally, working as a group, the participants used the objectives, Intent and Priority Structures to formulate a mission statement in the form of a set of key goals for the department. The department's Decision Support Room was used to provide an appropriate environment for group work. The sessions thus incorporated a form of the five ingredients which it has been suggested are desirable for the practice of Interactive Management (Christakis and Keever, 1984):

- a **participant group** with content knowledge relevant to the problem;
- **methodologies** for intelligence, design and choice activities;
- a **facilitator** to guide the group through the steps of the methodologies;
- a **computer** and peripheral equipment which provide hardware and software to help the group organize its thinking;
- a **decision support room** offering an environment equipped for effective group work.

3. PRODUCTS OF THE SESSIONS

3.1 Objectives

Nominal Group Technique (NGT) designed by Delbecq et al (1975) was used to generate, clarify, edit and obtain a preliminary ranking of a set of objectives. It involves five basic steps.

(i) Clarification of a trigger question.

(ii) Silent generation of ideas in writing by each participant.

(iii) Round-robin recording of the ideas on a flip-chart.

(iv) Serial discussion of each idea for clarification and evaluation.

(v) Voting to obtain a preliminary ranking of the ideas in terms of importance.

Step (iv) of the NGT process enables a full discussion of the ideas generated in order to clarify and edit them and ensures that all participants have a clear understanding of the ideas. The voting scores obtained in step (v) provide a rough and ready initial assessment of the participants' judgements concerning relative importance of the ideas. The trigger question to which participants were asked to respond on this occasion was :

"What should the Department of Systems Science be trying to achieve over the next five years?"

As a result 52 objectives were generated, clarified, edited and ranked.

3.2 Intent Structure

Interpretive Structural Modelling (Warfield 1976, Janes 1988) is a method which helps participants to examine the interrelationships between the elements in a complex issue. In this case a computer-assisted ISM session was carried out to construct an Intent Structure (Figure 1). This shows how the achievement of one objective would contribute to the achievement of another. 19 objectives were selected for structuring on the basis of the NGT voting scores. The ISM process requires the group to respond to a series of questions put by the computer with regard to how the objectives interrelate. For example:

"Would accomplishing the objective

20. To expand the number of postgraduate research students

help to achieve the objective

1. To increase the departmental research rating in terms of both input and output measures?"

As with the NGT, a five-year time horizon was assumed. After discussion of the question, the group responds with a "Yes" or a "No" answer, taking the results of a vote when the participants are not unanimous. The response is fed into the computer which draws logical inferences from the answers as the process proceeds. Gradually, the computer builds up an ISM "map", portraying the group's perceptions of the interrelations between the objectives.

(Insert Figure 1 about here)

Interpretation. The boxes in Figure 1 contain the objectives and the arrows between the boxes represent the relation "would help to achieve". The map thus shows what helps to achieve what. When interpreting the map it should be remembered that the relation used is transitive in nature. Thus the path 39 → 6 → 34 is explicitly shown. However, the nature of the map means that 39 contributes directly to any objectives which it reaches via a path of one or more arrows, e.g. 6, 31, 34, 2, 18, 5, 4, 30. A similar transitive interpretation may be made regarding any of the other paths between the objectives. The cycle on the map indicated by the black dots denotes the strong mutual interrelations between objectives 1,7 and 53.

3.3 Priority Structure

A Priority Structure (Figure 2) was developed in a similar way and shows the group's ranking of objectives in order of importance, assuming limited resources as the key criterion. It provides a much more rigorous set of priorities than the preliminary ranking obtained during the last step of the NGT process. The 21 objectives selected for this ISM session were chosen on the grounds that they had significant resource implications for the department. This time the group was asked to respond to a series of questions of the form:

> **"Is the objective**
>
> 53. To generate money and resources
> for supporting activities of the department
>
> **a higher priority than**
>
> 6. To integrate the use of computers
> more fully into the Management
> and Systems BSc degree?"

(Insert Figure 2 about here)

Interpretation. The arrows between the objectives in Figure 2 denote the relation "is a higher priority than". Thus No 1 was seen as the most important objective at the top of ten different levels of priority. A group of objectives appearing together within a box indicates that they were seen as being equally important, e.g., numbers 12 and 19.

3.4 Mission Statement

Following the setting of priorities a mission statement was formulated consisting of a set of key goals for the department. This was written by the participants using the objectives, the Intent Structure and the Priority Structure and is reproduced below:

"To be recognized as a leading international centre for Systems Science by :

1. Developing a major research school in the areas of: Conflict Management; Decision Making; Engineering Management; Human-Activity Systems; Medical Informatics; Systems Theory; Technological Change.
2. Developing teaching activities by:
   - improving the undergraduate Management and Systems degree,
   - introducing a postgraduate degree programme focussed upon Systems Management,
   - expanding the programme of post-experience courses,
   - enhancing Engineering Management education.
3. Developing the discipline of Systems Science.
4. Improving facilities for teaching and research, particularly in the areas of Information Technology and Decision Support Systems.
5. Promoting the skills and activities of the department through the development of closer links with other institutions and organizations, e.g., by courses, contracts and consultancies.
6. Creating a management structure which facilitates the achievement of the goals listed above and promotes departmental cohesion."

4. REFLECTIONS OF THE PROCESS

Here, the head of department, who was a participant in the sessions, reflects on the processes used.

- It was an interesting experience to share views with academic staff, particularly towards the end of the three sessions. The relaxation of hidden tensions together with the absence of a hierarchial structure in the group meant that all the participants were equal contributors to the decision making process.
- The high priority given to research in the department was a surprise. The growth in the research activity in the past year may be seen as directly attributable to the exercise.
- Significant progress has been made in implementing the top 14 of the objectives in the Priority Structure and results are starting to emerge. Many of the other objectives are being developed but on a longer time scale.
- The appointment of a new academic leader started out in the NGT session as an important objective but as the exercise progressed became less of a priority, ending up at the lowest level (Figure 2, No 3). This was possibly due to the recognition that such a panacea was unlikely to be realisable in practice and was, in any case, not necessary.
- The establishment of a staff appraisal scheme in the university has established a need for all departments to have clear and well defined objectives. This exercise has provided such a set of objectives and priorities for the department.

5. USES MADE OF THE PRODUCT

The objectives, Intent Structure and, in particular, the Priority Structure and mission statement have been used in the following ways over the eighteen months since the sessions took place.

- o To identify and share specific areas of existing interest and knowledge.
- o To assist in the identification of new areas for development.
- o To give the head of department confidence that he knows the views of all the participants.
- o To represent the views of the academic staff of the department to the outside world.
- o To negotiate with and represent the views of the department to the central university authorities (Academic Registrar, Finance Officer, University Secretary).
- o To enable the head of department to allocate resources within the department.
- o To help design and coordinate the organizational structure within the department.
- o To assist in decision making.

6. CONCLUSIONS

The planning sessions served to focus ideas clearly and to promote clarification and learning through structured discussion and argument. The participants understand the reasons for and logic behind the resulting products. They thus feel a sense of ownership and commitment to the objectives, priorities and mission statement. This is evident in the way in which implementation of the priorities has proceeded over the eighteen months since the sessions took place.

The processes of Interactive Management appear at first sight to be both demanding and time consuming, but then so is any worthwhile planning activity which attempts to gain the commitment of those in the organization by involving them in the planning process. In this context Interactive Management can be seen to offer an efficient and effective planning process.

7. REFERENCES

Christakis, A.N., and Keever, D.B., 1984, "Management's quest for new solutions", Center for Interactive Management, George Mason University, Fairfax, Virginia.

Delbecq, A.L., Van de Ven, A.H., and Gustafson, D.H., 1975, "Group Techniques for Program Planning", Scott, Foresman and Company, Illinois.

Janes, F.R., 1988, Interpretive structural modelling: a methodology for structuring complex issues, Trans. Inst. Meas. & Cont., 10 (3).

Koontz, H., O'Donnell, C., Weihrich, H., 1984, "Management", McGraw-Hill Book Co., Singapore.

Warfield, J.N., 1976, "Societal Systems : planning, policy and complexity", John Wiley & Sons Inc., New York.

Warfield, J.N., 1982, Organizations and systems learning, Gen Syst, 27, 5-74

Warfield, J.N., 1984, Principles of interactive management, Proc.Int. Conf on Cybern. and Soc., IEEE, New York.

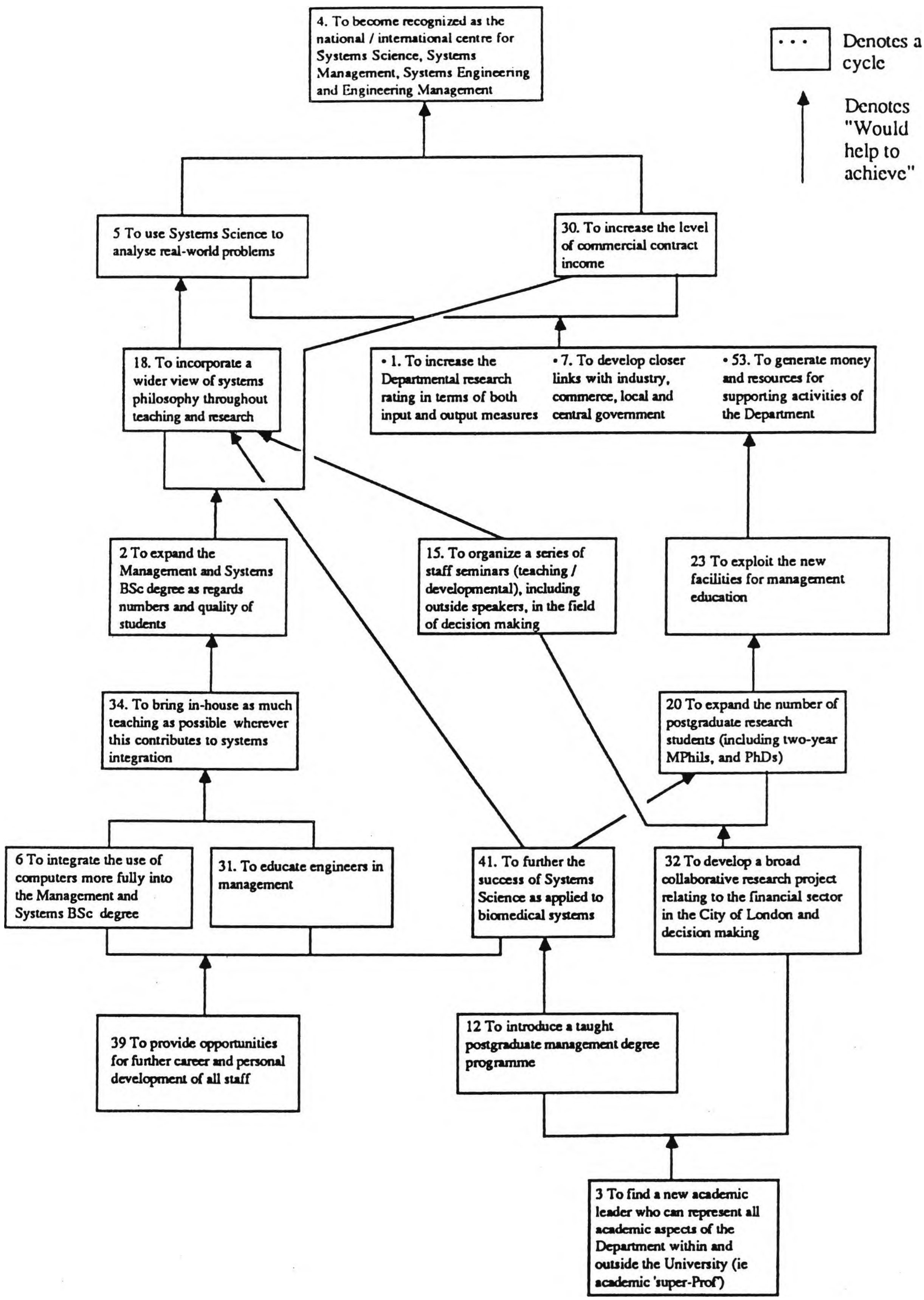


Figure 1 Intent Structure

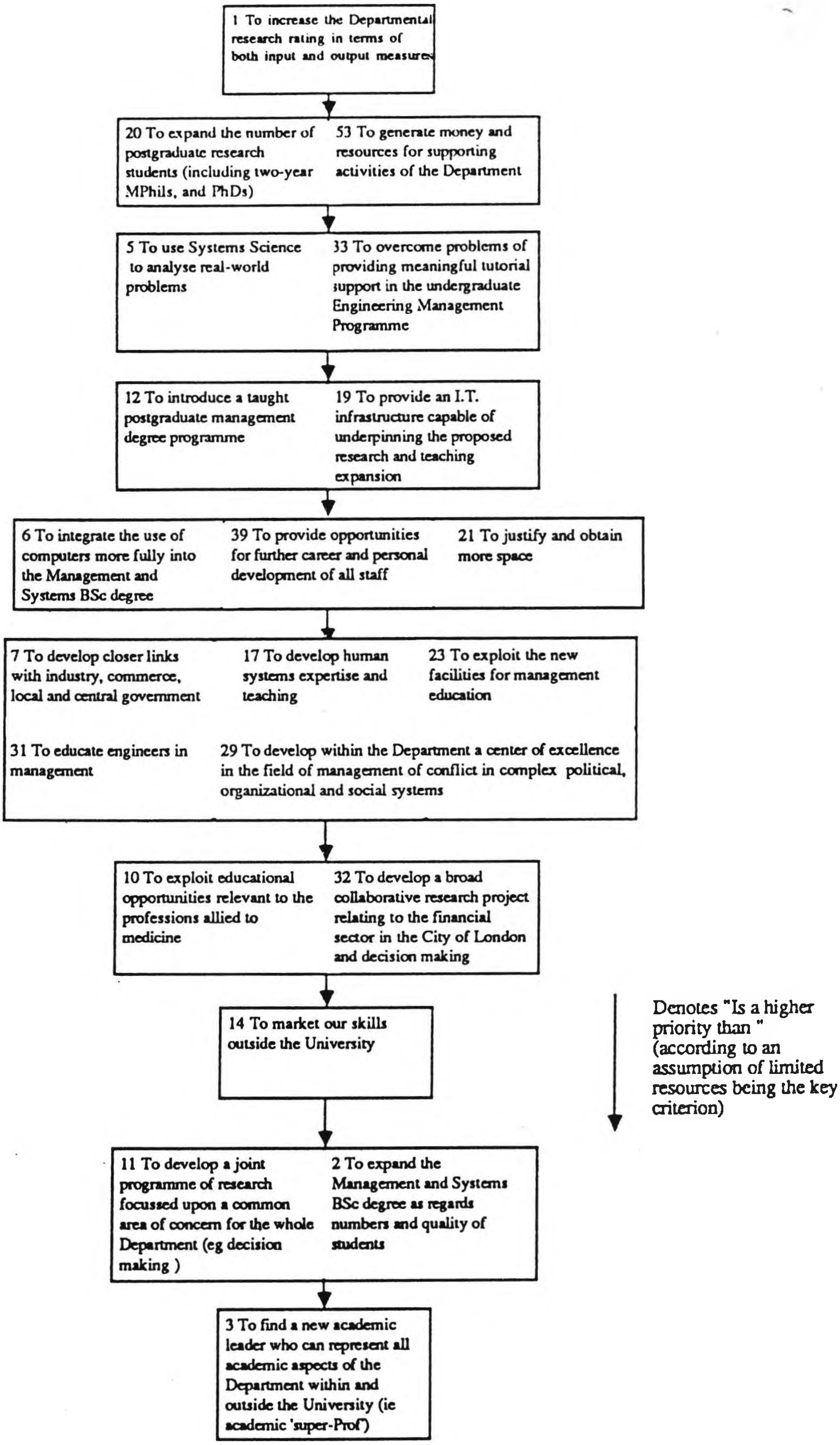


Figure 2 Priority Structure

SUPPORTING PAPER C

Janes, F.R. and Jeffery, R. (1989). Objectives and priorities for the Accommodation and Conference Service of City University, London. Technical Report No. DSS/FRJ-RJJ/257, Dept. of Systems Science, City University, London. 33pp.

(Appendices A, B and D of this report have been included)

OBJECTIVES AND PRIORITIES

for

THE ACCOMMODATION AND CONFERENCE SERVICE

of

CITY UNIVERSITY, LONDON

(A report on a two-day planning workshop held
at City University on 23 & 24th January, 1989)

F.R. Janes and R.J. Jeffery

Interactive Management Unit
Department of Systems Science
City University
Northampton Square
London EC1V OHB

February, 1989

Technical Report No. DSS/FRJ-RJJ/257

CONTENTS

FIGURES

APPENDICES

Abbreviations

NGT Nominal Group Technique
ISM Interpretive Structural Modelling
F&H Finsbury and Heyworth Halls
NH Northampton Hall

1. SUMMARY

Eight staff of the Accommodation Office, Conference Office and Halls of Residence at City University participated in a two-day planning workshop held in the Decision Support Room of the Department of Systems Science. The workshop was designed to enable the participants collectively to formulate their ideas on the objectives and priorities of the Accommodation and Conference Service. The methods of interactive management were used for this purpose with the staff of the Interactive Management Unit acting as facilitators throughout, leading the group through a series of meetings specifically designed to promote the efficient generation and structuring of ideas.

On day one an idea-generation method, Ideawriting, was used to assist participants in generating and categorising the issues facing the Service. A second idea-generation method, Nominal Group Technique, was then used to generate, clarify, edit and obtain a preliminary ranking for a set of over 30 objectives for the Service over the next five years. The objectives were then placed into categories.

On day two a computer-assisted method, Interpretive Structural Modelling, was used to help the participants in setting priorities. Firstly, the eight categories into which the objectives had been placed were set in order of importance. Then, for each category in turn, the objectives within that category were prioritised. The resulting composite priority structure portrays the group's priorities for the complete set of objectives. Finally, drawing upon the objectives and priorities agreed at this stage, the group formulated a mission statement for the Service together with a set of key goals to support the mission. Suggestions for a corporate name embracing the Accommodation Office, Conference Office and Halls of Residence were also proposed and one was selected.

The planning workshop has given a clear picture of the objectives and priorities which the participants think the Service should be directing its efforts towards. These, together with the recommendations in this report should provide valuable information for those concerned with strategic planning for the Service.

2. TERMS OF REFERENCE

This report has been produced for Mrs I.T. Stockdale, Head of Accommodation at City University by Mr F.R.Janes and Mr R.J.Jeffery of the Interactive Management Unit[1]

At the request of Mrs Stockdale, the Interactive Management Unit organised a planning workshop (Appendix A) for the Accommodation and Conference Service. This took place over two days on the 23rd and 24th of January 1989, in the Decision Support Laboratory of the Department of Systems Science.

The aims of the workshop were to enable the participants collectively to plan for the Accommodation and Conference Service by:

- Identifying issues of concern
- Establishing objectives
- Setting priorities
- Writing a mission statement

The methods used in the planning workshop to accomplish these aims were designed to improve inter-departmental communication and group identification, and to promote team building amongst the participants.

[1] Department of Systems Science, City University

3. INTRODUCTION

The City University Accommodation and Conference Service is a title used in this report to describe the different services under the control of the Head of Accommodation. This post was created in August 1987 as a means of integrating the various services that were involved in providing student and conference accommodation. These comprised the Accommodation Office, the Conference Office and the University Halls of Residence. The new Head of Accommodation perceived the need to develop closer links between the various sections of the Service so that overall effectiveness could be improved. Problems identified included only limited of understanding by staff of the role other services, the lack of an integrated approach and low morale. Another major problem was the deteriorating state of the largest Hall of Residence, Northampton Hall.

In order to address these issues, it was decided hold a two day planning workshop for the managers of the various departments, using the methods and skills of the Interactive Management Unit. The eight participants were chosen as a representative group of the Service as a whole. These included tutorial staff from the Halls of Residence who are not actually within the Accommodation and Conference Service, i.e. are not controlled by the Head of Accommodation, as they represent a major party affecting accommodation.

The stages of the workshop were:

1 Identification of issues facing the Service
2 Identification of the objectives for the Service over the next 5 years
3 Classification of the objectives into categories
4 Setting of priorities between the objectives
5 Development of a mission statement and a set of key goals for the Service
6 Identification of a corporate name for the Service as a whole

4. ISSUES FACING THE ACCOMMODATION AND CONFERENCE SERVICE

4.1 Method

In order to identify the issues of concern to staff of the Accommodation and Conference Service, an idea-generation method called Ideawriting was used. The method, used under the guidance of a facilitator, assists a group in generating and categorising ideas on a specified issue.

Steps of Ideawriting

1 Clarification of a trigger question to focus the idea generation.
2 Silent generation of ideas in writing in response to the trigger question.
3 Exchange lists of ideas and continue idea generation. Repeat this until the lists have been seen and added to by all participants.
4 Categorise the ideas generated and produce an edited categorised list.
5 Present a summary of the ideas.

In this case the participants were divided into two groups and each group was asked to respond the the question:
"What are the issues facing the Accommodation and Conference Service?"

4.2 Issues identified by group A[2]

The resulting ideas generated by group A, after classification into categories were as follows:

Finance

- Sound financial backing for support of Service
- Finding resources to enable students to read for a degree here
- Maximise income
- Minimise cost
- Chasing debtors
- Keeping residence fees as low as possible
- Marketing - increase marketing skills
- Installing the idea of the University Accommodation and Conference Service as a commercial outfit in the minds of some established academics and others

[2] Ray Jowitt, Chris Powner, John Tibble, Hilary Wigmore.

Staffing

- Retention of staff
- Develop staff inter-personal and negotiating skills
- Staff training
- Improve marketing skills

Organisation

- Greater integration of personnel
- Integrate conference (out-of-term) and student (in-term) accommodation
- Rationalisation of course dates
- Common stationery etc
- Divorce Students' Union from Halls of Residence
- Avoid Halls of Residence being used as a political football
- Give the Warden more/less authority
- Give the Warden more/less responsibility
- Give the Warden more line management responsibility for the running of Hall
- Consider the relationship of the Warden and the 'management view' of the Service

Communication

- Computerisation; develop this facility in all support departments
- Improve communication between departments in the University involved in conference activities
- Try to build a good communal spirit between students and all staff in Halls of residence
- The idea of University as caring but firm on disciplinary matters
- Identify unused space
- Improved communication of information
- Develop better understanding of tasks undertaken by others in the Service
- Improve image of Conference Office within the University
- Improvement of communication between departments in the Service by computerisation

Students - Halls

- Increasing University owned and managed bed space
- Deal with known groups of disaffected students

Students - other accommodation

- Increasing self-catering residential provision
- Increasing provision for mature students, couples and families

Student issues

- Affect of community charge
- Target numbers (fraction of total City student population) provision
- Cut down excessive drinking of some students
- Overseas students - cost and provision
- Consider providing *low* quality accommodation at *low* cost
- Providing *reasonable* quality accommodation at *reasonable* cost
- Changing demand from students
- Threat of student loans - affect on student numbers
- Threat of loss to students of state benefits

Facilities

- Long term development / purchase of property for accommodation and classrooms
- Exploitation of current facilities
- Improve facilities - classrooms, bedrooms, catering area.
- Improve maintenance standards of buildings

Standards of Service

- On-going training of staff to enable acceptance of prestigious conferences and their successful management
- Offer higher standards of cleanliness and service to conference guests in Halls
- Improve quality of food
- Develop professionalism amongst the staff at all levels

Conference Provision

- Increasing University owned and managed bed space
- Attracting more prestigious conferences

4.3 Issues identified by group B[3]

Finance

- Increase in conference numbers to improve Halls
- How to cope with lack of bed spaces for undergraduates and postgraduates
- Are we here for the students or to make money?
- Change the selling of the Halls, i.e. charge more for F&H and concentrate students in NH during vacation period

[3] Jim Burton, Venkat Rao, Irene Stockdale, Tim Wright.

Discipline

- Bring students into the discipline and policing of Halls
- Should the students be a self-governing body?

Manpower

- Who is to be the Warden of NH?
- Staff implications of working weekends
- Difficulty of recruiting staff
- How to cope with the decline in conditions
- Present level of staff makes cover difficult

Policy

- What is the future of NH?
- What dependency do the Halls have on funds provided by the conference service?
- Change the selling of the Halls, i.e. change role for F&H and concentrate students in NH during vacation
- Why not simply make F&H an hotel?
- Are we to allow the students to learn and study without disruption?
- Should tutors' duties continue during conference periods?
- Take the maintenance budget and works away from present department
- Encourage the movement of accommodation staff around the departments to see what everyone's problems are.
- Take over sports facilities in vacation times for added income
- Use the Halls' kitchens on a commercial basis, plus the basis for extra business and working days. i.e. large conferences in this area.
- Open shops in Halls
- Managers and Wardens' role
- Increase timetabled usage of rooms versus decrease of conference income in main building
- Computerise the whole system
- Ensure that all students' courses start and finish at the same time; ideally more or less the same dates each year.
- Improve the catering in Halls
- Establish priorities of students versus conferences
- To integrate Hall catering with house management
- Possibility of establishing an overall policy in all services both for students and outside visitors
- Academic year needs to be reorganised to release use of Hall for early summer for conferences
- Hall management i.e. catering, admin.etc. to be under one roof
- Bars to come under management admin.

Communication

- Students, managers and tutors seem to require more interaction between each other
- How to cope with providing more interaction between Conference Office and other related services
- To establish better lines of communication between Halls and Building and Works Department

Students

- Loss of key self-catering accommodation
- Provide a more extensive facility for supporting students who wish to live out, thereby reducing Hall pressure

Improvement

- Gradually, through extra business, raise the standard of furniture and fittings in the Halls

Training

- To encourage Hall staff to see themselves as University staff. i.e. less parochial
- More staff training

4.4 Summary of key issues

Some of the key issues highlighted were:

- Increasing the quantity of accommodation.
- The future of Northampton Hall.
- Improving the quality of all accommodation and facilities.
- Improving the standards of service and catering.
- Providing reasonably priced accommodation for students.
- Changes in student support, e.g loans.
- Improving integration of the Service: Accommodation Office, Conference Office, Halls of Residence.
- Improving communication within the Service and with the University.
- Better use of information technology.
- Clarifying lines of authority with regard to both staff and facilities.
- Staffing: recruitment, motivation, development, retention.
- Obtaining more resources.
- Better marketing of facilities.

- Better use of facilities to generate more income.
- Establishing clear policy regarding student use and conference use.
- Improving the sense of responsibility of students in Halls.

5. OBJECTIVES OF THE SERVICE

5.1. Method

In order to identify objectives for the Service, the group participated in a second idea-generation method, Nominal Group Technique (NGT). This is described in Appendix C and enables the generated ideas to be systematically and thoroughly clarified, edited and given a preliminary ranking through a voting procedure.

Steps of Nominal Group Technique

1 Clarification of a trigger question to focus the idea generation.
2 Silent generation of ideas in writing in response to the trigger question.
3 Round-robin recording of ideas, whereby the ideas of participants are recorded on a flip chart and displayed.
4 Serial discussion of ideas for clarification, whereby each item is discussed in turn with the group in order to clarify and edit it.
5 Voting in order to enable participants to express their value judgements with regard to the importance of the ideas generated.

The trigger question posed to the group was:

"What should the Accommodation and Conference Service be trying to achieve over the next five years?"

A total of 44 objectives were generated during the NGT as shown in section 5.2. The number appearing before each objective reflects the sequence in which the ideas were presented and are not of any other significance. For simplicity of cross referencing this original numbering scheme has been retained throughout the report. Subsequent to the NGT the objectives were reviewed for completeness in the light of the issues identified (section 4). Two further objectives (nos 45 and 46) were identified, discussed and added to the list.

5.1.1 Explanation of voting

Following clarification of the objectives generated, the participants were asked to select individually the six which they considered to be the most important given the context of the trigger question. They were then asked individually to rank their six selected items, assigning a '6' to the most important and a '1' to the least important and so on. These voting scores are listed alongside the objectives below.

The voting scores should not be taken as an accurate ranking. They provide a rough and ready assessment of the participants' judgements concerning the relative importance of the objectives. Given time constraints this enables the facilitator to select a subset of items to be structured subsequently in the time available.

5.2. The objectives generated

Key

Objectives in *italics* were deleted during the clarification steps as they duplicated other items.
Objectives 45 and 46 were added after the review.

1.	To provide University accommodation for all students who apply	5,5,6
2.	To use all money made through business for improving standards of essential facilities e.g. classrooms, bedrooms, catering.	6,2,1
3.	*To increase the amount of University residential accommodation*	
4.	To improve the quality of life at City	4
5.	To meet the challenges of change in funding support for students	6,5,6
6.	To maximise conference surplus, potential and actual	2,6,5,5
7.	To increase amount of owned and managed University residential accommodation	6,4,4
8.	To integrate more closely the functions of the Accommodation Office, Conference Office and Halls	4
9.	To increase post-graduate, married couple and family accommodation	5
10.	To distinguish year periods: maintenance, student accommodation and conference	1
11.	To improve relations and communications within all areas of the Service	3
12.	To establish, encourage and maintain staff enthusiasm for the Service as a whole	1
13.	To attract better students to the University i.e. enthusiastic, motivated	2,4
14.	To improve conference facilities i.e. classrooms, refectories, bars and corridors	3,5
15.	*To maximise all potential income from space*	
16.	To present a corporate image	
17.	To employ City students to assist the Service	
18.	To make all accommodation and services self funding	
19.	To improve medical, sport, academic and general (e.g. quiet room) facilities throughout the Service	2,1
20.	To establish and maintain a staff training programme	2,3
21.	To attract more student applicants to City University	
22.	To examine feasibility of maximising classroom usage	

23.	To expand private sector Accommodation Office activity for students and staff	3,4
24.	To recruit and retain a full staff complement suitable for the service	3
25.	To have a policy of one week minimum for conference bookings	
26.	To establish an alternative contract for permanent staff working in residences (i.e. more flexibility of working hours).	
27.	To improve the quality of catering	3,2
28.	To replace Northampton Hall as soon as possible with better residential accommodation	3,6
29.	To provide and support a good educational experience for all students	4
30.	To improve marketing of the Service	
31.	To make full use of new technology in shortest possible time	4,2
32.	To increase student accountability for quality of life in Halls	
33.	To rotate staff, as appropriate, to facilitate understanding within the Service	1
34.	*To improve facilities for disabled students*	
35.	To improve communications with university support services	2
36.	*To combat changes of student support*	
37.	*To introduce computerisation in the shortest possible time*	
38.	To improve the reputation of City University	6
39.	To compete more effectively with other universities e.g. students, research, conferences	1,3
40.	To target conference clients	
41.	To improve facilities and access for disabled people	4,1,1
42.	To improve the image of the Conference Office	
43.	To improve the ratio of tutors to students within residences	
44.	To have a four-term year	

---

45. To address the problem of responsibility for line management and the role of the Warden
46. To bring all Hall support functions under one administration

5.3 Classification of objectives

The group was taken by the facilitator through a process to classify the objectives into categories of related items. These categories were then each given a heading. The classified objectives are shown in figure 1 under the appropriate heading. The sequencing of the headings is of no particular significance in this figure.

The participants then examined the objectives for resource implications in order to identify those which required significant new resources. In figure 1 these are indicated by the boxes with the serrated edges.

Fig 1. Objectives Classified into Categories

A To improve provision of all accommodation

- 1. To provide University accommodation for most students who apply
- 7. To increase amount of owned and managed University residential accommodation
- 9. To increase post-graduate, married couple and family accommodation
- 23. To expand private sector Accommodation Office activity for students and staff
- 28. To replace Northampton Hall as soon as possible with better residential accommodation
- 41. To improve facilities and access for disabled people
- 14. To improve conference facilities i.e. classrooms, refectories, bars and corridors
- 27. To improve the quality of catering

B To support a good educational experience

- 4. To improve the quality of life at City
- 19. To improve medical, sport, academic and general (e.g. quiet room) facilities throughout the Service
- 32. To increase student accountability for quality of life in Halls
- 29. To provide and support a good educational experience for all students

C To improve the Service organisation

- 8. To integrate more closely activities of Accommodation Office, Halls and The Conference Office
- 11. To improve inter-personal relations and communications within all areas of the Service
- 12. To establish, encourage and maintain staff enthusiasm for the Service as a whole
- 33. To rotate staff, as appropriate, to facilitate understanding within the Service
- 20. To establish and maintain a staff training programme
- 24. To recruit and retain a full staff complement suitable for the Service
- 31. To make full use of new technology in shortest possible time

D To influence University policy

- 10. To distinguish year periods: maintenance, student accommodation and conference
- 18. To make all accommodation and services self funding
- 26. To establish an alternative contract for permanent staff working in residences
- 22. To examine feasibility of maximising classroom usage
- 43. To examine the role of Tutor within Halls of Residence
- 44. To have a four term year
- 45 To address the problem of responsibility for line management and the role of the Warden
- 46 To bring all Hall support functions under one administration

E To increase commercial activity

- 2. To use all money made through business for improving standards of essential facilities e.g. classrooms, bedrooms, catering
- 6. To maximise conference surplus, potential and actual
- 25. To have a policy of one week minimum for conference bookings
- 40. To target and deliver conference clients

F To improve liaison within the University

- 16. To present a corporate image of the Service
- 35. To improve communications with University support services
- 42. To improve image of Conference Office within the University

G To improve the presentation of the University image

- 30. To improve marketing of the Service
- 39. To compete more effectively with other universities e.g. students, research, conferences
- 38. To improve the reputation of City University

H To be succesful in the student market

- 5. To meet the challenge of changes in funding support for students
- 13. To attract better students to the university i.e. enthusiastic, motivated
- 21. To attract more student applicants to City University
- 17. To employ City students to assist the Services

Category headings

Significant new resources required

6. SETTING PRIORITIES AMONGST THE OBJECTIVES

6.1 Method

In order to examine the priorities amongst the objectives the group participated in a process called Interpretive Structural Modelling (ISM). This is a computer-aided method which helps participants to examine the interrelationships between the elements in a complex issue. In this case ISM was used to produce a priority structure, taking the objectives developed during the NGT as the elements to be structured.

The ISM process required the participants to respond to a series of paired comparisons put by the computer as questions in the following form:

"Is

24. To recruit and retain a full staff complement for the service.

a higher priority than

8. To integrate more closely the functions of the Accommodation Office, Conference Office and Halls?"

Each question was discussed and argued by the participants under the guidance of a facilitator. The answer to each question fed into the computer was based on the votes of the participants, a majority vote being used whenever they were not unanimous. As the process proceeded the computer built up a number of priority structures, showing the group's perceptions of the importance of the various objectives. When assessing priority, participants were reminded that they were considering objectives of the Service over the next five years. In addition, they decided to make the assumption that the existing level of University resources would continue with no increase or decrease.

6.2 Priority structures produced

Nine separate priority structures were produced. The first one ranked the category headings into which the objectives had been classified (Figure 2). The other eight dealt with the individual objectives in each category. As they were produced, each structure was displayed, discussed and agreed by the group. Figure 3 gives the composite priority structure on one sheet. The category headings are ranked across the top in order of priority from left to right, with the individual priority structure for each category shown underneath the appropriate heading. (Appendix C gives each of the individual priority structures as a separate figure).

In each case the arrows between the boxes in the figures denote the expression "is a higher priority than". Thus under the heading of influencing University policy in figure 3, the objective of bringing all Hall support functions under one administration was seen as the highest priority, whilst having a four-term year was regarded as the lowest priority. Where two or more objectives appear in a single box this signifies that they are of equal importance. For example, this applies to items 26 and 45 and also to items 22, 43 and 10. Care should be exercised when interpreting the priorities. It should not be assumed that an objective at a low level of priority under one category heading, e.g no. 41, is more important than an objective of high priority, e.g no. 46, under a category heading of lower priority. With regard to interpretation of all the structures it should be remembered that they represent priorities from the viewpoint of Service staff taking a five-year time horizon and assuming that the existing level of resources will be maintained.

It may be noticed that the ordering in the priority structures differs somewhat from the initial tentative rankings provided by the NGT voting scores (section 5.2). This is a measure of the learning that took place when the participants had an opportunity to reflect upon and argue the relative merits of the various objectives. It may also be noticed that there are some minor changes in the wording of certain items when the ISM structures are compared with the list of objectives, generated in the NGT session, for example, items 1 and 43. Such changes are a natural part of the argument, discussion and learning that arises during a typical ISM session.

Figure 2. Priorities for the Categories of Objectives

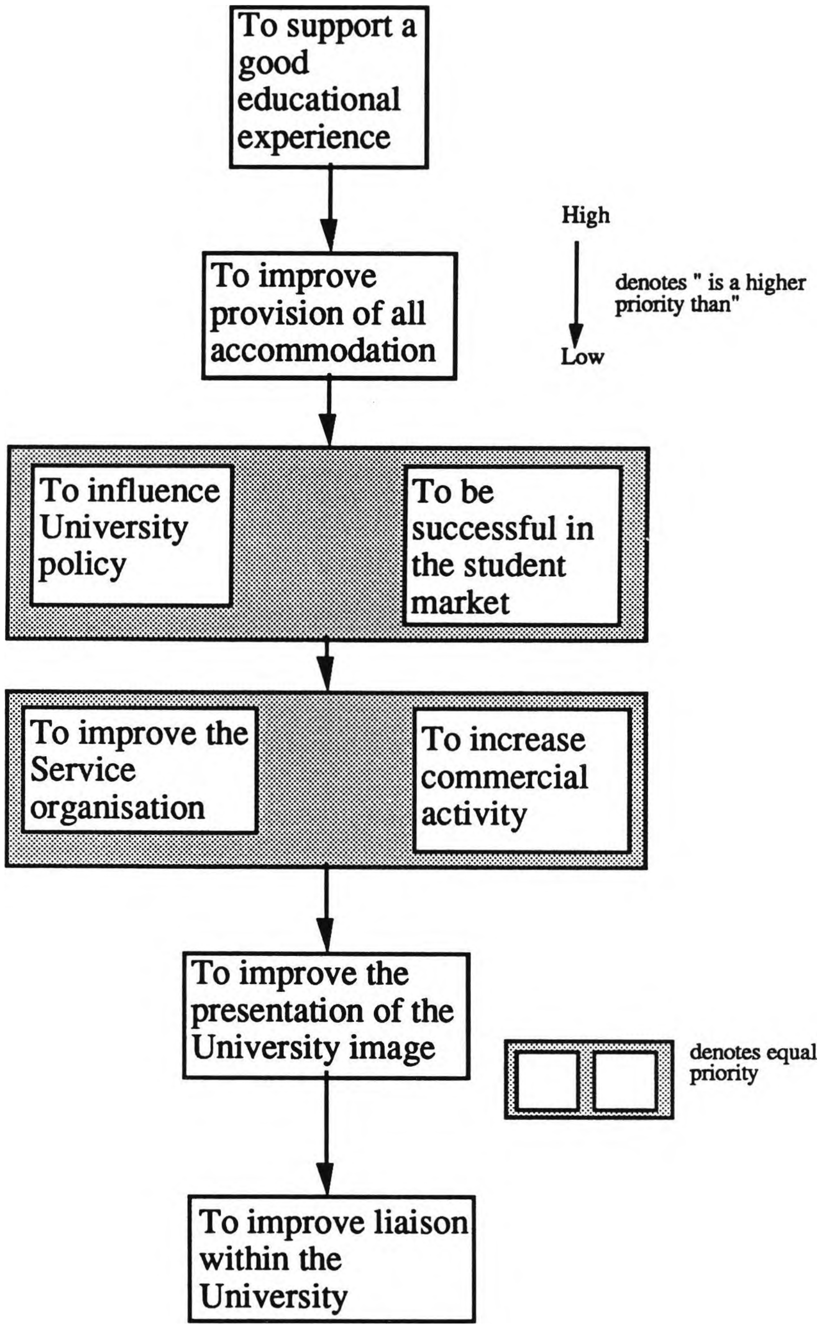
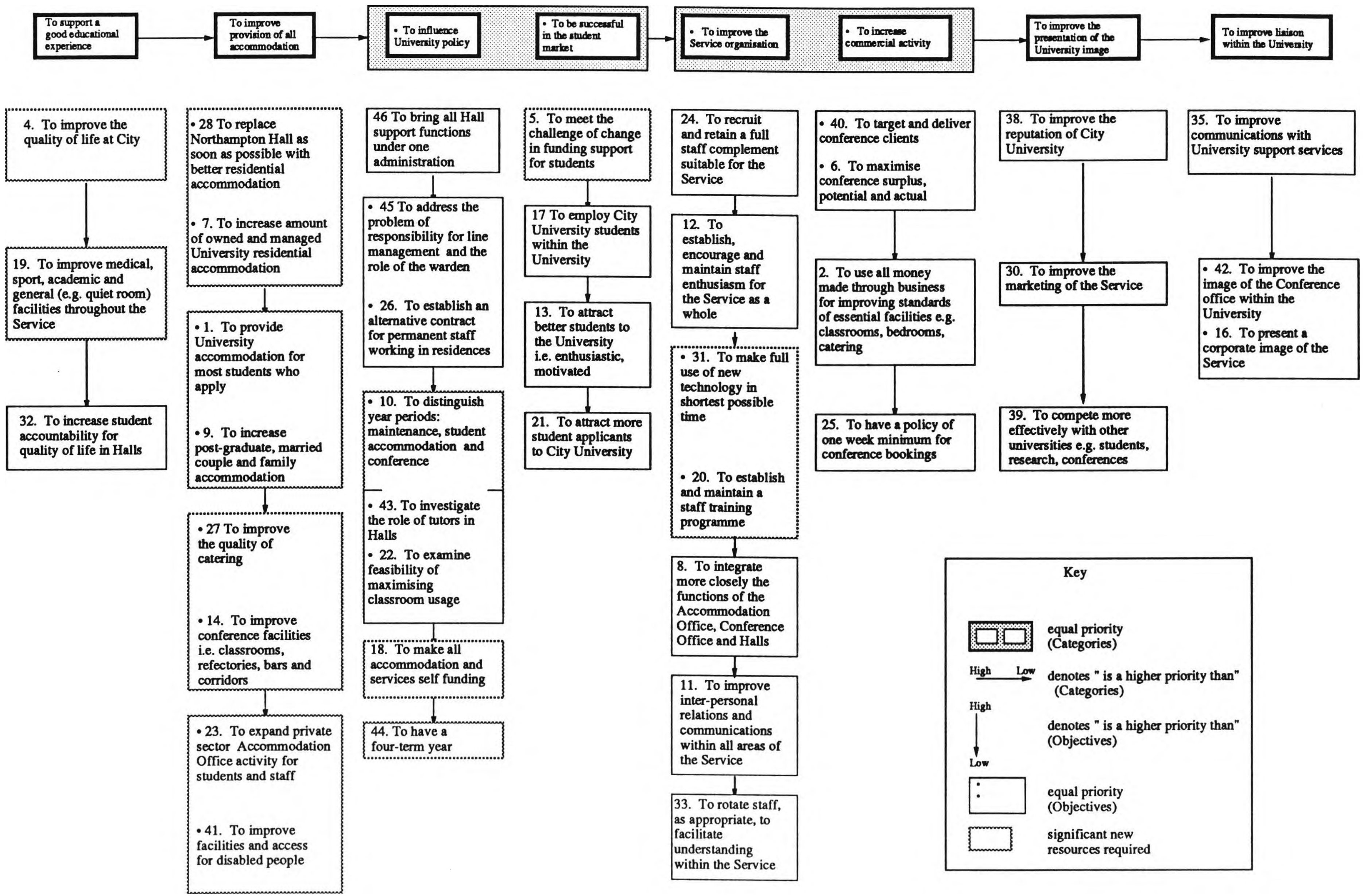


Figure 3 Composite Priority Structure for the Service



7 MISSION, GOALS AND CORPORATE IDENTITY

7.1 Method

During the last phase of the workshop participants were asked to formulate a mission statement and set of key goals for the Service. They worked in the same two groups A and B as during the Ideawriting session (section 4), each group being asked to respond to the question:

"Based on the issues, objectives and priorities identified so far, prepare a mission statement for the Accommodation and Conference Service and a set of key goals to support this mission."

The products of each group (Appendix D) were then discussed and combined into a single statement as shown below.

7.2 Mission of the Service

The mission statement was agreed as :

"The mission of the Accommodation and Conference Service is to support a good university experience by providing adequate accommodation suitable to meet the needs of prospective and enrolled students of the University and to raise revenue in order to improve facilities offered to members of the University community"

The key goals to support the mission were agreed as:

1. To improve and increase the provision of accommodation and related facilities.
2. To help attract high quality, motivated undergraduate students to the University.
3. To meet the challenge of all changes in legislation concerning students.
4. To assist the University in realising its full potential revenue.
5. To enhance the University's image and reputation.
6. To generate and distribute information on accommodation, conference and related activities.
7. To achieve a unified approach to the Service.
8. To recruit, train and retain suitable staff.

7.3 Corporate name

Finally, the participants discussed various corporate names for the Service which would embrace the Accommodation Office, the Conference Office and the Halls of Residence. Prior to the planning workshop no such name existed, the phrase

Accommodation and Conference Service having been suggested for convenience at the start of the workshop. The following names were proposed.

Conference and Accommodation Services
Accommodation Service
Conference, Accommodation and Halls
Accommodation and Conference Service
Department of Accommodation and Conferences
Accommodation and Conference Department
Centre for Residential Placement

After discussion the group agreed that the title:

Accommodation and Conference Department

was most appropriate as it both reflected the activities of the Service and was in line with other administrative units of the University, e.g Finance Department, Personnel Department.

8. CONCLUSIONS

8.1 Summary of the results of the planning workshop

The major results of the planning workshop are summarised below.

- A listing of the issues of concern to staff of the Service.

- An explicit statement by the participants as to the objectives of the service including:
  - a classification of the objectives into categories showing major areas of activity,
  - an identification of those objectives requiring significant new resources for implementation.

- A priority structure giving:
  - a ranking of the categories of objectives in terms of importance,
  - a ranking of the individual objectives within each category in terms of importance.

- A mission statement for the Service and set of key goals to support that mission.

- A proposed corporate name for the Service.

- A better understanding by staff of the Service regarding what the Service as a whole should be trying to achieve and where the priorities lie.

- Some team building and planning momentum.

- A basis for future activities and for allocation of resources.

- This report on what occurred and the results of the work for discussion within the Service and the University.

8.2 Recommendations

- This report should be circulated for discussion within the Accommodation and Conference Service and to relevant people in the University Administration.

- The priorities established in the planning workshop (figure 3) should be used when making decisions about the allocation of resources.

- Responsibilities for achieving the objectives should be allocated amongst staff.

- Staff in the Service should be made aware of how their various tasks contribute to the objectives of the Service.

- The Head of Accommodation should place greater emphasis on influencing University policy in those areas where it affects the Service.

- The corporate name "Accommodation and Conference Department" should be adopted by the Service.

- Action should be taken immediately to begin implementing those objectives listed as high priority which do not appear to require significant new resources. These include:
    - seeing that improvements are made to the management structure in the Halls of Residence,
    - improving the recruitment, motivation, development and retention of staff,
    - increasing commercial activity to generate income for improvement,
    - improving the marketing of the Service,
    - improving the integration between various sections of the Service,
    - increasing student accountability in the Halls of Residence,
    - improving communications with University support services.

- Effort should be made to persuade the University to allocate more resources to achieving those objectives which require significant new resources. These include:

    - improving the provision and quality of accommodation generally,
    - resolving the uncertainty over the future of Northampton Hall in particular,
    - meeting the challenge of changes in funding support for students,
    - making full use of new technology within the Service,
    - establishing and maintaining a staff training programme.

- The situation should be reviewed in six months time to assess whether the stated priorities and rec ommendations are being implemented.

Appendix A

List of Participants

Participants

Mrs I.T. Stockdale	Head of Accommodation
Mr J. Tibble	Accommodation Officer
Miss H. Wigmore	Conference Manager
Mr K.V. Rao	Finsbury and Heyworth Halls Warden
Mr J. Burton	Finsbury and Heyworth Halls Manager
Mr R. Jowitt	Finsbury and Heyworth Halls Tutor
Mr C. Powner	Northampton Hall Manager
Mr T. Wright	Northampton Hall Tutor

Interactive Management Unit Staff

Mr F.R.Janes	Senior Lecturer and Unit Director
Mr R.J.Jeffery	Unit Manager
Mr K.Hammer	Research Assistant

Appendix B

City University
Department of Systems Science
Interactive Management Unit

Planning and Team Building for the Accommodation Area

1 Purpose of Meetings

- Team building amongst participants
- Develop corporate identity for the Accommodation Area
    * name
    * awareness of identity by staff involved
    * awareness of identity by University
- Improve inter-department communications
- Establish objectives
- Set priorities
- Establish mission statement

2 Proposed Programme

Monday:

9:30	Introduction to the sessions
9:45	Identification of current issues
11:15	Generation and clarification of objectives
1:00	Lunch
2:00	Clarification (cont)
4:00	Categorise product
5:30	End

Tuesday:

9:30	Setting priorities
1:00	Lunch
2.00	Develop Mission Statement & Name
4.00	Review
4.30	Finish

(Breaks for tea and coffee will be provided)

RJJ/FRJ 3/1/89

Appendix D

Mission statements produced by Groups A and B

Group A

Mission

The mission of the Accommodation and Conference Service is to provide adequate accommodation suitable to meet the needs of prospective and enrolled students of the University and to raise revenue in order to improve facilities offered to members of the University community, commensurate with enhancing their university experience.

Goals to support the mission

1. Act as an agent to attract high quality, motivated undergraduate students to the University.
2. To stimulate and provide information on accommodation, conference and related activities.
3. To assist the University in realising its full potential revenue.
4. To enhance the educational experience of members of the University community.
5. To enhance the University's image and reputation.
6. To improve and increase the accommodation and its related facilities.

Group B

Mission

The mission of the Accommodation and Conference Service is to support a good university experience for all users of its facilities by using generated surpluses to provide, improve and maintain standards in all related services.

Goals to support the mission

1. To improve the provision of accommodation
2. To meet the challenge of all changes in legislation concerning students.
3. To increase surpluses overall by maintaining a programme of improvements in all areas .
4. To achieve a unified approach to the Service.
5. To establish an appropriate form of contract for all permanent staff working in residences.
6. To recruit, train, and retrain suitable staff.
7. To improve the presentation of the University image.

SUPPORTING PAPER D

Janes, F.R., Hammer, K. and Jeffery, R. (1989). Issues, objectives and priorities for the Department of Civil Engineering of City University, London. Technical Report No. DSS/FRJ-KH-RJJ/263, Dept. of Systems Science, City University, London. 25pp.

(Appendix C of this report has been included)

ISSUES, OBJECTIVES AND PRIORITIES

for

THE DEPARTMENT OF CIVIL ENGINEERING

of

CITY UNIVERSITY, LONDON

(A report on a planning workshop held at City University over three days during 1989.)

F.R.Janes, K.Hammer and R.J.Jeffery

Interactive Management Unit
Department of Systems Science
City University
Northampton Square
London EC1V OHB

Technical Report No. DSS/FRJ-KH-RJJ/263 .October, 1989.

CONTENTS

FIGURES

APPENDICES

Abbreviations

NGT: Nominal Group Technique

ISM: Interpretive Structural Modelling

1. SUMMARY

Academic staff of the Department of Civil Engineering at City University participated in a planning workshop designed to enable the participants collectively to formulate their ideas on the objectives and priorities of the Department. The methods of interactive management were used for this purpose with the staff of the Interactive Management Unit acting as facilitators throughout, leading the group through a series of meetings specifically designed to promote the efficient generation and structuring of ideas.

At the first meeting, all the academic staff of the Department were invited to participate in generating and categorising the issues facing the Department. The idea-generation method, Ideawriting, was used for this purpose.

At the second meeting, the Departmental Advisory Committee participated in the use of a second idea-generation method, Nominal Group Technique, to generate and clarify a set of objectives for the Department over the next five years. The objectives were then placed into categories.

At the third meeting Interpretive Structural Modelling was used to help the Committee in setting priorities. This was done by ranking the objectives for importance within categories. The resulting priority structure shows the Committee's priorities for the set of objectives. Finally, drawing upon the issues, objectives and priorities identified at this stage, the group formulated a mission statement for the Department.

The products of each of these meetings are given in Sections 3 to 6, together with an outline of the methods used. In Section 7 the results of the planning workshop are summarised and recommendations are made based upon the products of the meetings.

The planning workshop has given a good picture of the objectives and priorities which the participants think effort should be directed towards. It has also identified the issues of concern to academic staff throughout the Department. The objectives and priorities, together with the recommendations in this report should provide a valuable basis for future activities and planning within the Department.

2. TERMS OF REFERENCE

This report has been produced for Professor K.S.Virdi, Head of the Department of Civil Engineering. It was prepared by Mr F.R.Janes, Mr K.Hammer and Mr R.J.Jeffery of the Interactive Management Unit.[1] The work was funded through the Office of the Academic Registrar, Dr. A.H.Seville.

At the request of Professor Virdi, the Interactive Management Unit organised a planning workshop (Appendix A) for the Department of Civil Engineering. This took place over two and a half days on the 15th February, 14th April and 18th July, 1989, in the Decision Support Room of the Department of Systems Science.

The aims of the workshop were to enable the participants (Appendix B) collectively to plan for the Department of Civil Engineering by:

- Identifying issues of concern
- Establishing objectives
- Setting priorities
- Writing a mission statement

The methods used in the planning workshop to accomplish these aims were designed to improve inter-departmental communication and to promote team building amongst the participants.

[1] Department of Systems Science, City University

3. ISSUES FACING THE DEPARTMENT OF CIVIL ENGINEERING

3.1 Method

In order to identify the issues of concern to staff of the Department of Civil Engineering, an idea-generation method called Ideawriting was used. The method, used under the guidance of a facilitator, assists a group in generating and categorising ideas on a specified issue.

Steps of Ideawriting

1. Clarify the trigger question.
2. Silently generate ideas in writing.
3. Exchange lists of ideas and continue idea generation. Repeat this at intervals until the lists have been seen and contributed to by all participants.
4. Identify headings to categorise the ideas.
5. Categorise and edit the ideas.
6. Present a summary of the ideas.

All the academic staff of the Department were invited to participate in this first afternoon session of the workshop held in February, 1989. The participants were split into three groups representing the various subject areas in the Department (Appendix B). Each group was asked to respond to the same trigger question:

"What are the issues facing your Department/Division/Research Centre over the next five years?"

3.2 Issues Identified

The three groups, working separately, each identified a list of issues and proceeded to categorise them. The following summaries, as presented by the groups, draw attention to important issues as seen by each group. The complete list of issues generated is given in Appendix C.

3.2.1 <u>Summary Presented by the Structures Group</u>

Undergraduate Recruitment
Improve demand for taught courses.

Staff Identity
Improve working relationships.

Research
There is concern about the funding, general support and time allocation for research.

Organisation and policy development is required with proper University support.

Research areas should be reviewed as should co-operation between all parties concerned.

Administration
Avoid inefficient division of responsibilities and concentrate efforts by individuals on areas they are best able to perform.

Seek support (central) for administrative functions within the Department and also improve central administration attitudes to repair, maintenance, etc., and provision of better office facilities.

Course development
Traditionally and currently, sandwich courses in our Department have been shown to be an efficient and popular means of teaching; the shape of such courses has changed recently but such courses maintain the vital link with industry.

Staff development
Staff development in the light of : staffing levels, subject coverage, retraining, work load distribution and career development.

Euro-dimension
Develop activities to enhance the standing of the Department through European collaboration.

External interaction
Increasing the interchange of staff with other institutions.

Finance and funding
Selective funding; review sources of income in view of reduced government funding.

3.2.2 Summary Presented by the Hydraulics Group

Research
Increase and broaden research activity particularly in pre-competitive area.

Teaching
Development of new postgraduate course.

Increase intake to courses generally.

Manpower
Additional academic staff plus research and technical support.

Links
Academic, industrial and European links.

Facilities
Undergraduate teaching facilities.

Finance
Changes in University financial structure.

Administration
Reduction of administration needed through effective central support.

3.2.3 Summary Presented by the Geotechnics, Surveying, Photogrammetry and Highways Groups

Image
How do we stop the 'rest of the world' (e.g. school leavers, other engineers, overseas academics) regarding us as a minor technical college on the outskirts of London ?

We require good publicity. City University needs to be attractive to those outside and inside the University.

Survival
Undergraduate numbers need to increase. Is there a role for a traditional Civil Engineering course? In what direction should we move? - towards broad based engineering and wider access.

Research
There is a need for growth in research activity and to attain a prominent position in the world league of research institutions.

Big funding is needed for chairs and other posts. Increase the number of research assistants and research students. Respond to the change in research funding.

Organisation
The inter-relationship of School/Departments/Divisions/Centres.

Administrative incompatibilities of teaching and research.

4 OBJECTIVES FOR THE DEPARTMENT

4.1 Method

In order to identify objectives for the Department, members of the Departmental Advisory Committee participated in a second idea-generation method, Nominal Group Technique (NGT). The Committee includes all senior staff in the Department who lead the various teaching and research groups. The NGT method enables the generated ideas to be systematically and thoroughly clarified, edited and given a preliminary ranking through a voting procedure. The one day meeting took place in April 1989.

Steps of Nominal Group Technique

1. Clarification of a trigger question to focus the idea generation.
2. Silent generation of ideas in writing in response to the trigger question.
3. Round-robin recording of ideas, whereby the ideas of participants are recorded on a flip chart and displayed.
4. Serial discussion of ideas for clarification, whereby each item is discussed in turn with the group in order to clarify and edit it.
5. Voting in order to enable participants to express their value judgements with regard to the importance of the ideas generated.

The trigger question posed to the group was:

"What should the Department of Civil Engineering be trying to achieve over the next five years?"

It was noted during discussion of the trigger question that the objectives generated should encompass all areas of the Department's present activity and should identify new areas for development.

A total of 28 objectives were generated during the NGT as shown in Section 4.2. The list was reviewed whilst the objectives were being classified (see Section 4.3) and this resulted in nos. 29-32 being added. A further review for completeness, in the light of the issues raised in Section 3, was carried out at the start of the priority setting session described in Section 5, when nos. 33-35 were added.

4.1.1 Explanation of voting

Following clarification of the objectives, the participants were asked in step 5 to select individually the seven which they considered to be the most important given the context of the trigger question. They were then asked individually to rank their seven selected items, assigning a '7' to the most important and a '1' to the least important and so on. These voting scores are listed alongside the objectives below.

The voting scores should not be taken as an accurate ranking. They provide a rough and ready assessment of the participants' judgements concerning the relative importance of the objectives. Given time constraints this enables the facilitator to select a subset of items to be structured subsequently in the time available.

4.2 Objectives Identified

The number appearing before each objective reflects the sequence in which the ideas were presented and is not of any other significance. For simplicity of cross referencing this original numbering scheme has been retained throughout the report.

No voting scores are shown for objectives 29-35 as they were put forward after completion of the NGT and circumstances did not permit a repeat of step 5 (voting). However, these objectives were all considered during the priority setting session. The objectives in italics were agreed as self-evident and were not included in the voting.

Objective	Votes	Total
1. To acquire a national identity as a centre of excellence in a limited number of fields of engineering.	6,1,7,7	21
2. To establish staff interchange with industry (i.e. two-way).	1	1
3. To become one of the foremost departments in research, education, training and consultancy.		
4. To develop an additional degree course(s) which allows intake from a broader group of applicants (e.g. BSc in Engineering Design and Management).	4,2,6	12
5. To create an efficient environment of work using information technology; networked PC's for all staff.		
6. To develop a stimulating environment for academic, research and technical staff.		
7. To link more effectively with industry in joint teaching and research programmes (e.g. for teaching IGDS[2]; cooperative research).	2,1,3	6

[2] IGDS : Industrial Graduate Development Scheme

8.	To publicise our achievements. (e.g. improving the corporate image; personal contacts)	6	6
9.	To improve the quality and quantity of the undergraduate intake.	7,6,3,6	22
10.	To have a limited number of high quality MSc courses	5,1	6
11.	To improve communications within the Department (i.e. provide a staff common room).		
12.	To expand links within Europe (e.g. joint research projects, joint courses, staff and student exchanges).	4,2,2	8
13.	To integrate fully within the School of Engineering.	3,5	8
14.	To establish industrial scholarship funding for undergraduates.		
15.	To increase all research income, particularly from Research Councils	5,7,5,5	22
16.	To acquire better secretarial and PA support (i.e. quality and quantity).		
17.	To get more money from industry for staff posts at all levels (i.e. from chairs to research staff).	4,4	8
18.	To concentrate individual efforts more on specific areas of ability and reallocate duties effectively.	3	3
19.	To upgrade the laboratories in the Department to modern standards		
20.	To increase our services to industry (e.g. consulting and contract testing related to research activities).		
21.	To exploit the unique nature of the sandwich pattern of the BEng course (e.g. increase number of sponsors involved with the course).	1	1
22.	To improve the PhD completion rate.	3,2	5
23.	To increase the number of lecturing staff in the Department to around 25.	7,4	11
24.	To establish sponsored industrial design tutoring posts.		
25.	To widen access to the BEng course (e.g. taking people without 'A' level mathematics which would require additional foundation studies).		
26.	To create a more cooperative environment in the Department.		
27.	To increase and coordinate our activity in continuing education and training.		
28.	To improve the commercial utilisation of the Department's laboratory		

facilities (e.g. routine testing).

----

29. To increase the quantity of technical support.
30. To improve links with the Centre for Engineering Management.
31. To support the Department's Research Centres (i.e. allocation of people, space and money).
32. To increase research output from the Department (e.g. publications and degrees).
33. To encourage research activities with other universities and research institutions in Britain.
34. To establish industrial scholarship funding for postgraduate students.
35. To provide incentives and status for staff who fulfill key roles which meet the Department's objectives.

4.3 Classification of Objectives

The group was taken by the facilitator through a process to classify the objectives into categories of related items. These categories were then each given a heading. The classified objectives are shown in Figure 1 under the appropriate heading. The sequencing of the headings is of no particular significance in this figure.

Relationships within the University	Publicity	Research	Facilities	Ideals	External Links	Teaching	Human Resources	Working Environment
13. To integrate fully within the School of Engineering	8. To publicise our achievements. (e.g. improving the corporate image; personal contacts)	15. To increase all research income and particularly that from Research Councils	5. To create an efficient environment of work using information technology; networked PC's for all staff.	1. To acquire a national identity as a centre of excellence in a limited number of fields of engineering.	2. To establish staff interchange with industry (i.e. two-way).	4. To develop an additional degree course(s) which allows intake from a broader group of applicants e.g. BSc in Engineering Design and Management.	16. To acquire better secretarial and PA support. (i.e. quality and quantity).	6. To develop a stimulating environment for academic, research and technical staff
30. To improve links with the Centre for Engineering Management		31. To support the Department's Research Centres	19. To upgrade the laboratories in the Department to modern standards	3. To become one of the foremost departments in research, education, training and consultancy.	7. To link more effectively with industry in joint teaching and research programmes. (e.g. for teaching IGDS; cooperative research)	9. To improve the quality and quantity of the undergraduate intake.	18. To concentrate individual efforts more on specific areas of ability and reallocate duties effectively.	11. To improve communications within the Department. i.e. provide a staff common room.
		22. To improve the PhD completion rate			12. To expand links within Europe. (e.g. joint research projects, joint courses, staff and student exchanges).	10. To have a limited number of high quality MSc courses	23. To increase the number of lecturing staff in the Department to around 25	26. To create a more cooperative environment in the Department
		32 To increase research output from the Department			17. To get more money from industry for staff posts at all levels. (i.e. from chairs to research staff)	14. To establish industrial scholarship funding for undergraduates.	29. To increase the quantity of technical support	
					20. To increase our services to industry. (e.g. consulting and contract testing related to research activities)	21. To exploit the unique nature of the sandwich pattern of the BEng course. (e.g. increase number of sponsors involved with the course).		
					28. To improve the commercial utilisation of the department's laboratory facilities. (e.g. routine testing)	24. To establish sponsored industrial design tutoring posts		
						25. To widen access to the BEng course, (e.g. taking people without A level maths which would require additional foundation studies)		
						27. To increase and coordinate our activity in continuing education and training		

Figure 1. Objectives classified into categories

5. SETTING PRIORITIES AMONGST THE OBJECTIVES

5.1 Method

In order to examine the priorities amongst the objectives the Departmental Advisory Committee participated in a third process called Interpretive Structural Modelling (ISM). This is a computer-aided method which helps participants to examine the interrelationships between the elements in a complex issue. In this case ISM was used to produce a priority structure, taking the objectives developed during the NGT as the elements to be structured. The one-day meeting took place in July, 1989.

The ISM process required the participants to respond to a series of paired comparisons of the objectives put by the computer as questions in the following form:

"Is

15. To increase research income and particularly that from the Research Councils

more important than

22. To improve the PhD completion rate?"

Each question was discussed and argued by the participants under the guidance of a facilitator. The answer fed into the computer in response to a question was based on the votes of the participants, the results of a majority vote being used whenever they were not unanimous. As the process proceeded the computer built up a priority structure, showing the group's perceptions of the importance of the various objectives. When assessing importance, participants were reminded that they were considering objectives for the Department over the next five years.

5.2 Priority Structure

Initially, the objectives were selected for prioritising from the list of 35 without considering them according to the categories such as "Research" or "External Links" identified in Figure 1. However, attempting to set priorities between dissimilar objectives was not very productive on this occasion. In particular, after dealing with 13 items, seven remained in one block at the highest level of importance. It was thus decided to set priorities amongst objectives within categories. To this end the nine categories in Figure 1 were amalgamated into four:

- Research
- Teaching
- External/Industry Links
- General

The initial 13-element priority structure was then disaggregated under these four headings and the remaining objectives prioritised. In addition, the participants decided that a number of the objectives could be thought of as ideals. They agreed that these items (nos. 1, 3, 7, 13, 18) should be incorporated directly into the mission statement.

Figure 2 shows the resulting priority structure with the objectives in the four categories. In each case the arrows between the boxes in the figures denote the expression "is more important than". Thus under the heading of "Teaching" in the figure the three objectives numbered 9, 4 and 25 are all shown as having equal importance at the highest level in that category. Similarly, items 19 and 29 are shown as having equal importance at the lowest level under the heading "Research". With regard to the four categories themselves, the participants did not wish to set priorities between them and consequently they are shown as being of equal importance.

It may be noticed that the ordering in the priority structure differs from the initial tentative rankings provided by the NGT voting scores (section 4.2). This is a measure of the learning that took place when the participants had an opportunity to reflect upon and argue the relative merits of the various objectives. It may also be noticed that there are some minor changes in the wording of certain items when the ISM structure is compared with the list of objectives generated in the NGT session, for example, items 11 and 12. Such changes are a natural part of the argument, discussion and learning that arises during a typical ISM session.

5.3 Resource Assumptions

Prior to the start of the ISM process, the participants were asked whether they wished to make any general assumptions about the future level of available resources in order to provide a context for the questions, for example, "a criterion of limited resources". However, they were not willing to recognise a constraint on funding and so no such assumption was made.

As each objective was called up for comparison with other items as part of the ISM process, a judgement was made as to whether the objective required significant new resources for its implementation. "Significant" was taken in this sense to be a sum in excess of £10,000. The objectives so identified are marked with a black dot in the boxes in Figure 2.

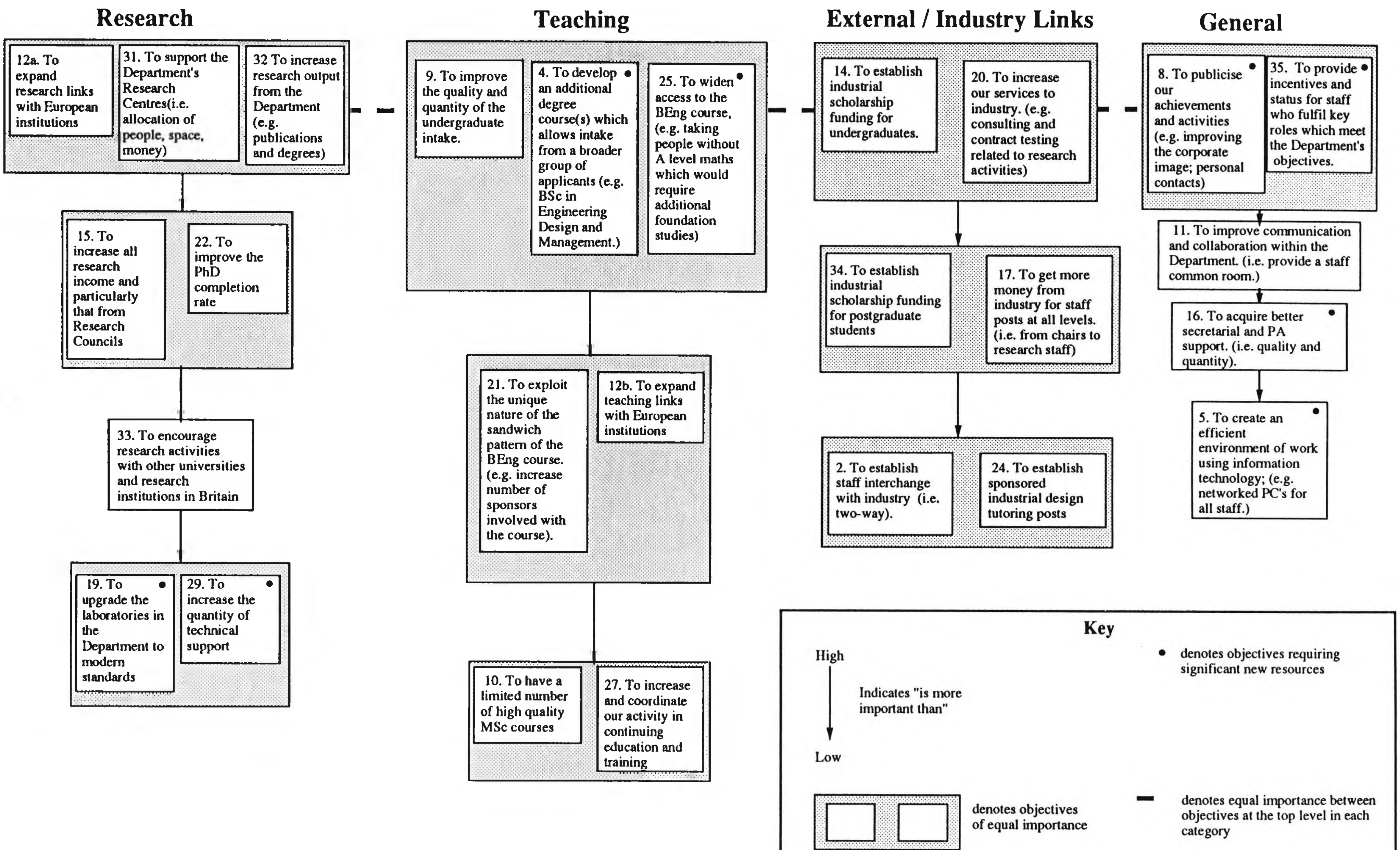


Figure 2. Priority structure for Department of Civil Engineering

6 MISSION STATEMENT FOR THE DEPARTMENT

6.1 Method

During the last phase of the workshop, immediately following the ISM session, the group was asked to write a mission statement for the Department. The task put to them was:

"Based on the issues, objectives and priorities identified so far, prepare a mission statement incorporating a set of key goals for the Department of Civil Engineering."

6.2 Mission Statement

The mission statement for the Department was agreed as :

"To become one of the foremost departments for research, education, training and consultancy in Civil Engineering and associated disciplines by:

1 Improving our international standing for research in Geotechnical Engineering, Hydraulics, Ocean Engineering, Structural Engineering, and Surveying,

2 Improving the quality and quantity of undergraduate students by:

- developing an additional degree course in engineering design and management which allows intake from a broad base of applicants,

- widening access to the existing BEng courses,

3 Linking more effectively with industry to provide income for teaching and research,

4 More effective publicising of the Department's activities and achievements,

Individual effort will be concentrated to implement this mission, within the framework of the School of Engineering."

7 CONCLUSIONS

7.1 Summary of Results of the Planning Workshop

The major results of the planning workshop are summarised below.

(i) A categorised listing of the issues of concern to academic staff of the Department.

(ii) An explicit statement by the participants as to the objectives of the Department together with a classification of the objectives into categories showing major areas of activity.

(iii) A priority structure giving:
- a ranking of the individual objectives within each category in terms of importance,
- an identification of those objectives requiring significant new resources for implementation.

(iv) A mission statement for the Department.

(v) A better understanding by academic staff of the Department regarding what the Department as a whole should be trying to achieve and where the priorities lie.

(vi) Some team building and planning momentum.

(vii) This report on what occurred and the results of the work for discussion within the Department and the University.

7.2 Recommendations

(i) This report should be circulated for discussion within the Department, the School of Engineering and to relevant people in the University Administration.

(ii) The priorities established in the planning workshop should be referred to when making decisions about the allocation of resources.

(iii) Responsibilities for achieving the objectives should be allocated amongst staff.

(iv) Staff should be made aware of how their various tasks contribute to the

Departmental objectives.

(v) The situation regarding limited resources needs to be communicated effectively to staff as does the consequent need to allocate effort to agreed priorities.

(vi) The workshop has been productive in identifying and clarifying objectives, and in setting priorities. However, there are still effectively 10 objectives at the top level of priority when all four categories are taken into account in Figure 2. Given a situation of limited resources a smaller number of top level priorities would seem desirable. More work needs to be done by those responsible for planning in further clarifying priorities.

(vii) A more outward looking emphasis on the market the Department serves is needed. Educational products could then be adapted to the needs of that market.

(viii) Notwithstanding the above comments, action should be taken to begin implementing those objectives listed as high priority which were identified as not requiring significant new resources. These include :

- Increasing research output, including publications and degrees,
- Allocating resources so as to support existing Research Centres,
- Exploring ways of expanding research links with European Institutions,
- Increasing research income,
- Exploring ways of increasing the undergraduate intake,
- Establishing industrial scholarship funding for students, particularly undergraduates,
- Increasing revenue raising services to industry,
- Exploring ways of obtaining more money from industry for academic staff posts,
- Improving communication and collaboration within the Department.

(ix) Action should also be taken to explore further the implications and means of achieving those objectives identified as requiring significant new resources. These include:

- Investigating ways of widening access to the BEng course, including taking people without "A" level Mathematics,

- Exploring the possibility and implications of an additional degree course(s) which would allow for intake from a broader range of applicants,

- Exploring ways of providing incentives and status for staff who fulfill key roles which meet the Department's objectives,

- Examining ways of publicising the Department's achievements and activities.

Appendix C

Complete List of Issues Identified by the Groups

The issues and categories identified by each of the three groups which were summarised in section 3.2 are given below.

Trigger Question: "What are the issues facing your Department/Division/Research Centre over the next five years?"

1. Structures Group

Need to increase undergraduate quantity of appropriate quality.
- Increase student recruitment/intake - undergraduate and postgraduate.
- Build effective links with industry.
- Student numbers are reducing.
- Review activities on a cost-effectiveness/benefit basis.
- Teaching loads.
- Student recruitment to postgraduate courses.

Staff identity
- Communication.
- Discussion of policy/consultation/consensus.
- Interaction between Divisions.
- Groupings with other Departments and Divisions.
- Identification of new directions.
- Establishment of individual and group identity.
- Creation of more co-operative environment.
- Improve perception of School of Engineering.
- Improve conditions of service.
- Improve feeling of belonging and commitment.
- Development of business attitudes.
- Development of expertise across Departmental boundaries.

Research
- Research time curtailed.
- Technical support to laboratories.
- Recruitment of good quality research staff.
- Increasing research performance.
- Falling research funding.
- Development of special units for new advanced technology.
- Research/teaching balance.
- Research interests.
- Organisation.
- Policy development.
- University support.

Administration
- Avoid inefficient division of responsibilities.
- Seek provision of support (central) for administrative functions.
- Reduce message delays.

- Increasing demand on staff time disrupts research and teaching activities.
- Improve office facilities.
- Improve central administration attitudes to repair, maintenance and safety issues.
- Improve assessment of administrative duties.
- Concentrate activities on particular abilities.
- Improve general operating efficiency at all levels.

Course development
- Develop the potential of the sandwich course as a City University feature.
- Improve postgraduate courses.
- Improve undergraduate courses.
- Adjustment in undergraduate courses to new technologies.

Staff development
- Improve the staffing in Structures Division.
- Even distribution of work load.
- Development of retraining policy.
- Development of effective career structure.
- Effect of staff reduction on number of taught subjects.

Euro-dimension
- European dimension must be taken up.

External interaction
- External activities which benefit the Department.
- Contact and collaboration with other Civil Engineering Departments.

Finance and funding
- Research income.
- Favouring particular topics at the expense of others.
- Constantly review all possible sources of income.
- Government pressures on finance.

2 Hydraulics Group

Research
- Increase and broaden activities.
- Increase conversion of students to research.
- Ability to engage in long term and speculative research.
- Attract research assistants, research students and secondments.

Teaching
- Increase undergraduate and postgraduate intake without reducing quality.
- Develop remote teaching aids.
- Develop courses towards design objectives plus other new material.
- Introduction of new postgraduate course.
- Short course development.

Manpower

- Technical support for laboratory.
- Research assistant and research student recruitment.
- Morale.
- Secondment to industry.
- Personal development though conferences, courses and sabbaticals.
- Recruitment of new academic staff to reflect new developments in research and teaching priorities.
- Flexible approach to new opportunities presented to the Department.

Links

- Collaboration in research and teaching with other groups/individuals in the University and other universities.
- Increase individual links as a contribution to experience on undergraduate and post graduate courses.
- European links - undergraduate and postgraduate courses.
  - 1992.
  - implication of water industry changes.

Facilities

- Laboratory facilities for undergraduate and postgraduate teaching.
- Laboratory facilities for research.

Finance

- Consultancy work.
- Treatment of overheads.
- Changes in University financial structure.
- Equitable distribution of School and Department resources.

Administration

- Reduction of administrative load.
- Effectiveness of central and departmental support for administration.

3 Geotechnics, Surveying, Photogrammetry and Highways Groups

Image

- Publicity is terrible/ non-existent.
- Improve image through more attractive publicity.
- Initiate exciting activities outside Civil Engineering.
- Get big funding.
- What will be the image of the Civil Engineering Department?
- Make City University attractive.
- How to make the Department important.

Survival

- How to avoid closure.
- Decline in suitable students.
- How to avoid closure without students.

Recruitment

- Changing entry qualifications.
- Demographic decline.
- Attract more students.
- Decline in suitable students.
- Need to encourage postgraduate students.
- Student numbers.
- Reducing postgraduate applications from overseas.
- Not enough UK postgraduates.
- Increase research staff.
- Home/overseas student balance.
- Make City University attractive.
- Attract more research staff/students.
- Get funding for staff (especially Chairs).

Research

- Increase contracts.
- Widen activity.
- Prominent position in world league of research institutions.
- Broaden into new and interdisciplinary areas.
- Obtain big funding: new chairs and new posts.

Courses

- Broaden into interdisciplinary areas.
- Broad based ENGINEERING course.

Organisation

- Cut out time-wasting activities.
- Make administration more efficient.
- Cope with changing nature of research funding.
- Staff cuts causing imbalance within Divisions.
- What is the need for Civil Engineering Department in a School of Engineering?
- Reduce time inefficiencies in teaching and administration.
- Develop wider market (i.e. less emphasis on Civil Engineering).
- Development of research base.
- Move away from mainstream Civil Engineering.
- Are the needs of teaching and research within a single Departmental umbrella compatible?.
- Low staff morale.
- Lack of support staff.
- Too much emphasis on "research".
- Reduce administration.
- Reduce inefficiencies in teaching.
- Move away from Structures domination.

SUPPORTING PAPER E

Jeffery, R.J. and Janes, F.R. (1988b). Planning for the Short Course Unit of City University, London. Technical Report No. DSS/FRJ-RJJ/252, Dept. of Systems Science, City University, London. 23pp.

PLANNING

for

THE SHORT COURSE UNIT

of

CITY UNIVERSITY, LONDON

(A report on a two-day planning workshop held
at the City University on June 6th and June 7th, 1988)

R.J. Jeffery & F.R. Janes

Interactive Management Unit
Department of Systems Science
City University
Northampton Square
London EC1V OHB

August, 1988

Technical Report DSS / RJJ - FRJ / 252

CONTENTS

FIGURES

APPENDICES

Abbreviations

SCU Short Course Unit
IMU Interactive Management Unit
ISM Interpretive Structural Modelling
NGT Nominal Group Technique

1. SUMMARY

A group of six members of City University staff involved in the area of short courses met on two occasions in the Decision Support Laboratory of the Department of Systems Science to identify and structure the objectives of the Short Course Unit.

The programme of meetings involved participants in, firstly, developing an appropriate set of objectives for the Unit and, secondly, examining how these objectives were interrelated. The methods of computer-aided interactive management were used for this purpose with the staff of the Interactive Management Unit acting as facilitators throughout, leading the group through a series of processes specifically designed to promote the efficient generation and structuring of ideas.

On day one, an idea-generation method was used to help participants in generating, clarifying and editing a set of over 30 potential objectives for the unit. A preliminary ranking was developed for the objectives using a voting procedure.

On day two, a subset of 26 of these objectives was structured with the help of a computer to produce an Intent Structure, which shows how they could influence one another. The various objective groupings within the Intent Structure were subsequently identified and labelled.

Subsequent to this group work, a Priority Structure was produced by the SCU manager for 15 of the objectives having significant resource implications. This could be used as an aid to deciding on the allocation of SCU resources.

A preliminary analysis carried out by the SCU manager prior to the group work using the same techniques served to illustrate the ambiguity over the role of the SCU within the University.

The planning workshop and products resulting from it give a picture regarding the participants' thinking on the role and functions of the SCU. This provides information for subsequent planning and development. In addition, the study illustrated a number of problem areas for the SCU, in particular those of identity and role, financial planning and staffing.

2. TERMS OF REFERENCE

This report has been produced for Ms. C. Leigh[1] and Dr. S. Parker[2] by Mr R.J. Jeffery[3] and Mr. F.R. Janes[4] of the Department of Systems Science.

At the suggestion of Mr Jeffery, the Interactive Management Unit (IMU) of the Department of Systems Science organised a planning workshop to consider the objectives of the Short Course Unit (Appendix 1). This took place over two half-days on the 6th and 7th of June, in the Decision Support Laboratory of the Department of Systems Science. A group of six participants from within the University took part, including the SCU manager, three SCU secondees, one Head of Department and the Director of Continuing Education (Appendix 2).

The aim of the workshop was to enable the participants collectively to generate, clarify and structure their ideas for the objectives of the Short Course Unit. It was considered that this would help the development of the unit as the whole and provide information to the Short Course Unit manager when deciding how to allocate time and resources.

In addition to this workshop, Caroline Leigh and Richard Jeffery undertook a preliminary analysis and, following the group sessions, used the objectives produced by the participants to continue the study.

---

[1] Short Course Unit Manager

[2] Head of Center for Continuing Education

[3] Manager, Interactive Management Unit

[4] Senior Lecturer

3. GENERATION OF OBJECTIVES FOR THE SHORT COURSE UNIT

3.1. Method

At the first meeting, the team participated in an idea-generation method called Nominal Group Technique. This was used to generate, clarify, edit and obtain a preliminary ranking of a set of objectives for the S.C.U.

3.2. Nominal Group Technique (NGT): Steps

NGT involves the following steps:

1. Silent generation of ideas in writing in response to a trigger question.

2. Round-robin recording of ideas, whereby the ideas of participants are recorded on a flip chart and displayed.

3. Serial discussion of ideas for clarification, whereby each item is discussed in turn with the group in order to clarify and edit it.

4. Voting, in order to enable participants to express their value judgements with regard to the importance of the ideas generated.

3.2.1. Trigger question

The question posed to the participants was:

"What should the Short Course Unit be trying to achieve over the next 2-3 years?"

3.2.2. Ideas Generated

A total of 37 ideas were generated during the NGT and are shown in Appendix 2. They may be considered as a set of objectives for the SCU, where the word 'objectives' is used in its broadest sense to denote potential accomplishments over the 2 - 3 year period specified in the trigger question.

The number appearing before the objectives reflects the sequence in which the ideas were presented and are not of any other significance. For simplicity this original numbering scheme has been retained throughout the report. During discussion and clarification (step 3 of the NGT) certain ideas were deleted as they were judged to be redundant, e.g. they duplicated other ideas. These items

(Numbers 18, 24, 28, 31, 33) are shown in Appendix 2 in *italics*.

3.2.3. Explanation of voting

Following clarification of the ideas generated, the participants were asked to select individually the eight which they considered to be the most important given the context of the trigger question. They were then asked individually to rank their eight selected items, assigning an '8' to the most important and a '1' to the least important and so on. These voting scores are listed alongside the ideas, in Appendix 2.

The voting scores should not be taken as an accurate ranking. They provide a rough and ready assessment of the participants' judgements concerning the relative importance of the objectives. Given time constraints this enables the facilitator to select a subset of items to be structured in the time available.

4. STRUCTURING THE OBJECTIVES

4.1 Method

In order to examine the relationships amongst the objectives, the team participated in a process called Interpretive Structural Modelling (ISM). This is a computer-aided method which helps participants to examine the inter relationships between the elements in a complex problem or situation. It enables a group to pool their thinking and reach agreement on the structure of the problem. In this case an ISM session was carried out at the second meeting, taking the objectives developed during the NGT as the elements to be structured. The resulting Intent Structure is outlined below.

4.2 Developing an Intent Structure

An Intent Structure shows how the accomplishment of one objective or goal might contribute to the achievement of another. In this case, given the limited time available, 26 of the objectives were selected for structuring on a basis of the NGT voting scores. The ISM process requires the group to respond to a series of questions put by the computer of the form:

WOULD ACCOMPLISHING THE OBJECTIVE

13 To provide high quality products and services for clients

HELP TO ACHIEVE THE OBJECTIVE

10 To enhance the reputation of City University ?

As with the NGT, a 2-3 year time horizon was assumed. After discussion of the question, the group responds with a 'Yes' or a 'No' answer, taking the results of a vote when the participants are not unanimous. The response is fed into the computer which draws logical inferences from the answers as the process proceeds. Gradually, the computer builds up an ISM 'map', portraying the group's perceptions of the interrelations between the objectives.

The map can be displayed at any stage of the process, examined by the group and amended by hand as desired. The Intent Structure in Figure 1 shows the completed 26 element map.

4.3. Interpretation of the Intent Structure

The boxes in the map contain the objectives with the original numbering scheme as in Appendix 3. The arrows between the boxes represent the relation 'would help to achieve'. The Intent Structure thus shows what helps to achieve what.

4.3.1. **Paths.** A sequence of objectives connected by arrows is known as a path on the map. For example, the path 35 -> 7 -> 27 is explicitly shown. This may be interpreted as a statement that objective 35 helps to achieve objective 7 and that 7 helps to achieve 27. However, the nature of the map means that 35 may help to achieve directly any element which it reaches via a path of one or more arrows, e.g. objectives 7, 27, 13, 14, 2, 4, 38, 29, 6, 10, 30. A similar interpretation may be made regarding the interrelations between the other objectives on the map.

4.3.2. **Objective groupings.** The Intent Structure may be partitioned (Figure 2) into a number of labelled blocks as indicated by the shaded areas. For example, the 'Course Provision' group shows those objectives which if accomplished would significantly contribute to the provision of short courses. This block feeds directly into two groups of objectives labelled 'Reputation' and 'Finance' respectively. Figure 3 shows, in simplified form, the interactions between these major groups of objectives. When reading Figure 3 it should be remembered that any given block helps to achieve any other block which it can reach via a path on the map. Thus, for example, 'Support Services' helps to achieve the blocks 'Reputation' and 'Finance'.

4.4 Uses of the Intent Structure

Within the context of the SCU, the uses of such an Intent Structure include the following.

- Making explicit the multiple objectives of the SCU and their interrelations.
- Clarifying thinking through asking the team systematically to think through the complex interactions between the objectives.
- As a way of explaining the purpose of the SCU to those within the University.

- As a way of assessing and reporting progress. Many objectives may be followed at the same time and effort may be switched between them.

- As a base from which to change objectives as new ideas are developed or as circumstances change.

- As a basis for programme planning. The groupings which emerge from the structure and the interrelations between the objectives provide useful information for this purpose.

- As a basis for policy analysis. Given limited resources, the structure can assist in deciding on the allocation of resources to those activities which will be the most productive.

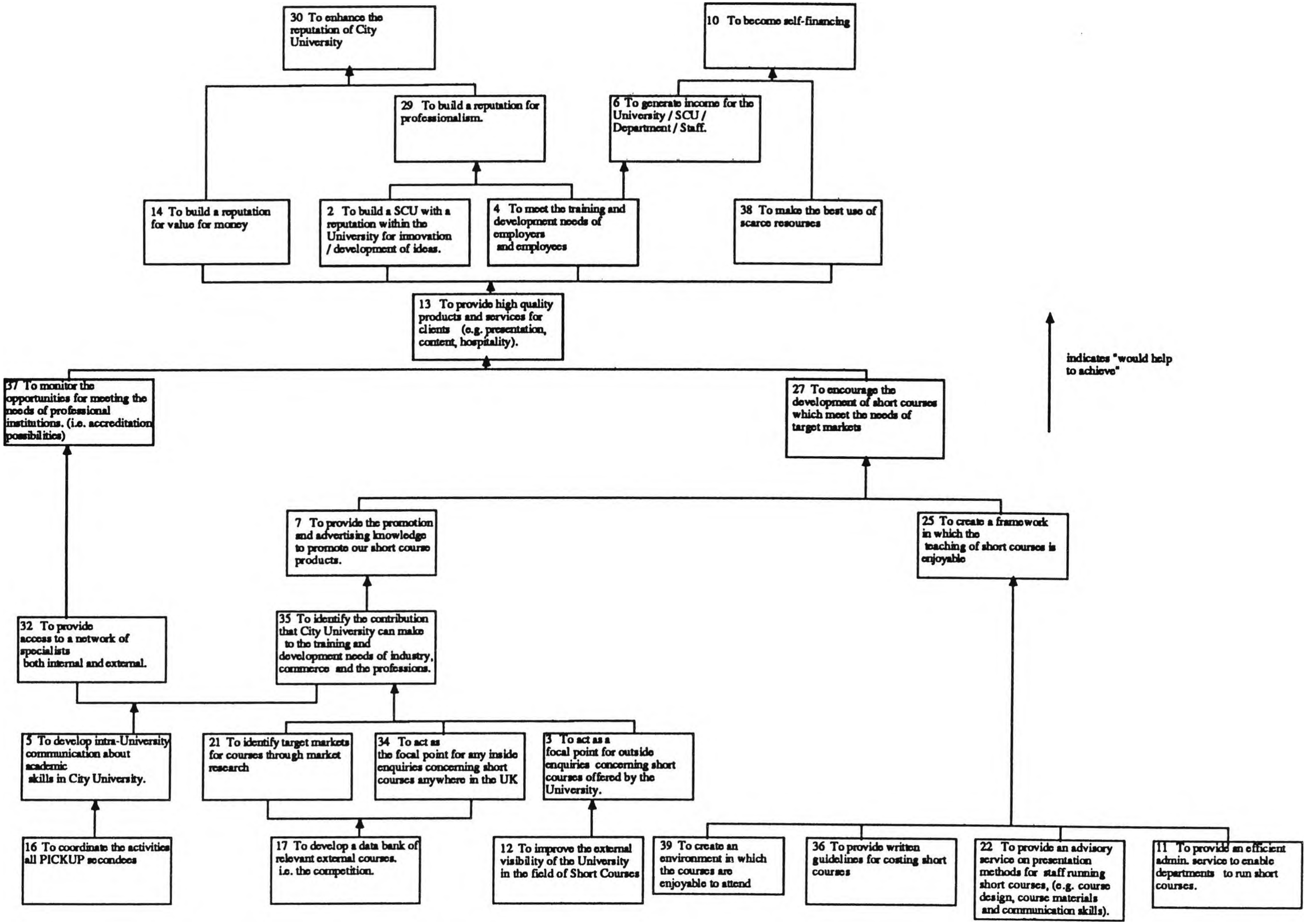


Figure 1 Intent Structure

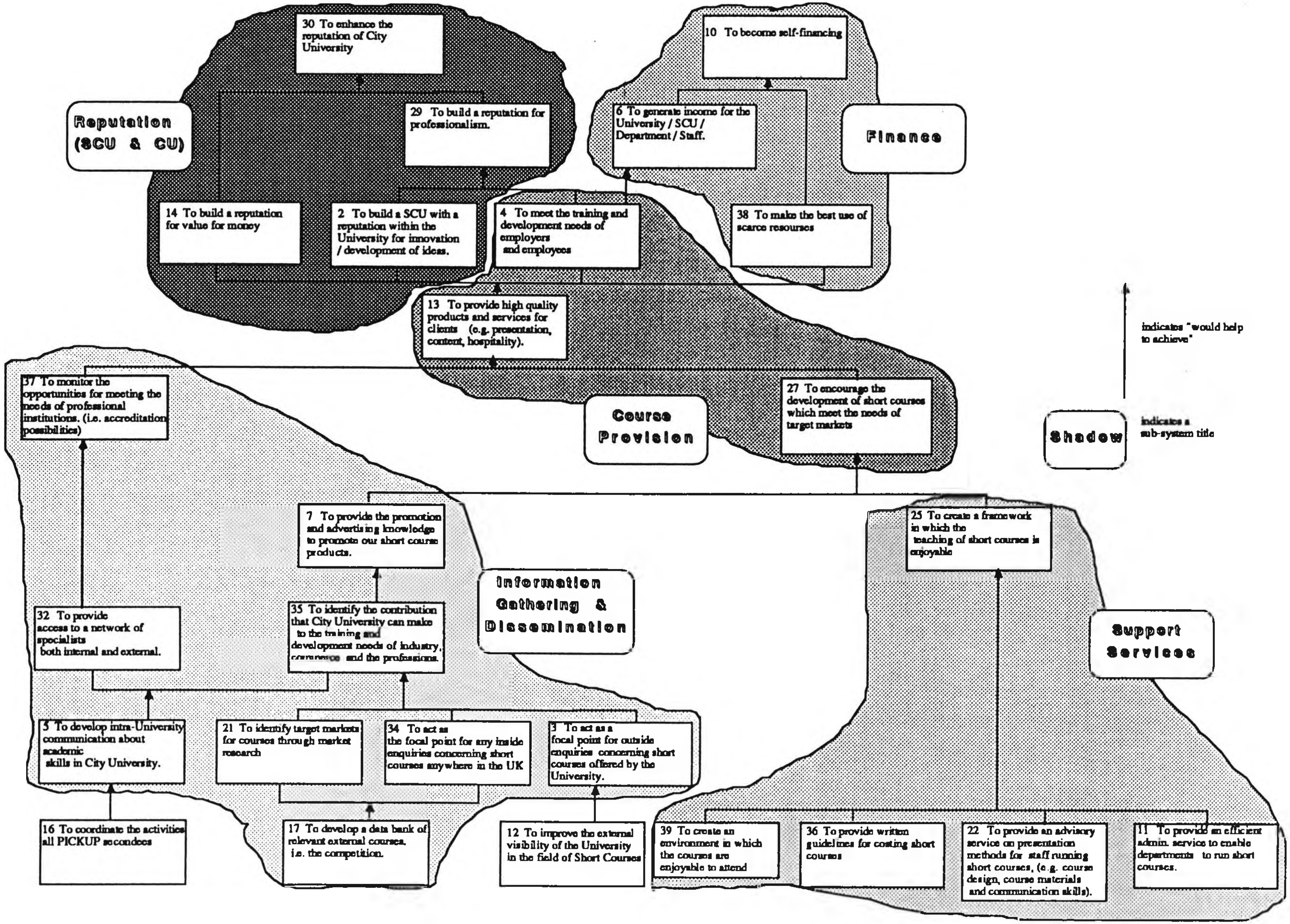


Figure 2 Intent Structure with Sub-systems

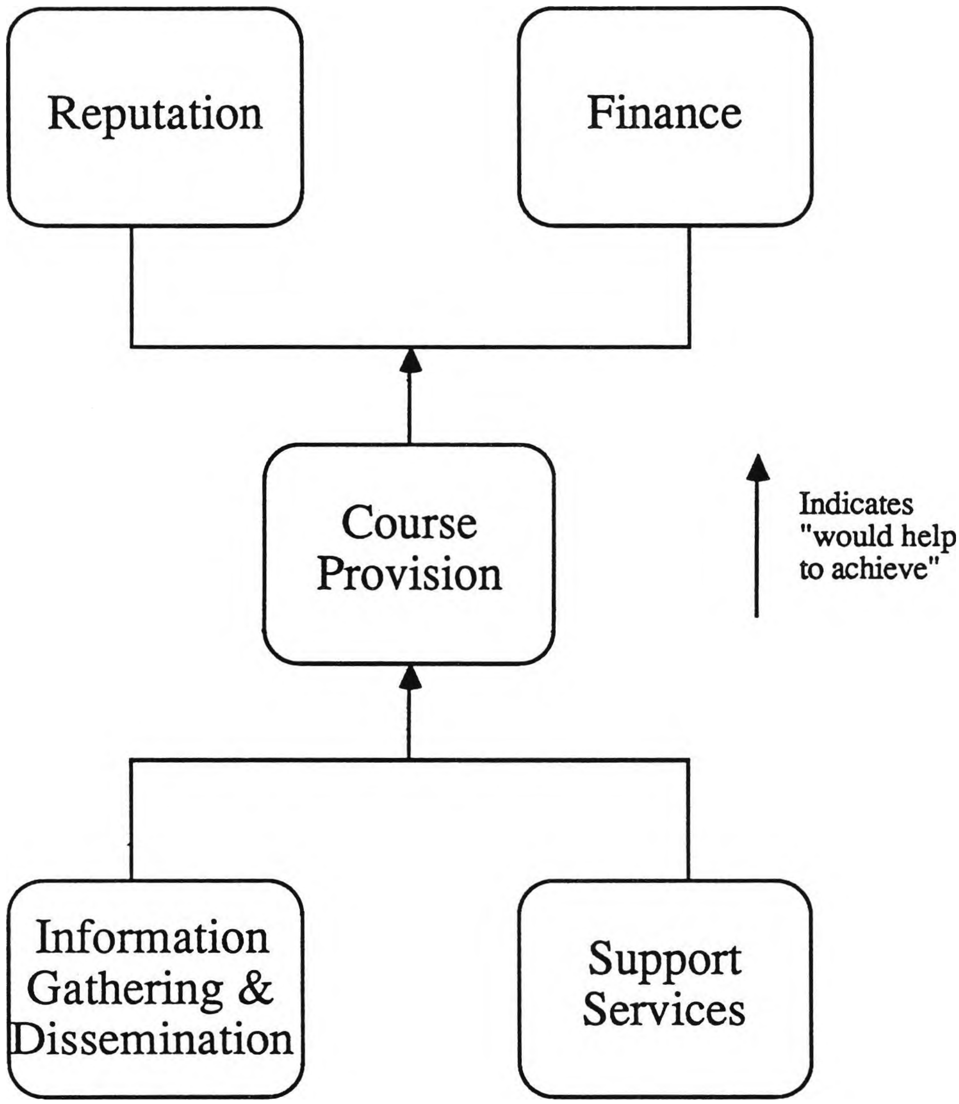


Figure 3 Sub-systems

5. PRODUCTION OF A PRIORITY STRUCTURE

5.1 Method

In order to examine the relative importance of specific elements with regard to each other, computer-aided ISM was used to produce a ranking of a subset of the elements. This was done according to the criterion "is a higher priority than". Thus the questions were phrased by the computer in the form:

IS

13 To provide high quality products and services for clients

A HIGHER PRIORITY THAN

12 To improve the external visibility of the University in the field of Short Courses ?

The elements selected for structuring were determined on the basis that they had resource implications for the SCU. By the term 'resources' was meant money, facilities, staff time and effort. Thus the element '17 To develop a databank of external courses' was included since resources would have to be devoted to accomplishment of this task, whereas the element '4 To meet the training and development needs of employers and employees' was excluded because it was not something directly achievable through the allocation of SCU resources.

Because it was not possible to reconvene the group to produce the Priority Structure, the analysis was carried out by the SCU manager Caroline Leigh, with the help of a facilitator from the IMU.

5.2. Developing a Priority Structure

During the ISM session, 15 elements were prioritised into five levels. The structure was simplified by considering that element 7 'To provide the promotion and advertising knowledge to promote our short course product s'encompassed four other elements, 21, 17, 35, 37. The completed structure is shown in Figure 4. The arrows between the boxes in the figure denote the relation 'is a higher priority than'. Thus '11 To provide an efficient admin. service to enable departments to run short courses' is a higher priority than '13 To provide high quality products and services for clients'. Multiple objectives listed within a box indicate objectives those of equal priority.

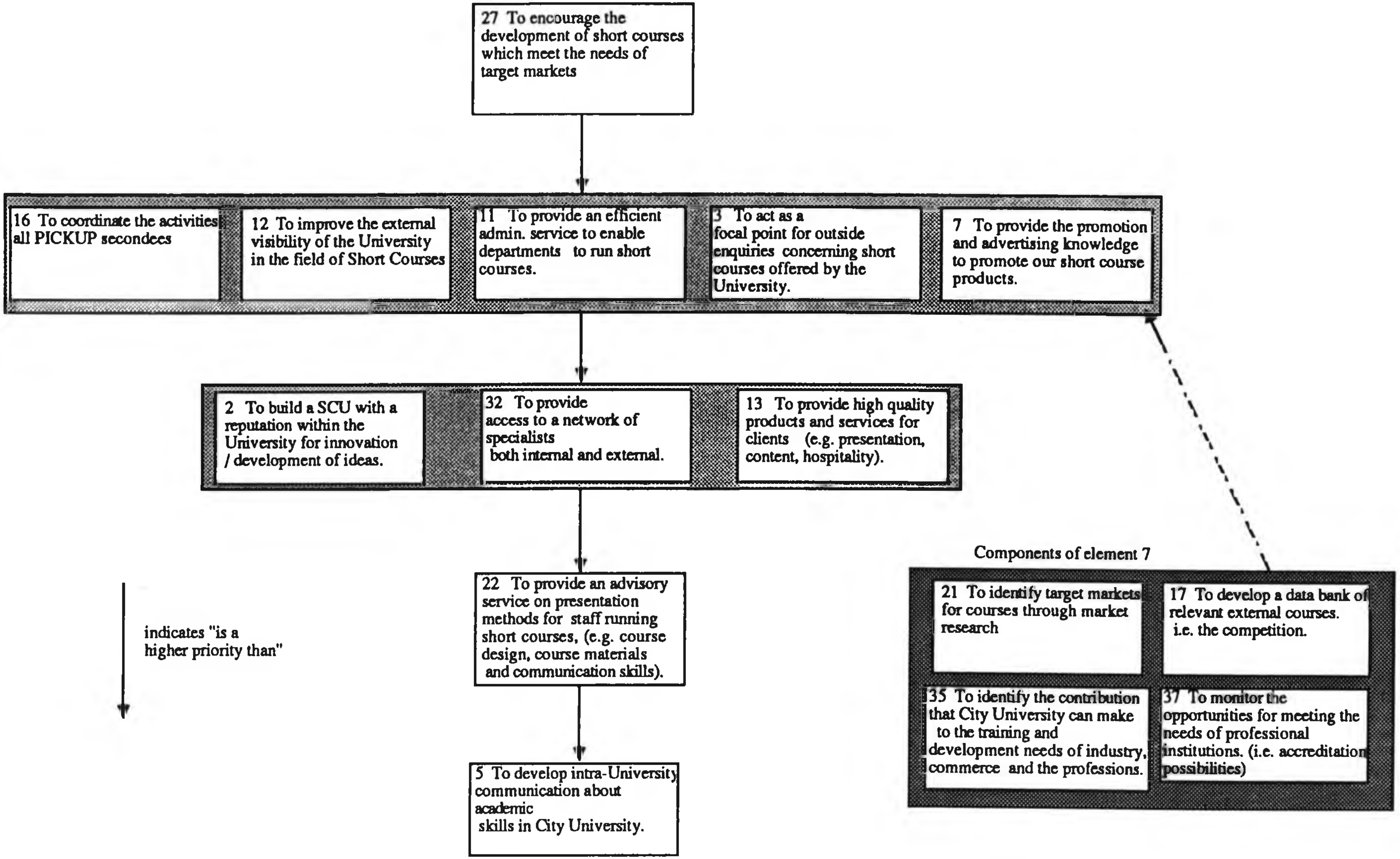


Figure 4 Priority Structure

6. PRELIMINARY INTENT STRUCTURE

Prior to the group workshop, a trial Intent Structure was produced by the Short Course Unit manager, with the help of a facilitator, to map out her initial ideas. The element set was produced using the trigger question "what should the Short Course Unit be trying to achieve over the next 2-3 years", i.e. the same question as was later posed to the workshop group. A total of 10 elements were mapped, and the result is shown in Figure 5.

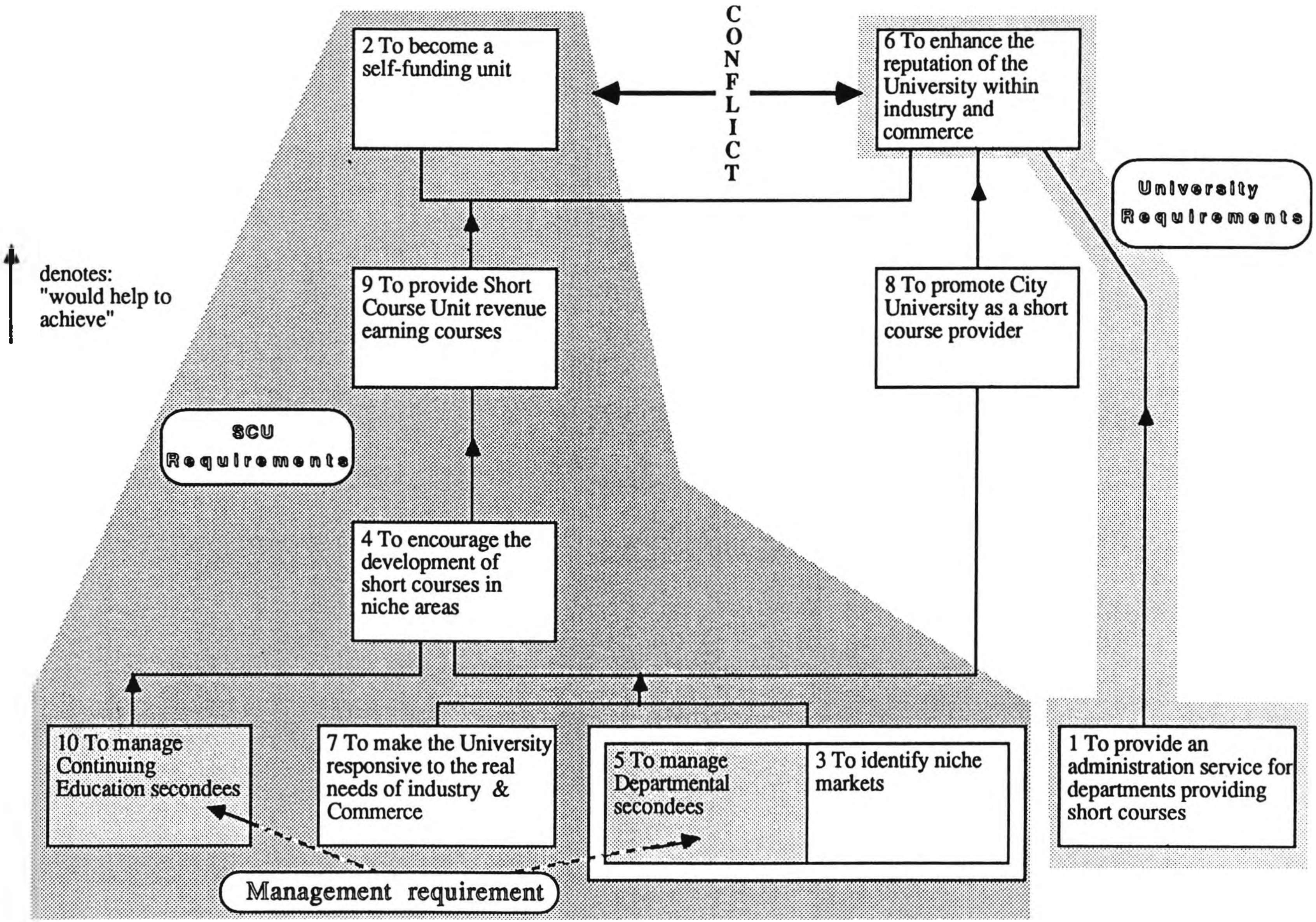


Figure 5 Preliminary Intent Structure

7. PROBLEM AREAS HIGHLIGHTED DURING STUDY

7.1 University Role / Status

There is a problem of identity for the SCU within the University. Departments appear to be unclear regarding the role and services of the Unit. This appears to be for two principal reasons:

7.1.1 **Misinformation regarding PICKUP funding.** A number of Departments appear to understand that the PICKUP support is intended directly to subsidise short courses, i.e.to cover any shortfall and fund activities which initially make losses. Thus it appeared that the funding was a 'pot of gold' that could be tapped at will. The message that the resources are dedicated to providing the infrastructure to support short course activities must therefore be conveyed to all Departments.

7.1.2. **Split purpose.** The initial requirements asked of the SCU are in conflict. These were, firstly, to be self-funding within two years and, secondly, to provide an administrative service for departments wishing to put on short courses. The requirement to be self-funding within a short timescale (two years), requires resources to be concentrated in high profit areas. However to provide the administrative service to departments, charging a management fee low enough to be acceptable, will not bring in sufficient revenue. This conflict is illustrated in Figure 5.

7.2. Unclear Funding/budgeting

The SCU appears to have some difficulty in identifying what resources are available. This should improve as the Unit becomes established. If future planning is to take place, however, it is necessary that the Unit has a budget and can allocate resources in advance.

7.3 Staffing 'Critical Mass'

The future of the Unit depends on the development of short courses which meet the need of target markets, but in order to do this it needs sufficient staff. The Intent Structure produced by the group (Figure 1) illustrates the various tasks that need to be done, and the Priority Structure (Figure 4) shows how a large number of these are of equal importance. It is difficult for one person effectively to :

- Coordinate PICKUP secondees
- Improve the external visibility of CU in the field of short courses
- Provide an efficient administrative service to Departments
- Act as a focal point for enquiries regarding short courses
- Provide the promotion and advertising knowledge to promote our short course products.

8. SUMMARY OF RESULTS OF PLANNING WORKSHOP

The major results of the planning workshop are summarised below:

- An explicit statement by the participant group as to their perceptions of the objectives of the Short Course Unit over the next 2-3 years.

- An Intent Structure, showing the interrelations between the objectives as perceived by the group.

- A Priority Structure, showing the relative importance of a subset of the objectives

- An Intent Structure, showing the objectives of the SCU as perceived by the Short Course Unit Manager.

- A better understanding by those involved in the process as to what the SCU should be trying to achieve.

- A statement of the problem areas identified during the study.

- A basis for future planning for the SCU.

- A report on what occurred and the results of the work for discussion within the University.

SUPPORTING PAPER F

Janes, F.R. (1991). The use of interactive management in designing a Centre for Enterprise Management: intent and priority structures. Research Memorandum No. DSS/FRJ/270, Dept. of Systems Science, City University, London. 26pp.

THE USE OF INTERACTIVE MANAGEMENT IN

BUILDING INTENT AND COMPOSITE PRIORITY STRUCTURES

FOR A CENTRE FOR ENTERPRISE MANAGEMENT

F.R.Janes

Interactive Management Unit
Department of Systems Science
City University
Northampton Square
London
EC1V 0HB

Research Memorandum No. DSS/FRJ/270 April 1991

CONTENTS

Abbreviations

CEM: Centre for Enterprise Management

CU: City University

DSS: Department of Systems Science

IM: Interactive Management

ISM: Interpretive Structural Modelling

NGT: Nominal Group Technique

1. SUMMARY

This research memorandum is a report on the use of the methodology of Interactive Management in helping a group of participants to design a Centre for Enterprise Management. The sequence of methods employed is explained and the resulting products are described. Ideawriting was used to identify the requisiste activities to achieve a viable centre. Nominal Group Technique (NGT) was then employed to generate possible objectives for the centre. This was followed by two Interpretive Structural Modelling (ISM) sessions, first to build an intent structure and then to set priorities for the centre.

The process of building two new types of priority structure, a composite priority structure and a composite aligned priority structure, is explained. The latter may be redrawn as a conventional linear priority structure. Prior to using ISM as a group to build the intent structure, each of the participants constructed an individual intent structure based on the same subset of objectives. Consensus and disagreement subgraphs for these individual models are used to illustrate the kind of differences in views which the ISM process helps to resolve.

2 INTRODUCTION

In 1989, a proposal to establish a Centre for Enterprise Management (CEM) was put forward by the then Professor of Engineering Management, D.K.Hitchins. The centre would principally supply services to aid ailing enterprises and would be able to focus university skills and research capability on such enterprises. It would draw upon the talents of the university's Department of Systems Science, School of Engineering and Business School and be self-funding. The founder member of the centre would be the Interactive Management Unit which would support the activities of the other four proposed units concerned with: audits and appraisals, tools and techniques, organisation and human factors, and the business surgery. The design of the centre is described in a paper by Hitchins, Janes et al (1989). As part of the design process, a planning workshop was held to develop the concept of the centre. A summary of the results of this workshop is given in the paper.

The purpose of this research memorandum is to describe the interactive management work in more detail as it involved a number of interesting and novel features. One of these concerns the construction of two new types of priority structure. The other concerns the use of subgraphs to show the commonality and disagreement between participants based on intent structures constructed by them individually.

The workshop took the form of one meeting a week for four weeks and amounted to a total of two and half days of group work (Appendix A). Table 1 gives the sequence of group activities undertaken, including the use of formal group methods and the products resulting from those activities.

Activity / method		Product
Ideawriting	→	Requisite activities
Nominal Group Technique	→	Objectives
Interpretive Structural Modelling	→	Intent structure
Group discussion	→	Sub-groupings in intent structure
Idea categorisation	→	Categorised objectives
Interpretive Structural Modelling	→	Composite priority structure
Group discussion	→	Composite aligned priority structure
Re-display	→	Linear priority structure
Group work	→	Mission statement

Table 1. Sequence of group activities and resulting products

3 REQUISITE ACTIVITIES

The first meeting involved the use of Ideawriting (Warfield, 1982; Moore, 1987) to address the issue of the future viability of the centre. The participants were asked to respond to the trigger question "What are the requisite activities to achieve a viable Centre for Enterprise Management?" The steps of the method and the complete list of 84 ideas generated and clustered into eight categories are given in Appendix C. The category headings, number of ideas in each category and examples of the ideas are shown below.

Objectives (15)

- Specify CEM objectives.
- Establish a clear mission statement.

Business Plan (5)

- Produce a business plan showing the realisation of CEM.
- Consider under what conditions CEM is viable/non-viable.

Funding (10)

- Identify sources of finance.
- Obtain resources for manpower and facilities.

Facilities (5)

- Determine physical resources available, e.g., equipment, location.
- Determine location of CEM.

Personnel (12)

- Prepare list of willing/interested staff and their skills.
- Provide incentives to attract involvement of academic staff, e.g., financial or research opportunities.

Research (5)

- Establish research character/objectives.
- Describe research capabilities that can be sold as services.

Management (13)

- Agree organisational structure.
- Obtain agreement of university to function.

Marketing (19)

- Establish CEM's unique selling points.
- Conduct market research into clients and functions.

On completion of the Ideawriting steps, the participants identified those activities they considered to be urgent and those they considered to be important. The activities were labelled accordingly with some appearing in both categories (Appendix C).

4 OBJECTIVES

At the second meeting, a list of possible objectives for the centre was generated and clarified using Nominal Group Technique (Delbecq et al, 1975). The trigger question chosen for this purpose was "What should the Centre for Enterprise Management be trying to achieve over the next two to three years?" The steps of the method and the complete set of ideas generated are given in Appendix D. The first ten of the 41 objectives remaining after clarification and editing are listed below. These were the ten used by the participants in constructing individual intent structures as described in Section 6 of this research memorandum.

1. To become recognised as a centre of excellence.

2. To become self-funding.

3. To exploit the university ethos (e.g., credibility and objectivity).

4. To provide a direct link between external enterprises and the Department of Systems Science.

5. To practice participative management.

6. To grow to a self-sustaining size (i.e., with regard to staff and turnover).

7. To operate to commercial disciplines.

8. To generate income for the university and the Department of Systems Science.

9. To attract research grants and contracts.

10. To become market-led.

5 INTENT STRUCTURE

5.1 Group Intent Structure

In order to examine the interrelations between the objectives, Interpretive Structural Modelling (Warfield, 1976; Janes 1988) was used at the third meeting to build an intent structure (Warfield, 1973). In the time available, 21 of the objectives were selected for structuring on a basis of the NGT voting scores and incorporated into the model. This is shown in Figure 1. It was possible to identify four clusters of sub-groupings of objectives concerned with: long-term goals, products and services, attracting resources, and internal objectives. These are shown as the four labelled, shaded blocks.

In the figure, an arrow denotes the contextual relation "would help to achieve". As with all ISM's, the contextual relation is transitive, which implies that any given objective helps to achieve any other objective which it reaches along a path of one or more edges. Thus, for example, objective 14 helps to achieve objectives 13, 29 and 17, as well as all the objectives above 17. The two objectives 21 and 25 are in a cycle, which denotes that they mutually help to achieve one another.

Interpretation of the figure may be further clarified by taking any specific objective and considering what items reach it from below. These indicate how that objective might be achieved. Conversely, consideration of the items above any particular objective, which are reached from that objective, indicate why that objective is being sought (Warfield, 1976, Ch. 15). These two sets of items could be labelled respectively the "hows" and the "whys" for any given objective.

The three meetings which had been held by this stage, involving Ideawriting, NGT and the production of an intent structure, had indicated to the participants the magnitude of the task faced in building such a centre. A collective view was forming as to the purpose of the centre and on what needed to be done, helping to forge a sense of team spirit and commitment to the project. The structured discussion and argument during the NGT and ISM sessions had helped to clarify thinking, to reduce misunderstanding and to break down any initial apprehension regarding motives and hidden agendas.

5.2 Individual Intent Structures

The way in which the structured discussion and argument, which is an inherent part of the ISM process, helps to move participants towards a shared perception of a situation was explicitly demonstrated during the workshop.

Prior to the construction of the above group intent structure, each participant was asked to use ISM independently to construct an individual intent structure based on the first ten objectives. As can be seen in Figures 2a, b, c and d, each of these is different, indicating the various perceptions that the four individuals had initially of the interrelations between the objectives. Figure 2e is extracted from the final structure (Figure 1) and shows how

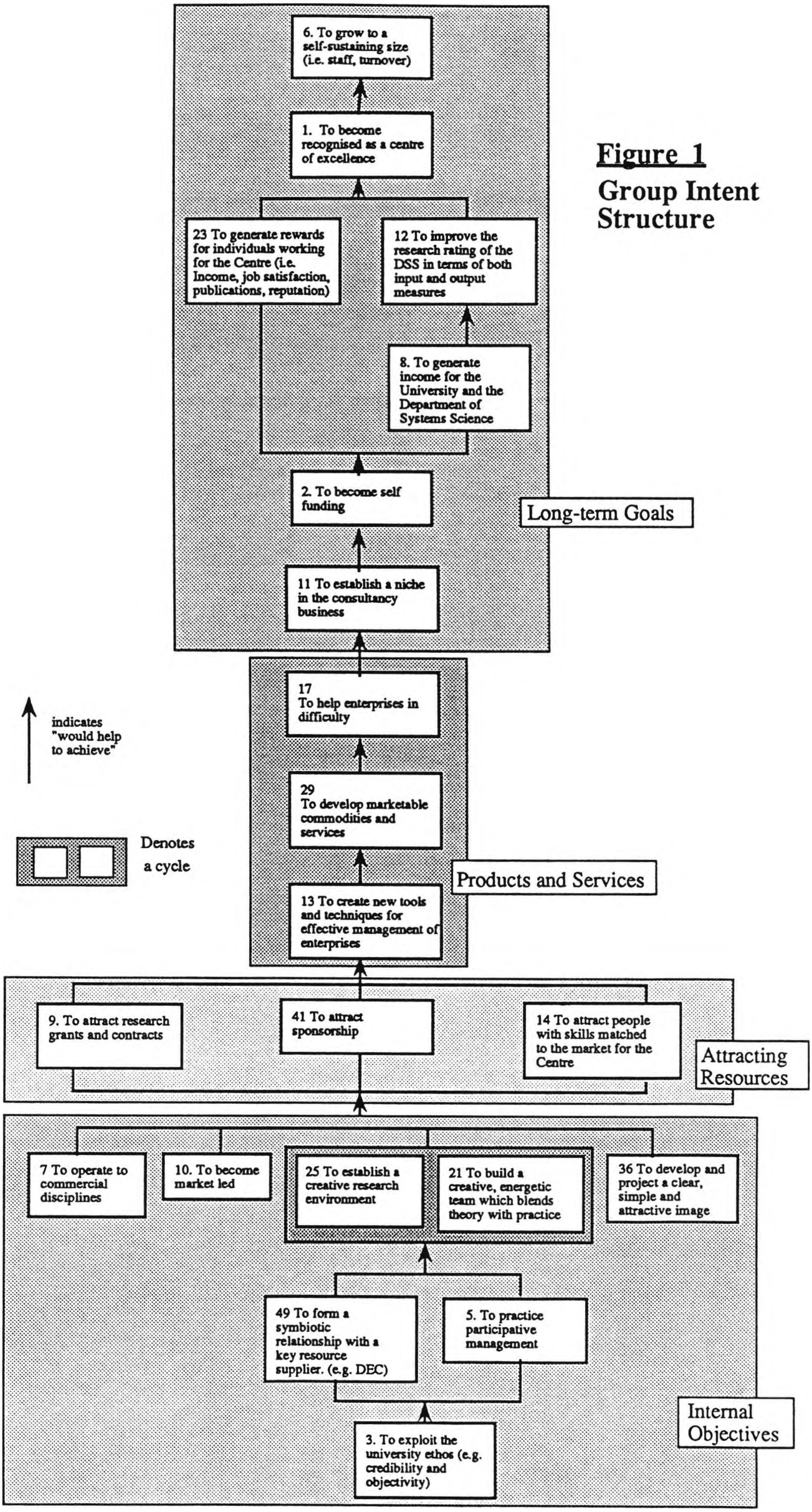


Figure 1
Group Intent Structure

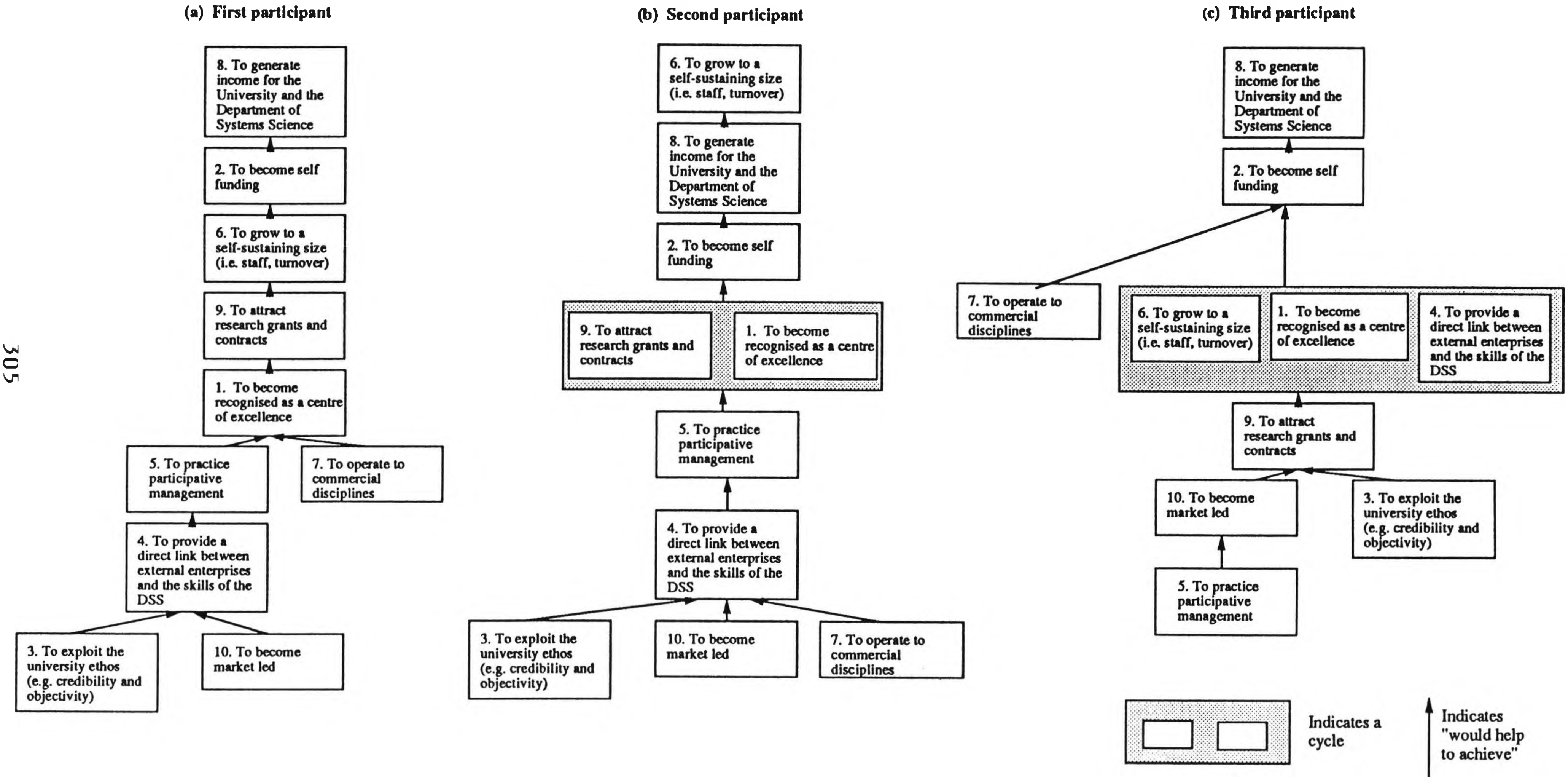


Figure 2 Individual intent structures

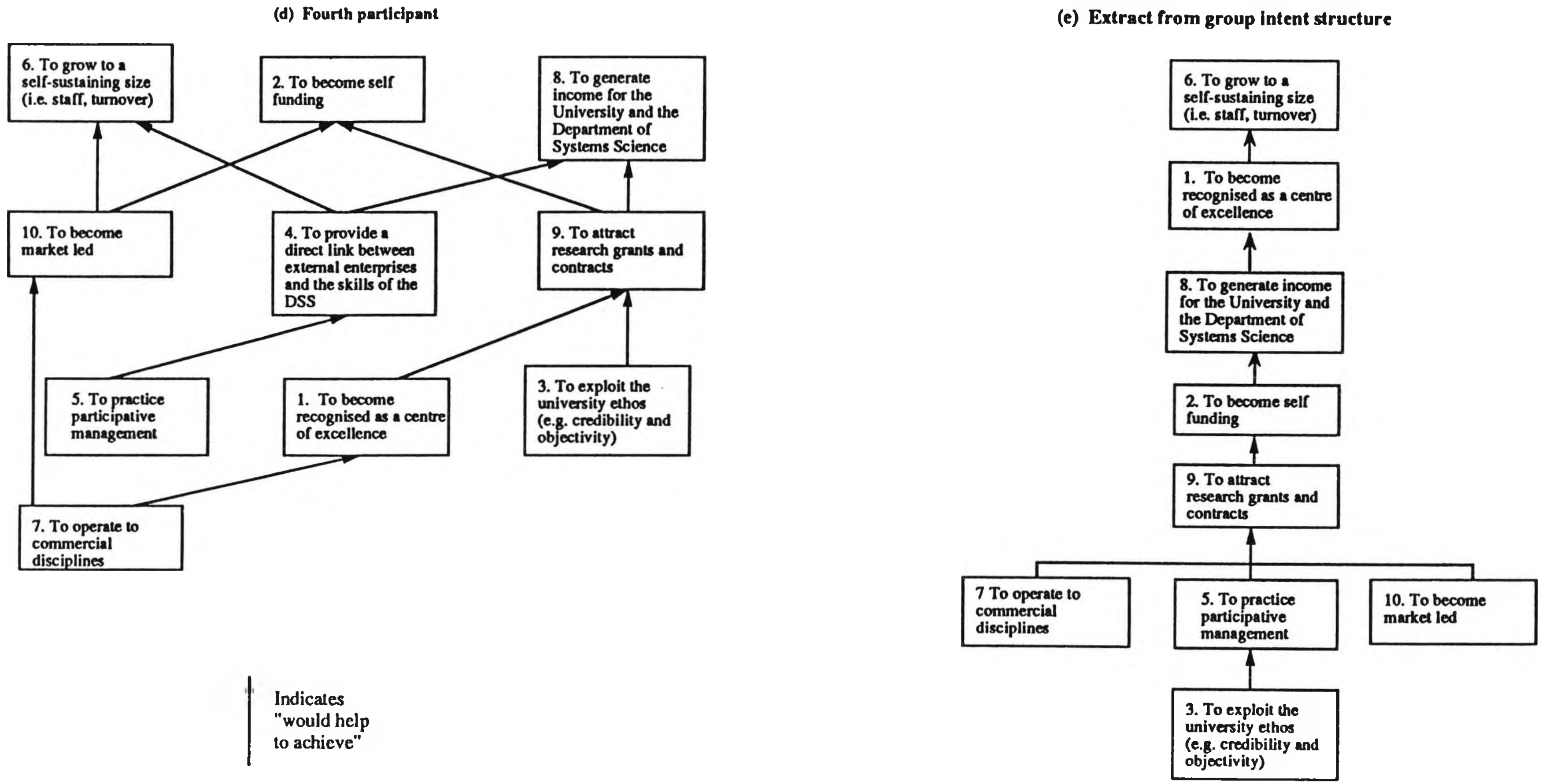


Figure 2 (cont.) Individual intent structures the participants structured the same objectives when working as a group. It should be noted that Figure 2e does not contain objective No.4 as this was not included in the final group intent structure.

5.2.1 Analysis of structures

An analysis in terms of digraphs may be used to illustrate the kind of differences in views which may be resolved through the use of ISM. Figure 3a shows the relations that are common to all of the individual intent structures (Figures 2a, b, c, d), developed by the four individuals. Waller (1979) has described a digraph which shows adjacency relations, where there is agreement on the part of two groups building separate models using ISM, as a "consensus subgraph". This term would appear to apply equally well to Figure 3a, based upon the work of four individuals rather than of two groups. The figure has three levels and contains 15 "walks", excluding trivial walks of length 0. (A walk is defined as a directed path on a digraph with an origin and a termination consisting of elements of the digraph. The total number of non-trivial walks may be calculated by determining the number of succedents for all the elements of the digraph and subtracting the number of elements (Warfield, 1980a).) In this case, the walks are largely composed of adjacency relations between two levels.

If a similar consensus subgraph is constructed for Figures 2a, b and c only, i.e., excluding the fourth participant, the commonality is much greater, as shown in Figure 3b. In comparison, this figure contains 30 walks and has five levels. The extent of agreement between these three participants would thus appear to have been considerably greater than that shown between all four. A "disagreement subgraph" (Waller, 1979) may also be constructed to show the contradictions in perceptions between these three participants (Figure 3c). Thus, for example, two participants thought that element No.6 related to element No.2 and not vice versa, whereas one participant thought that 2 related to 6 and not vice versa. Figure 3d shows the changes, in the form of added or deleted relations, which have to be made to Figure 3b to convert it into a digraph corresponding to the group mini-intent structure in Figure 2e. It should be noted that Figure 3d does not contain element No.4 for the reason stated above in Section 5.2, and that it would have to be redrawn with the deletion of transitive links to appear in the form of Figure 2e.

5.2.2 Resolving differences

During an ISM session, the differences in views held by the various participants, about whether a particular relation between a pair of elements exists or not, will be made explicit. A skilled facilitator should try to ensure that the arguments presented in response to the questions put by the computer are as productive as possible, so that each participant may learn from the views of others. In addition, the ISM process frequently focuses attention on the need for further clarification of the meanings of elements when it transpires that participants are interpreting some of them in different ways. Indeed, the capacity of individuals to attribute different meanings to the same concise statement

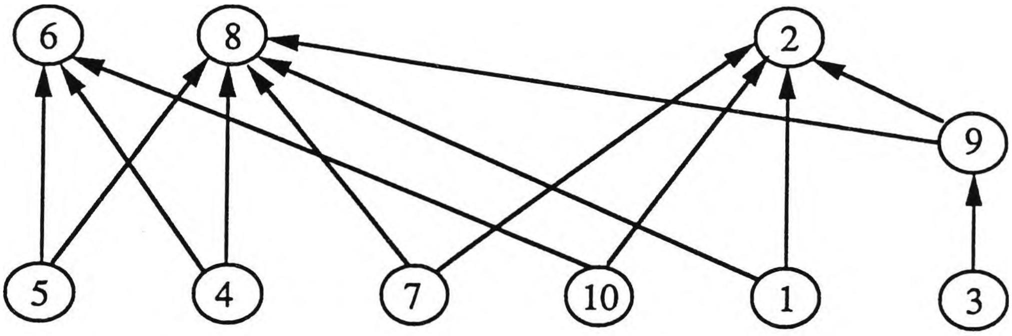


Figure 3a Consensus subgraph for Figures 2 a,b,c,d

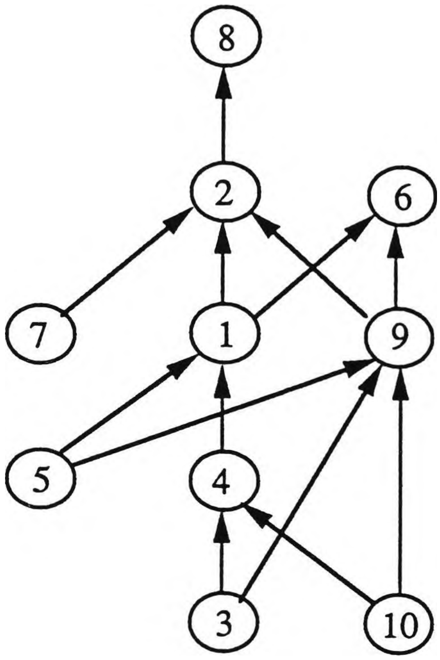


Figure 3 b Consensus subgraph for Figures 2 a,b,c

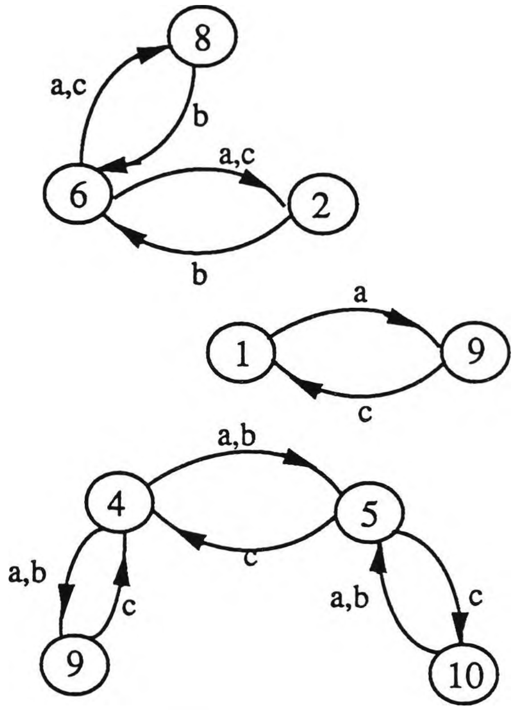
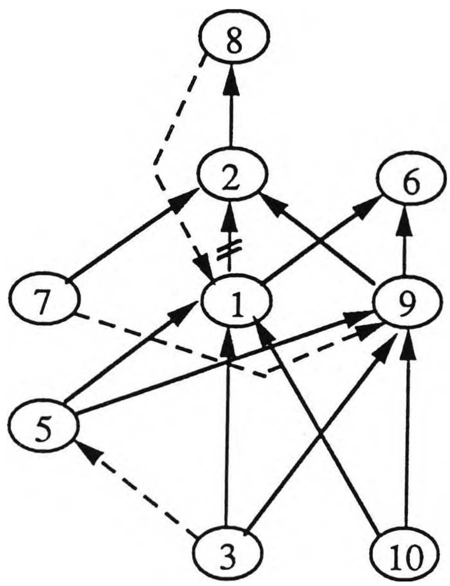


Figure 3c Disagreement subgraph for Figures 2 a,b,c



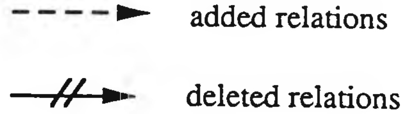


Figure 3 d Conversion of 3b into 2e

Figure 3 Subgraphs

constituting an element, is one of the features that a facilitator using these methods cannot help observing. This is despite the considerable discussion that takes place during the NGT clarification step, where great efforts are made to minimise ambiguity and to ensure that participants are agreed on the interpretation of the various elements.

In this workshop, the four participants were all agreed that the final group intent structure (Figure 1) was acceptable to them. Each had been prepared to listen to the views of others and to shift his position in the light of explanations and arguments put forward. In addition, further clarification of various elements took place, when it emerged that overlapping but different interpretations were still evident regarding some elements. For example, whether "centre of excellence" (element No.1) referred to a specific designation by the Research Councils alone, or more broadly to the views of clients, the university and peer groups generally. Similarly, the terms "self-funding" (No.2) and "participative management" (No.5) were being interpreted ambiguously and needed further clarification.

The analysis of individual intent structures in terms of subgraphs has illustrated a way of making explicit the areas of agreement and disagreement between individuals. It shows the kind of differences in views which ISM may help participants to resolve through structured discussion and argument.

6 SETTING PRIORITIES

ISM was used again at the fourth meeting, this time to set priorities between the objectives. To accomplish this, the objectives were initially clustered into categories and what will be termed here a "composite priority structure" was created by prioritising the objectives within categories. This composite priority structure was then converted into a linear priority structure.

6.1 Objective Categories

The group used a method to categorise the 41 objectives which did not predetermine the category headings. The objectives were taken one by one by the facilitator and displayed in turn to the participants who built up clusters of items having perceived commonality and distinction. The clusters were then given descriptive headings which expressed a common theme displayed by each cluster. Finally, all the ideas in each cluster were checked for consistency with the relevant heading. The method provides a relatively quick way of helping a group of people to agree on the categorisation of a large number of items. In this case it took under one hour. Nine categories were identified as shown below.

A. Job satisfaction.

B. Human resources.

C. Enabling linkages.

D. Intellectual reputation.

E. Sources of revenue.

F. Operational style.

G. Products and services.

H. Mission components.

I. External image.

6.2 Composite Priority Structure

The first stage in building the composite priority structure was to set priorities between the nine category headings using the ISM software. Then, priorities were set between the objectives within each category. In the four cases where there were groupings containing five or more objectives, the computer software was used. In the five other cases, where there were groupings of only three or four objectives, the priorities were set by hand; the latter was accomplished without difficulty given the small number of participants. The process thus involved a total of ten short priority setting sessions, five with the aid of the ISM software and five without. During the process, some minor iterations of previous decisions took place. For example, two of the objectives were absorbed within others, and three items were reallocated to different categories. The composite priority structure thus contained 39 objectives prioritised within nine categories and is shown in Figure 4.

There appear to be two advantages of proceeding in this way when setting priorities, as against attempting to prioritise all the objectives directly into one linear structure. First, it is generally easier to set priorities between items which relate to the same topic or theme, as when the objectives are clustered into a category, than it is to prioritise completely dissimilar items. This is particularly so when the priorities are being set, not by an individual, but by a number of people in a group who may have very different views on what is, or is not, important. Second, constructing a linear priority structure with a large number of items using ISM is a lengthy process. It may take several hours, involving a long series of questions put by the computer, which may become both tiring and tedious for the participants. Proceeding towards a composite priority structure, which involves a series of mini-ISM sessions, including group discussions of the resulting priority structures within categories, is a much more varied process. This helps to avoid the monotony which may occur when constructing a single linear structure.

As a product, the final format of a composite priority structure has the benefit of displaying within categories the priorities between items. This information regarding groupings of items within categories is not present in a linear priority structure.

6.3 Composite Aligned Priority Structure

A composite priority structure is helpful to decision makers, for example, with regard to

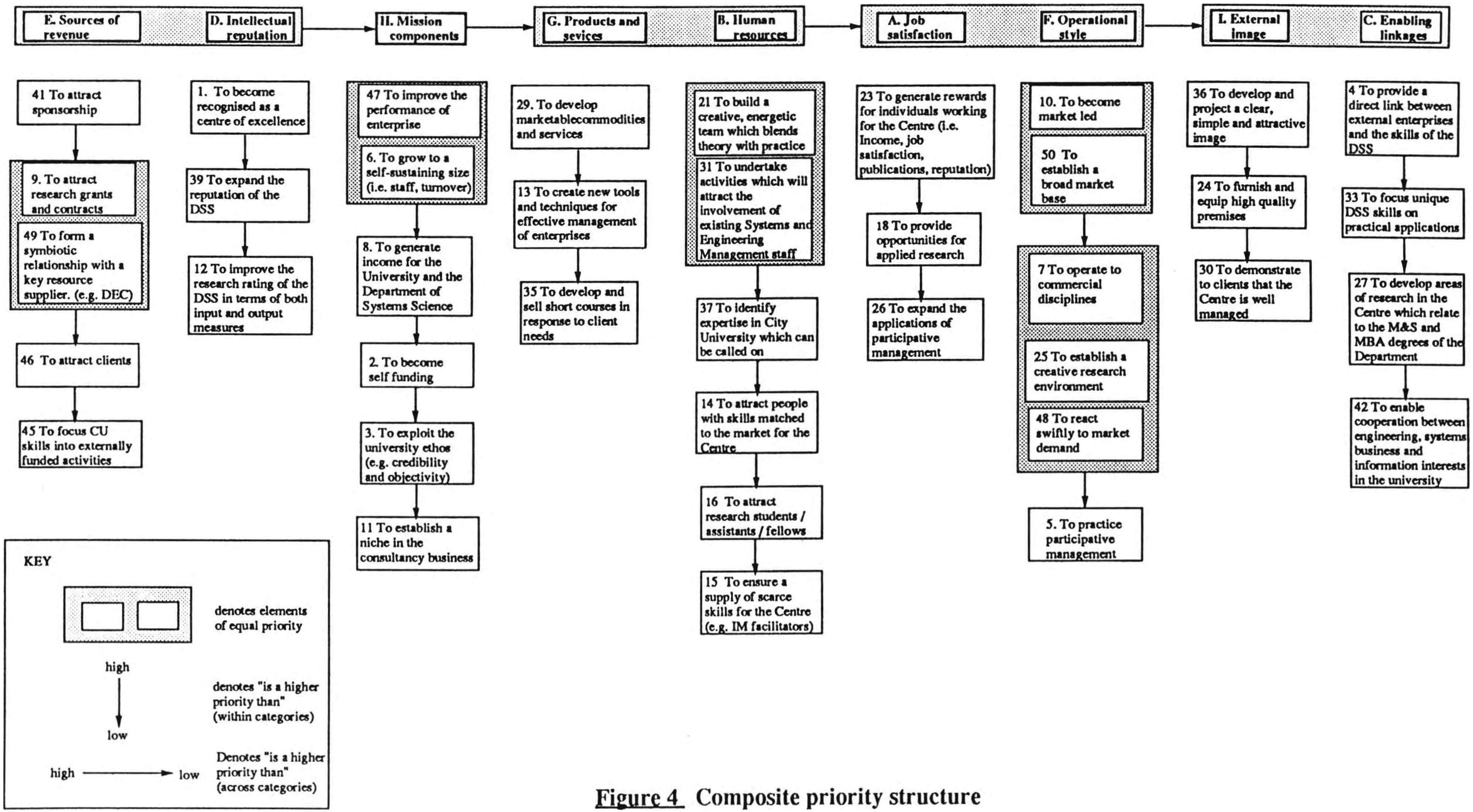


Figure 4 Composite priority structure

decisions about where human and financial resources might most effectively be allocated. However, whilst it gives a useful picture of the general pattern of priorities, it would not be sensible to interpret it as rigidly transitive in all respects. Thus, although in Figure 4 priorities have been set between the category headings themselves and between the objectives within each category, it should not necessarily be inferred that the bottom item in one category is more important than the top item in a category of lower importance; for example, that objective No.15, at the bottom of the "Human Resources" category, is a higher priority than objective No.23, at the top of the "Job Satisfaction" category.

In order to clarify the priorities further, the intention in this workshop was to convert the composite structure into a more conventional linear priority structure. The latter would remove any ambiguity about the relative priorities of objectives located in different categories, whilst the former would retain the useful information regarding priorities between categories.

To achieve this, the composite structure was re-displayed, taking into account the priorities already set between the category headings. The nine headings had been prioritised into five ranks in Figure 4 with E and D at the top and I and C at the bottom. To construct Figure 5, the top objective in category E (No.41) was placed at level one, with the other objectives in E listed appropriately below it; similarly for category D. Category heading H, which had been ranked second in Figure 4, had its top objective (No.47) placed at level two; whilst categories G and B, which had both been ranked third, had their top objectives (Nos.29 and 21) placed at level three. This procedure was repeated for the remaining categories. The position and spread of the objectives within categories, but not their sequence, was then adjusted by the participants after discussion of the relative priorities as they appeared across the levels. The resulting Figure 5 shows the 39 objectives aligned over eight levels of priority. To distinguish it from the composite priority structure of Figure 4, this figure is here called a "composite aligned priority structure".

Figure 5 may be redrawn in the form of a conventional linear priority structure as shown in Figure 6. This shows all 39 objectives distributed over the eight levels, but loses the information about categories.

6.4 Comments on the Structures

In terms of rigorous definitions of priority structures, the composite priority structure of Figure 4 does not conform to any of the three structural forms: linear hierarchy, linear mixed structure, or nonlinear regular hierarchy, defined by Warfield (1980b) as the forms which priority structures can take. The individual priority structures within the categories of Figure 4 do, however, constitute either linear hierarchies or linear mixed structures. Figure 6 is also an example of a linear mixed structure.

Two advantages of constructing a composite priority structure were mentioned in Section

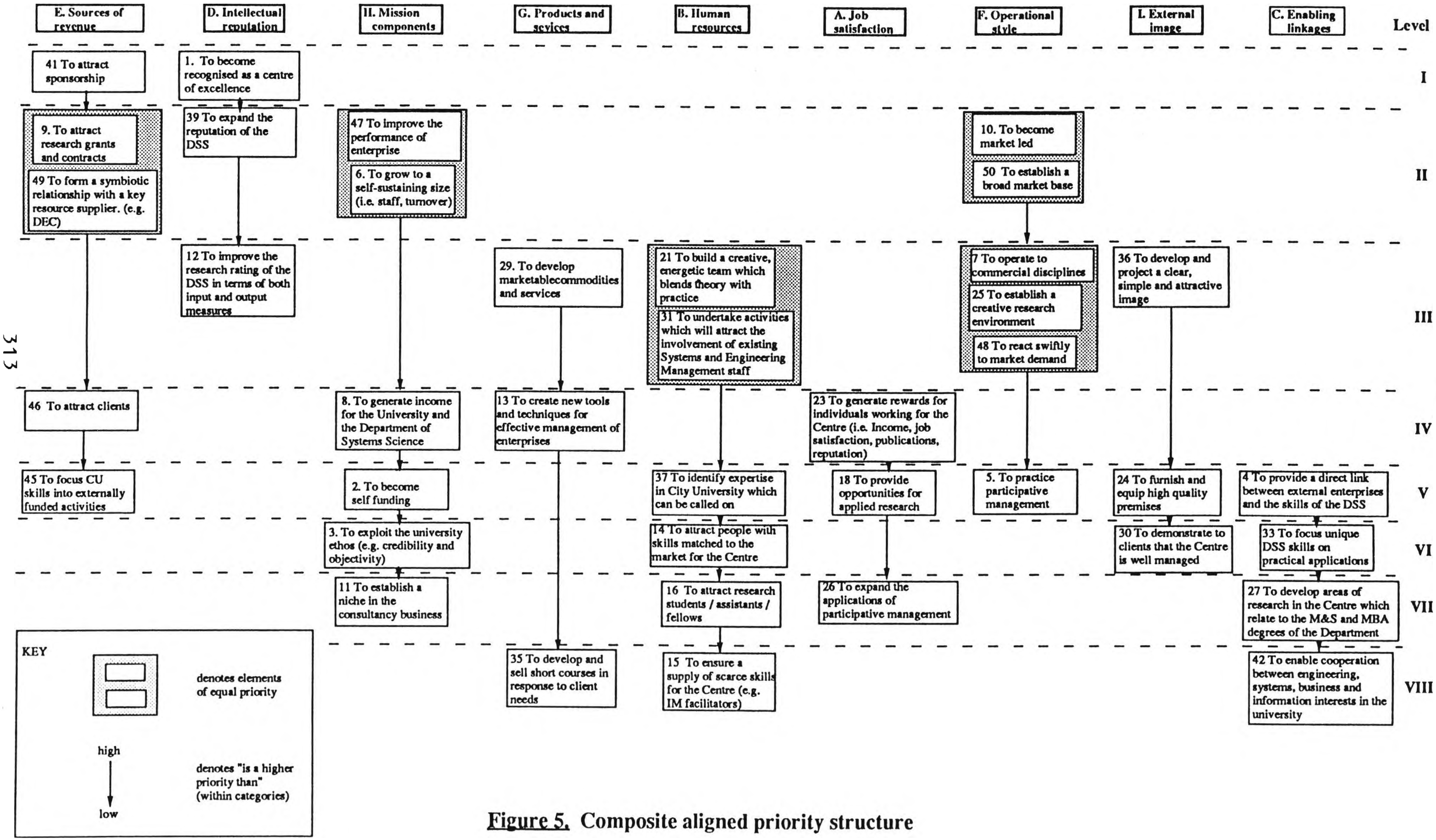
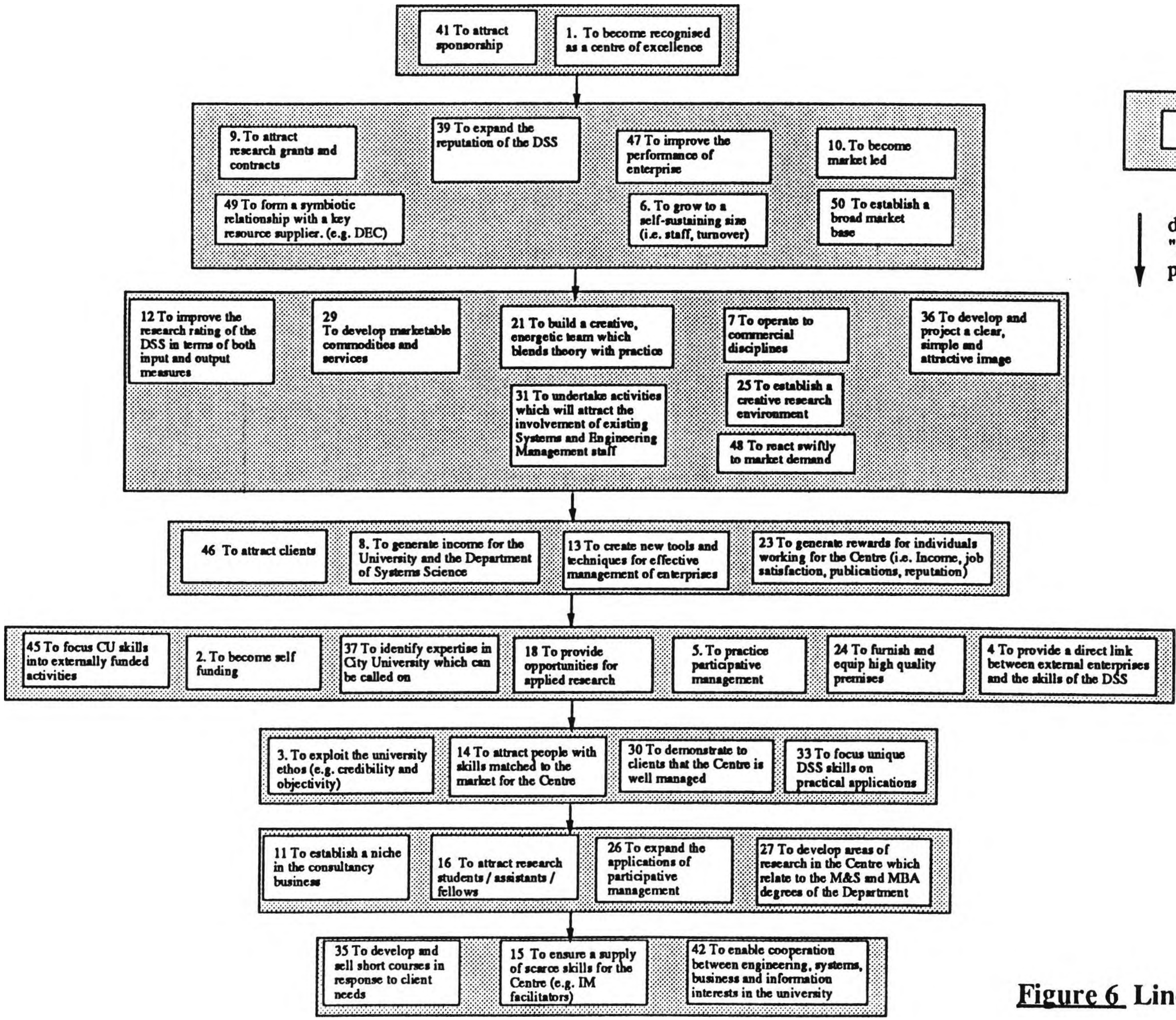


Figure 5. Composite aligned priority structure



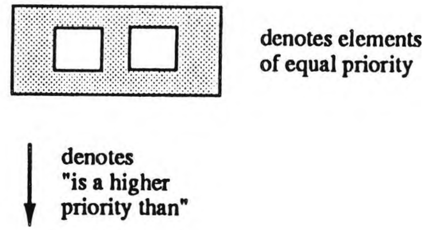


Figure 6 **Linear priority structure**

6.2. In the author's experience, it is also the case that managers find such structures of practical value within their organisations. The fact that priorities cannot be read across the levels in Figure 4 is a disadvantage, but the more conventional Figure 6 has the disadvantage of losing the category information. Figure 5, the composite aligned priority structure, overcomes both these shortcomings.

7. MISSION STATEMENT

Drawing upon the information contained in the intent and priority structures, the participants concluded the workshop by writing a mission statement for the centre. This was as follows:

> "To Advance Effective Management of Enterprise:
>
> through applying unique university skills and tools to the improvement of enterprise performance and, in so doing, establish a self-funding research and consultancy business within the university".

8. CONCLUSIONS

Interactive Management has been successfully used here to assist a group of participants in the process of designing a Centre for Enterprise Management. The sequence of methods employed during the planning workshop enabled participants to work together efficiently and effectively in identifying requisite activities and objectives, in building an intent structure and in setting priorities for the centre.

The priority setting involved the construction of two new types of priority structure, called here a composite priority structure and a composite aligned priority structure. Neither of these fits into the accepted classification of such structures, but each has advantages over a conventional linear priority structure.

In between two of the formal workshop sessions, the opportunity was taken to ask each of the participants to build their own individual intent structures using the same subset of objectives. These individual structures are compared with the relevant part of the intent structure later produced by the group. The comparison illustrates the way in which ISM enables individuals with different perceptions of a situation to move towards a common view on the way in which a set of elements, in this case objectives, interrelate. Consensus and disagreement subgraphs have been used to illustrate the sort of differences in views which ISM helps to resolve.

One interesting area for future research would be to explore the ways in which such consensus and disagreement subgraphs could be incorporated into the ISM process. For example, individuals could construct their own models using ISM based on a specified set of elements. With appropriate computer software, which would have to be written, such subgraphs could then be used to identify commonalities and differences in the individual models. The points of difference could then form a focus for debate.

9. REFERENCES

Delbecq, A.L., Van de Ven, A.H. and Gustafson, D.H. (1975) Group Techniques for Program Planning: a Guide to Nominal Group and Delphi Processes. Glenview, Illinois: Scott, Foresman & Co.

Hitchins, D.K., Janes, F.R., Jeffery, R. and Hammer, K. (1989) Designing a Centre for Enterprise Management. Proceedings IEE Management and Design Division Discussion Meeting on Systems Engineering and its Interrelationships with Academic/Industrial Collaboration. University of Strathclyde, July, 1989, 1-22.

Janes, F.R. (1988) Interpretive structural modelling: a methodology for structuring complex issues. Trans. Inst. Meas. & Cont. 10 (3), 145-154.

Moore, C.M. (1987) Group Techniques for Idea Building. Newbury Park, California: Sage Publications.

Warfield, J.N. (1973) Intent structures. IEEE Trans. Sys. Man Cybern., SMC-3 (2), 133-140.

Warfield, J.N. (1976) Societal Systems: Planning, Policy and Complexity. New York: Wiley. (Reprint ed., Salinas, California: Intersystems, 1989).

Warfield, J.N. (1980a) Complementary relations and map reading. IEEE Trans. Sys. Man Cybern., SMC-10 (6), 285-291.

Warfield, J.N. (1980b) Priority structures. IEEE Trans. Sys. Man Cybern., SMC-10 (10), 642-645.

Warfield, J.N. (1982) Organisations and systems learning. General Systems, 27, 5-74.

Waller, R.J. (1979) Comparing and combining structural models of complex systems. IEEE Trans. Syst. Man Cybern., SMC-9 (9), 580-586.

SUPPORTING PAPER G

Janes, F.R. (1987a). Applications of interactive management in planning for engineering education. In Problems of Constancy and Change. 31st Annual Meeting of the International Society for General Systems Research, Budapest, June, 1987. Vol.1, 520-525.

APPLICATIONS OF INTERACTIVE MANAGEMENT IN PLANNING FOR ENGINEERING EDUCATION*

F.R.Janes

Department of Systems Science
City University
London, England

KEY WORDS

Interactive Management, Ideawriting,
Nominal Group Technique, Interpretive Structural Modelling

ABSTRACT

This paper reports on the application of three interactive methods for idea generation and idea structuring. They were used by a group of faculty from various engineering disciplines in a project concerned with planning for the future of engineering education. Section 1 gives the background to the project. Section 2 presents the results of the first working meetings of the participant groups where the idea-generation method, Ideawriting, was used to consider the reasons why people should plan for the future of engineering education. Section 3 covers the results of meetings in which participants considered the topics they thought should be included in a plan for the future of engineering education. Here, a second idea-generation method, Nominal Group Technique, was used to generate, clarify, edit and rank a list of topics which should be included in such a plan. A computer-assisted method, Interpretive Structural Modelling, was then used to structure the topics and show their interdependence. An interpretation is given of the structure produced. Section 4 reports on sessions held to examine issues related to computers and the future of engineering education. Again the participants used Nominal Group Technique and Interpretive Structural Modelling to generate and structure the issues. It is concluded that the three methods used provided a powerful process of inquiry in the Interactive Management framework for investigating the structure of complex problems.

* This paper was presented in a shortened form at the 31st Annual Meeting of the International Society for General Systems Research. In **Problems of Constancy and Change, Vol.1,** 31st Annual Meeting ISGSR, Budapest, Hungary, June, 1987, pp 520-525.

1. INTRODUCTION

A number of faculty at the School of Engineering and Applied Science at the University of Virginia participated in a series of meetings concerned with the future of engineering education. The intention was to use interactive group methods to provide an opportunity for faculty from various disciplines to engage in planning for the long-term future of engineering education. The project was intended to look at such education in a national U.S. context rather than being focussed upon any particular institution.

Participants were involved in the use of a combination of idea-generation and idea-structuring methods which form part of a framework for Interactive Management (1,2) developed by the Centre for Interactive Management at the University of Virginia. The Centre's Situation Room provided the physical facilities and computer support for the group meetings. The work involved a total of some 20 faculty who participated, at various stages of the project, in a series of six meetings run over a period of seven weeks. The author was responsible for organising the project and acted as facilitator, taking participants through the steps of the various group processes used.

2. EXAMINING THE NEED FOR PLANNING

Initially, the participants were split into groups and asked to take part in a process known as Ideawriting (or Brainwriting), a method for the generation of ideas by groups (3,4). The version used involves the following steps:

(i) Clarification of a trigger question.
(ii) Silent generation of ideas in writing by each participant.
(iii) Exchange of lists of ideas and continuation of idea-generation.
(iv) Classification and editing of the resulting ideas.
(v) Presentation of the ideas.

The trigger question was designed to encourage the group to think about the need for planning in engineering education (5,6). It was:

> 'Why should people plan for the future of engineering education?'

Steps (i) to (iii) were undertaken by the respective groups under the guidance of a facilitator, whilst steps (iv) and (v) were done by the author. Given below are the headings under which the 192 ideas generated were classified, together with some abridged examples of the ideas under the first heading 'Educating for the Future'. The numbers in brackets denote the number of ideas generated in each category and are given to demonstrate the high productivity of Ideawriting as a group process.

EDUCATING FOR THE FUTURE (Total 34 ideas)

National Needs (11)
- To produce innovative engineers capable of responding to international challenges.
- To enhance the technological base of the country.

Technological And Social Change (15)
- To prepare people for the increasing complexity of technology.
- To prepare people for increasing technological and social change with its associated opportunities and problems.
- To produce adaptable graduates prepared for career changes.

Educating Leaders (4)
- To educate leaders for a technology-oriented society.

Better Problem Solving And Design (4)
- To produce better problem solvers.
- To educate engineers to produce designs which conserve resources.

PLANNING (33)

Plan Or Be Planned For (8)
The Need For Planning (20)
Achieving Goals (5)

RESOURCES (38)

Identifying Resource Needs (4)
Obtaining Resources (7)
Competition For Resources (9)
Efficient Use Of Resources (18)

LEARNING PROCESSES AND EDUCATIONAL CONTENT (41)

Learning Processes (10)
Broadening Engineering Education (9)
Content Of Engineering Education (22)

PROMOTING FACULTY EXCELLENCE (8)

INDUSTRIAL NEEDS (6)

SOCIETAL NEEDS (11)

MISCELLANEOUS (21)

The high productivity arises for a number of reasons (3). For example, all participants work continuously in parallel and in a highly focussed way during the process. There is also considerable cross-fertilization of ideas in step (iii) above, a step which is continued until all group members have seen and added to all the individual ideas generated. In addition, all the ideas are recorded including conflicting ones, there is no verbal criticism, and the dominance of strong personalities is reduced.

3. TOPICS TO BE INCLUDED IN A PLAN FOR THE FUTURE OF ENGINEERING EDUCATION

Following the Ideawriting sessions, the work of the participants diverged. One group examined topics they felt should be included in a plan for the future of engineering education, whilst a second group considered issues relating to computers and engineering education. The former work is discussed in this section.

3.1 Generation of Topics Using Nominal Group Technique (NGT)

The group of six participants was asked to generate topics using a second idea-generation process, Nominal Group Technique (7,8). This involves five steps:

(i) Clarification of a trigger question.
(ii) Silent generation of ideas in writing by each participant.
(iii) Round-robin recording of the ideas on a flip chart.
(iv) Serial discussion of each idea for clarification and editing.
(v) Voting to obtain a preliminary ranking of the ideas in terms of importance.

Steps (iii) and (iv) of the NGT process enable recording and a full discussion of the ideas generated in order to clarify and edit them. Step (v) enables the ideas to be ranked for importance. The process is thus more exhaustive than Ideawriting and, consequently, takes much longer. However, it ensures that all participants have a clear understanding of, and opportunity to express value judgements on, the ideas produced. The trigger question used on this occasion was:

'What topics should be included in a plan for the future of engineering education?'

Thirty-six topics were generated as a result and each was clarified, edited and ranked. Of these topics, those ranked most important according to the NGT voting scores were selected for subsequent structuring. These are shown in the form of a relation map which is discussed in section 3.2.

3.2 Structuring the Topics Using Interpretive Structural Modelling (ISM)

Interpretive Structural Modelling (3,9) is a method which helps participants to examine the interrelations between the elements in a complex problem or situation. It enables a group to pool their thinking and reach agreement on the structure of the problem. In this case a computer-assisted ISM session was carried out, taking the factors developed during the NGT session as the elements to be structured. The resulting ISM relation map shows the way in which clarifying one topic would help to clarify another. In this case 24 topics were selected for structuring. The ISM process required the group to respond to a series of questions put by the computer of the form:

'WOULD CLARIFYING
34. The environment in which the engineering graduate will work
HELP TO CLARIFY
3. The desirable characteristics of the engineering graduate of the future?'

As the process proceeds, the computer builds up a matrix recording the group's answers to the questions. It also makes logical inferences about the interrelations between the elements. A digraph can be extracted from the matrix and displayed in the form of a relation map at any stage of the process. This can be examined by the group and amended as desired. Figure 1 shows the completed 24 element relation map. The numbering scheme for the topics refers only to the sequence in which they were generated using the NGT method.

3.3 Interpretation of the Structure

Simplified block structure

The strong interactions between the elements contained in the blocks at the different levels permit an attempt to be made to show the broad structure of the map. This may be done by considering the major blocks and levels as identified in figure 1. These show which broad areas might usefully be investigated first in order to clarify others. For example, it suggests that clarification of the relevant international influences, such as challenges from Japanese industry, should precede an investigation of the national factors, such as the role of the engineer in national development. Similarly, these international and national topics would help to clarify the goals and objectives of engineering education and should thus precede a study of the latter.

Examples of interpreting the relations between topics

Interpretation of the map may be helped by considering some of the paths of relations between the various topics at different levels. Figure 2 shows the way in which topics 1, 3, 6, 13 and 15 interconnect. Thus clarifying 13, the role of the engineer in national development, should help to illuminate 3, the desirable characteristics of the engineering graduate of the future. Accordingly, 13 might usefully be studied prior to 3. Topic 3 would in turn shed light upon 15, the humanistic and cultural components which should form part of engineering education. A similar interpretation may be made between elements 15 and 6, and between 6 and 1. However, the transitive nature of the map means that 13 would clarify directly any topic that it reaches via a path of one or more arrows, e.g., topics 3, 15, 6, 1 in figure 2 and many of the other topics shown in figure 1. Figure 3 shows a second example of a path of relations between topics which may be interpreted in the same way.

Cycles on the map

The map contains a number of blocks of topics with cycles between the topics in any given block. These show the interdependence between the elements in the block, each illuminating the other. For example, the block at national level in figure 4 indicates that the role of the engineer in national development, the markets for engineering graduates, and the environment (technological, industrial and social) in which the engineering graduate will work, all help to clarify each other. These three topics could thus be profitably examined together, each shedding light on the others. They would all be clarified by a study of the international challenges to United States engineering at the level below. In turn they would all help to clarify a study of educational goals and objectives at the level above.

Similarly, strong interdependence between topics is shown by the other blocks present, such as the nine-element block at the school and programme level. Figure 5 shows the strong two-way interconnections between topics 6, 21, 22 and 28 in this block. This interdependence means that the process of clarifying them all must be iterative. For example, the optimum structure of an engineering institution in terms of size, number and nature of departments, given the particular context of the institution, will help to clarify a desirable structure for undergraduate engineering education with regard to the pattern of courses students should take in the school and vice versa. Similarly, ways of implementing change in engineering schools, with regard to the way they should be organised and run so that they initiate and implement changes appropriate to new technological developments, will both clarify and be clarified by the optimum structure of such institutions. The other topics in this same block, 7, 8, 9, 12, 17 (figure 1) will likewise shown two-way interdependence with each other and with the topics in figure 5.

4. ISSUES RELATED TO COMPUTERS AND ENGINEERING EDUCATION

This section considers the work of the second group of faculty who, following the initial Ideawriting session discussed in section 2, considered issues relating to computers and engineering education (10). The group used the Nominal Group Technique process described in section 3.1 to generate, clarify, edit and rank a list of issues. The trigger question used to focus the generation of ideas was:

> 'What issues involving or relating to the computer should be dealt with in a design for the future of engineering education?'

The 27 ideas generated were grouped into seven main areas: futures questions; policy issues; questions of definition/philosophy; resource issues; computers and educational methods; computers and educational content; providing a service; and technical issues.

4.1 Structuring the Issues

The group then participated in an Interpretive Structural Modelling session to map their perceptions of the interrelations between the 14 issues selected as being most important in the voting step of the NGT session. The relation used to structure the issues was again whether clarifying one issue 'would help to clarify' another. Figure 6 shows the 14 elements in the resulting ISM relation map and indicates the sequence in which issues might usefully be dealt with in order to clarify others.

Interpretation of the structure

Interpretation of the relation map may be done in much the same way as the interpretation of figure 1, described in section 3.3. For example, the path between issues 2, 4, 1, 6 is explicitly shown. Thus clarifying the uses to which computers are likely to be put in engineering in the future should give an idea of the extent to which future engineers will have to write their own software packages instead of just being users of software prepared by specialists. Understanding this will help to determine the role computers should play in engineering education. This in turn will throw light upon the proportion of the limited resources available for engineering education which should be allocated to, say, new micro-processors and terminals rather than to conventional engineering laboratory equipment. However, the transitive nature of the map means that clarifying element 2 will directly clarify any issues which it reaches via a path of one or more arrows. In this case that means all the issues in the map apart from element 7. There are six blocks, each containing two elements in a cycle. The strong interdependence between the two issues in each case indicates that each helps to clarify the other.

5. CONCLUSIONS

The work described has provided engineering faculty from a diverse range of disciplines with an opportunity to participate in an interactive planning process in order to look at the future of engineering education.

The ideas generated are the participants' own. They are not intended to be exhaustive, but to represent issues and topics of interest and importance to the groups involved. Similarly, the relation maps showing the interrelations between the ideas are not in any way immutable, but represent the participants' attempts to impose structure and order on the topics according to their own perceptions. A different participant group may well have produced different ideas and different structures. However, this does not detract from the value of either the process or the structures produced, as any group activity of this sort will be at once both as unbounded and as limited as the contributions the participants are able to make.

Both relation maps are thus open to revision or extension, either by the same participants, or by new colleagues bringing fresh insights to the subject. In this sense the maps should be regarded as working structures, suggesting a way forward. They are flexible rather than rigid, open to amendment as appropriate. Indeed, the maps represent only the products of the meetings. The understanding gained through interaction and exchange of ideas amongst the participants whilst producing such structures is itself important as a learning process, and is usually illuminating to the individuals involved.

The three methods described, Ideawriting, Nominal Group Technique and Interpretive Structural Modelling, are powerful tools for putting interactive planning and management into practice. The problems examined here have been concerned with engineering education. However, the methods are applicable in many situations where a participant group wishes to gain a better understanding of a complex situation. They may each be used independently or, as here, in combination to take a group through a process of inquiry to identify and structure the problem elements.

Acknowledegments

The author is indebted to Professor John N. Warfield for his help in organising this project.

REFERENCES

1. Warfield, J.N. (1982) Organisations and systems learning, **General Systems,** Vol. 27, 5-74.

2. Warfield, J.N. (1984) Principles of Interactive Management. In: **Proc. Intl. Conf. on Cybernetics and Society.** New York: IEEE, January, 1984, 746-750.

3. Warfield, J.N. (1976) **Societal Systems: Planning, Policy and Complexity.** New York: Wiley Interscience.

4. Moore, C.M. and Coke J.G. (1979) **Guide for Leaders Using Ideawriting.** Columbus, Ohio: Academy for Contemporary Problems.

5. Seamans, R.C. and Hansen, K.F. (1981) Engineering education for the future. **Technology Review** (Massachusetts Institute of Technology), February-March, 22-33.

6. Strohm, P. (1983) Faculty roles today and tomorrow. **Academe,** January-

February, 10-16.

7. Delbecq, A.L. et al (1975) **Group Techniques for Program Planning.** Glenview, Illinois: Scott, Foresman and Company.

8. Gill, S.L. and Delbecq, A.L. (1982) Nominal Group Technique (NGT). Chap 8 in: **Group Planning and Problem Solving Methods in Engineering Management** (S.A.Olsen, ed.). New York: Wiley Interscience.

9. Warfield, J.N. (1982) Interpretive Structural Modelling (ISM). Chap 5 in: **Group Planning and Problem Solving Methods in Engineering Management** (S.A.Olsen, ed.). New York: Wiley Interscience.

10. Van Valkenburg, M.E. and Huelsman, L.P. (1983) New technology and the curriculum. **Engineering Education** (American Society for Engineering Education), Vol. 73, No 5, 367-369.

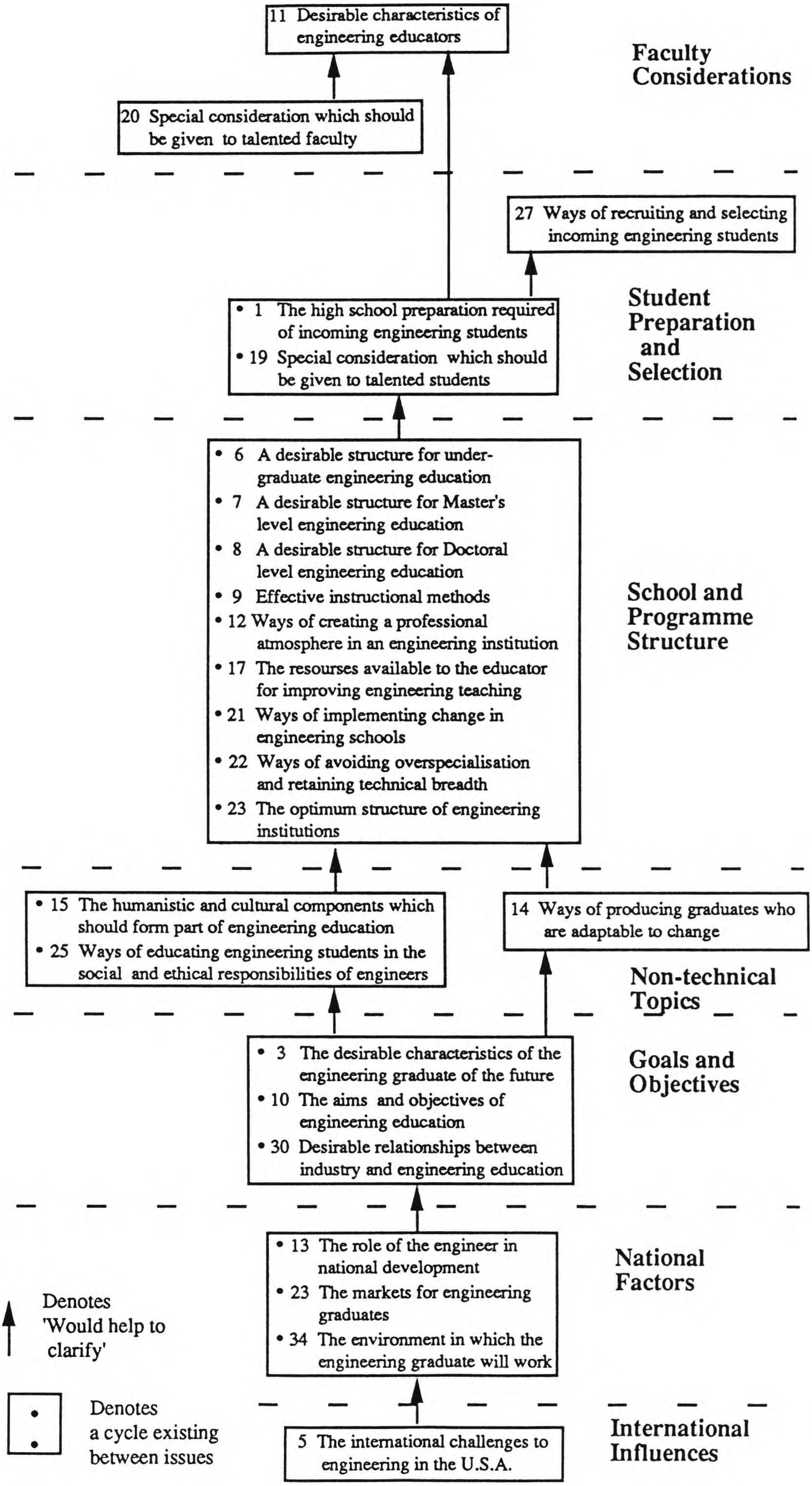


Figure 1. ISM relation map: topics to be included in a plan

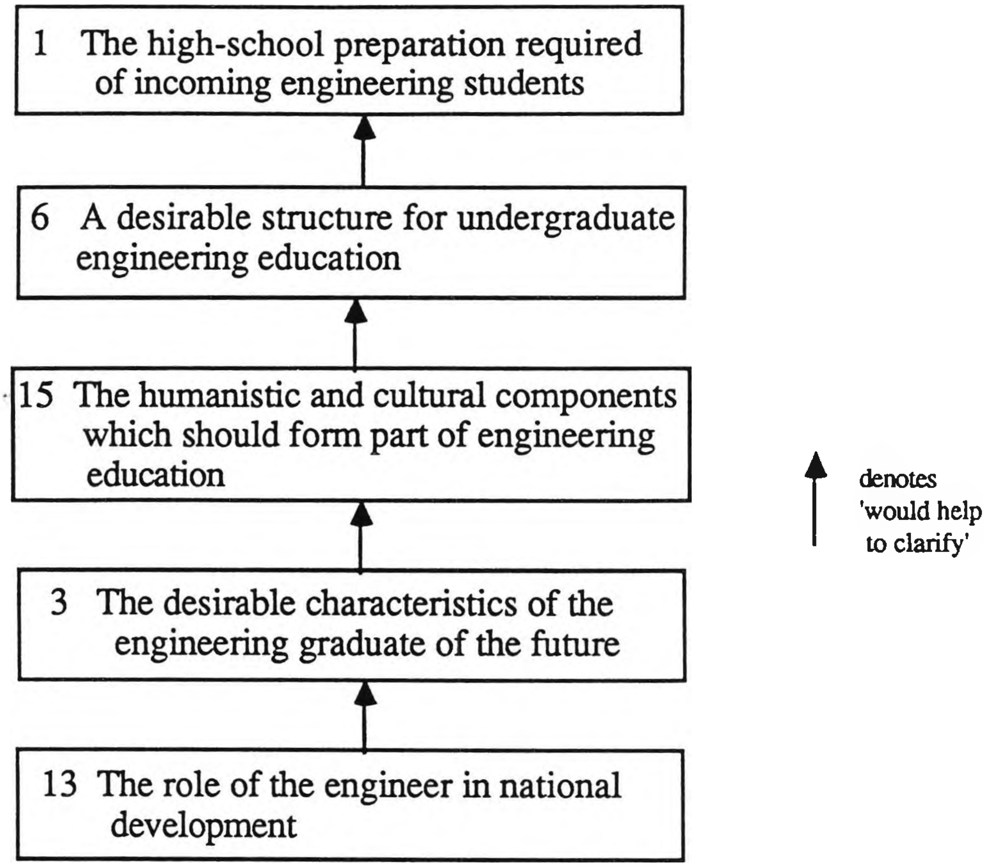


Figure 2. First example of a path of relations between topics

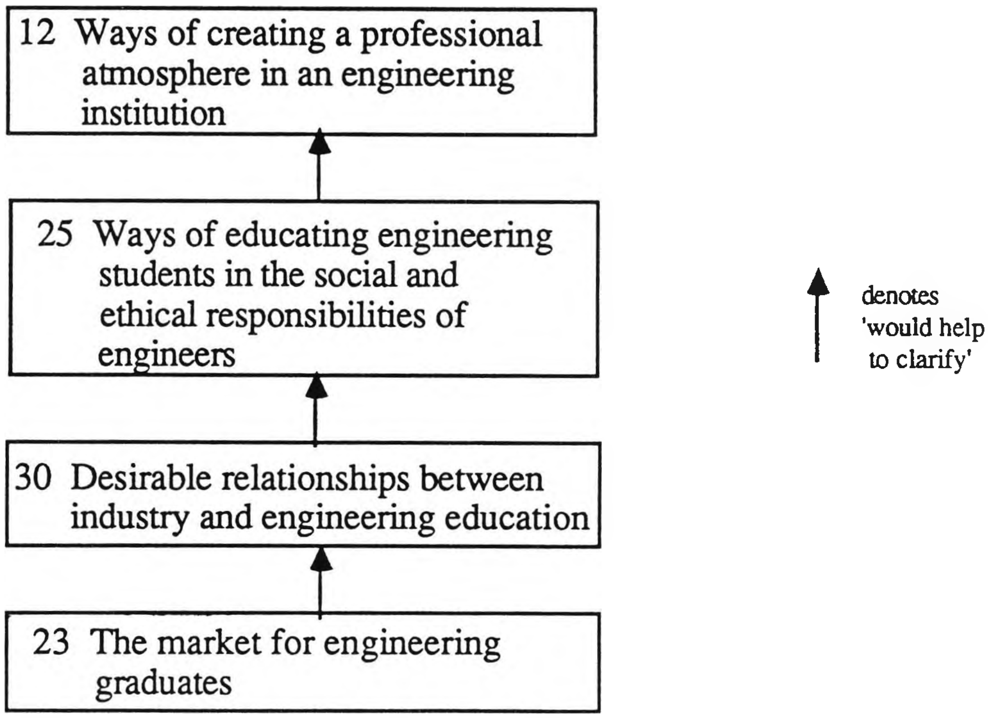


Figure 3. Second example of a path of relations between topics

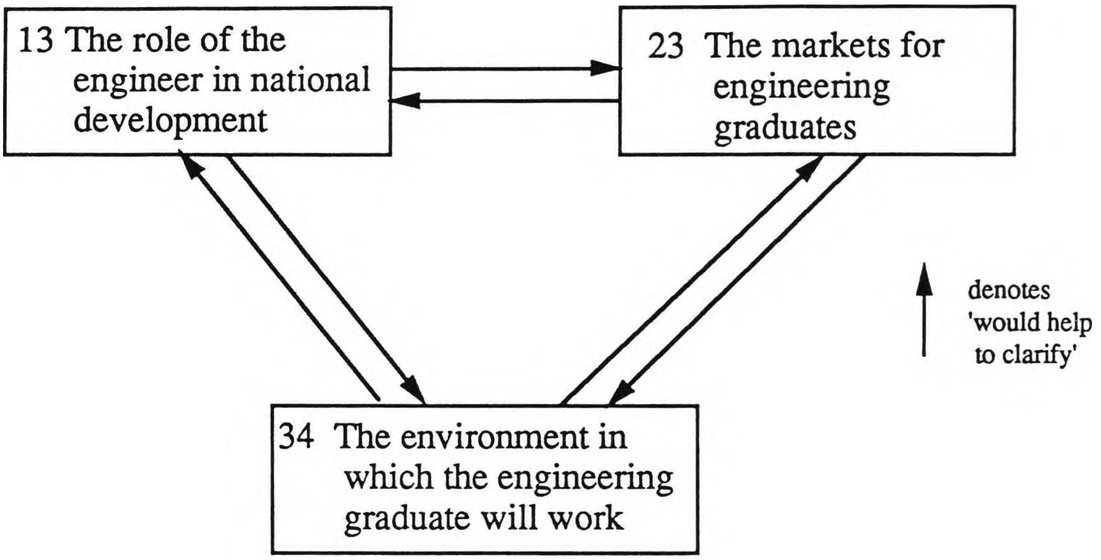


Figure 4. Cycles existing at the national level

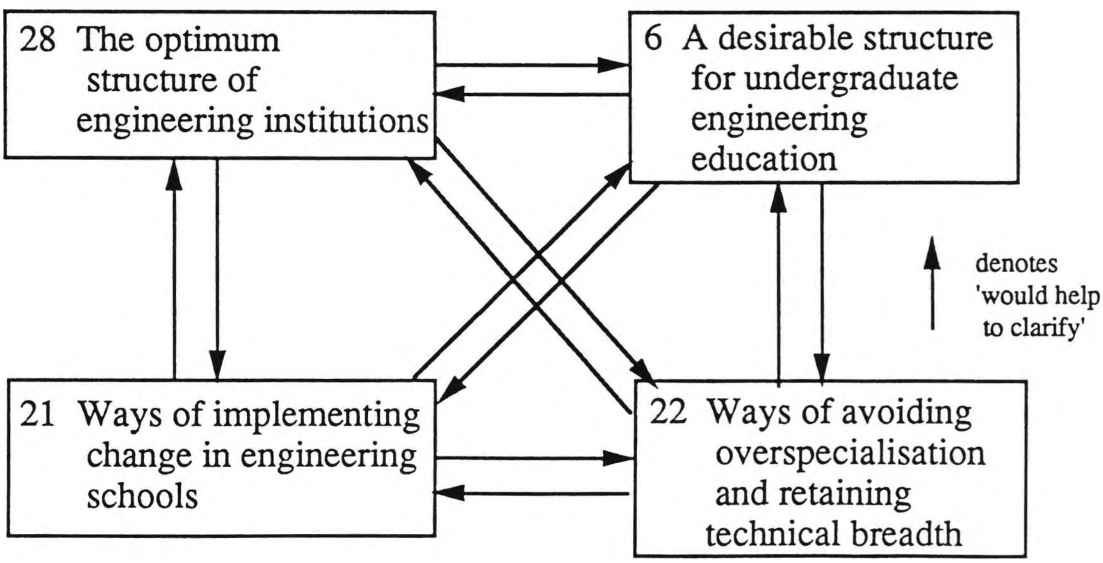


Figure 5. Cycles at the school and programme level

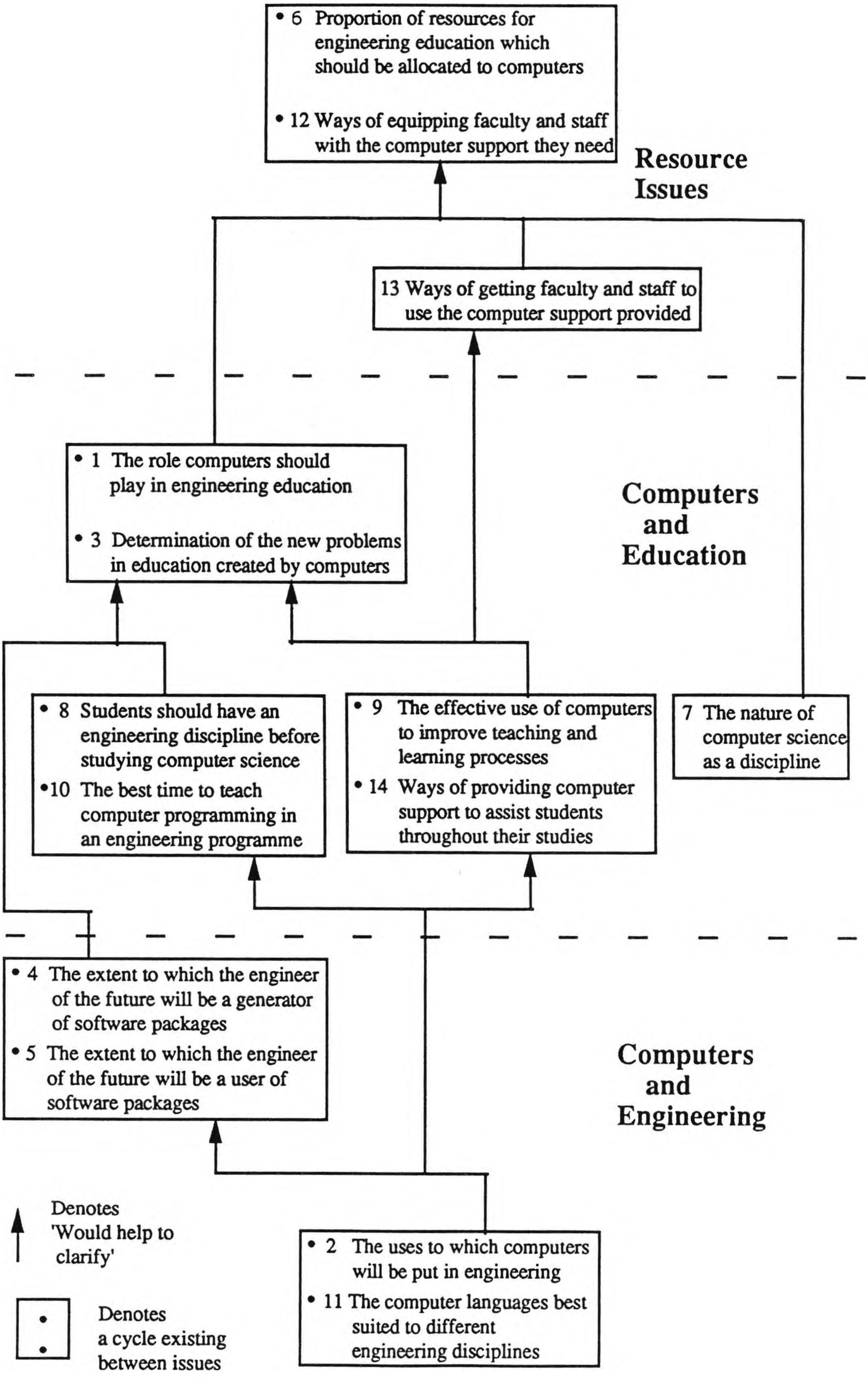


Figure 6. ISM Relation map: computers and engineering education

SUPPORTING PAPER H

Janes, F.R. (1992). Planning for an industrial training board team: an application of Interactive Management. In Information Technology and Society: Theory, Uses, Impacts, ed. J.L.Alves. Proceedings Int. Symp. on Communication Meaning and Knowledge vs. Information Technology, Lisbon, Sept., 1989. Lisbon: APDC and SPF (Associacao Portuguesa para o Desenvolvimento das Comunicacoes and Sociedade Portuguesa de Filosofia). 367-374.

PLANNING FOR AN INDUSTRIAL TRAINING BOARD TEAM: AN APPLICATION OF INTERACTIVE MANAGEMENT

F.R.Janes
Interactive Management Unit
Department of Systems Science
City University
London, England

ABSTRACT

This paper reports on an application of Interactive Management in planning for a development team within a national industrial training board. Commencing with a brief description of the background to the situation and the components needed to put Interactive Management into practice, the paper describes how idea generation and structuring methods were used by the team in setting and structuring objectives over a two-year time horizon. Initially, Nominal Group Technique was used to generate, clarify, edit and rank a set of over 40 objectives for the nine member team concerned with training development for the engineering industry. These objectives were then classified into groups representing different sub-systems of activity. A subset of the objectives, selected on the basis of the ranking scores, was structured during a computer-assisted Interpretive Structural Modelling session to produce an Intent Structure showing how the objectives interrelated. The various sub-systems of activity within the Intent Structure were subsequently identified and their interactions examined. The products of the sessions gave a clear picture of the participants' thinking on the role and functions of the team and provided a clear basis for future activities. It is concluded that Interactive Management provides both a context and process for such group work. This enables a pooling of content knowledge by the participants and results in both planning products and significant learning amongst the participants.

1. INTRODUCTION

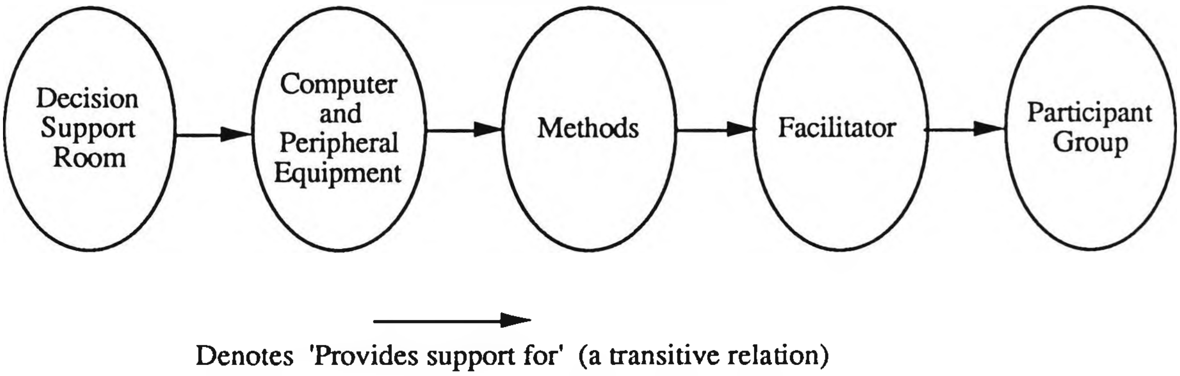
The work described here was carried out for a training development team of a national industrial training board. The Board is responsible for advising on, and monitoring, the training provided by companies in the engineering sector throughout the country concerned. The appointment of a new team manager presented an opportunity to rethink the direction of the work of the team. At his request, it was agreed that an Interactive Management approach [Warfield, 1984; Broome and Keever, 1986] be used to initiate planning for the team through a two-day planning workshop. After exploring various possibilities with the manager, it was decided to develop a set of objectives for the team with regard to what they should be trying to achieve over the next two years and to examine how those objectives were interrelated.

The team consisted of nine members, including the manager, and it was decided to involve them all in the planning workshop. The workshop sessions were designed to incorporate five components for effective group work in the context of Interactive Management [Christakis and Keever, 1984].

- **Participant Group** - the training development team members, being stakeholders with content knowledge relevant to the issue,
- **Facilitator** - to manage the work of the group and guide participants through the steps of the methods used,
- **Methods** - in this case Nominal Group Technique and Interpretive Structural Modelling for generating and structuring objectives,
- **Computer and Peripheral Equipment** - to run software associated with the methods, and to provide display facilities and word processing capability,
- **Decision Support Room** - offering an environment equipped for effective group work which would support the four components above.

The relations between these components are shown as a transitive digraph in Figure 1.

Figure 1. Relationships between the five components for effective group work



Denotes 'Provides support for' (a transitive relation)

2. GENERATION OF OBJECTIVES

2.1 Method

On the first day, the team participated in an idea-generation method, Nominal Group Technique (NGT) [Delbecq, 1975; Moore, 1987] . This was used to generate, clarify, edit and obtain a preliminary ranking of a set of objectives for the team. A classification scheme for the objectives was also developed.

Steps of Nominal Group Technique

1. Clarification of a trigger question to focus the idea generation.
2. Silent generation of ideas in writing in response to the trigger question.
3. Round-robin recording of ideas, whereby the ideas of participants are recorded on a flip chart and displayed.
4. Serial discussion of ideas for clarification, whereby each item is discussed in turn with the group in order to clarify and edit it.
5. Voting in order to enable participants to express their value judgements with regard to the importance of the ideas generated.

2.2 Resulting Objectives

The trigger question posed to the participants was:

'What should the training development team be trying to achieve over the next two years?'

A total of 45 objectives were generated and clarified during the NGT. They are not listed in full here, but a subset of them is shown in Figure 2. The numbers appearing before the objectives reflect the sequence in which the ideas were generated and are not of any other significance. The NGT voting scores obtained in step 5 do not give an accurate ranking. They provide a rough and ready assessment of the participants' judgements concerning relative importance of the objectives. Given time constraints this enables the facilitator to select a subset of items to be subsequently structured in the time available.

Following the NGT, the entire set of objectives was classified into groups as shown below:

- Ideals
- Public Relations
- Marketing
- Thinking Ahead
- Team Building
- Production of Material
- Development of Training System
- Regional Linkages

3. STRUCTURING THE OBJECTIVES

3.1 Method

In order to examine the relationships amongst the objectives, the team participated in a process called Interpretive Structural Modelling (ISM) [Warfield, 1976; Janes 1988]. This is a computer-aided method which helps participants to examine the interactions between the elements in a complex problem or situation. It enables a group to pool their thinking and reach agreement on the structure of the problem. In this case an ISM session was carried out on the second day, taking the objectives developed during the NGT as the elements to be structured. The resulting Intent Structure is outlined below.

3.2 Developing an Intent Structure

An Intent Structure shows how the accomplishment of one objective might contribute to the achievement of another. In this case, given the limited time available, 28 of the objectives were selected for structuring on a basis of the NGT voting scores. The ISM process required the team to respond to a series of questions put by the computer of the form:

'WOULD ACCOMPLISHING THE OBJECTIVE
23. To review, revise and generate
Board publications
HELP TO ACHIEVE THE OBJECTIVE
6. To produce specified training
material to the standards required
within time/cost budgets?'

As with the NGT, a two-year time horizon was assumed. After discussion, the answer to each question was fed in to the computer, the results of a majority vote being used whenever the participants were not unanimous.

During an ISM session, the responses of a group are fed into the computer which draws logical inferences from the answers as the process proceeds. Gradually, the computer builds up an ISM 'map', portraying the group's perceptions of the interrelations between the objectives. The map can be displayed at any stage of the process, examined by the group and amended by hand as desired. The Intent Structure in Figure 2 shows the completed 28 element map constructed by the training development team.

3.3 Interpretation of the Intent Structure

The boxes in the map contain the objectives with the original NGT numbering scheme. The arrows between the boxes represent the relation 'would help to achieve'. The Intent Structure thus shows what helps to achieve what.

Paths. A sequence of objectives connected by arrows is known as a path on the map. For example, the path 14 -> 22 -> 18 is explicitly shown. This may be interpreted as a statement that objective 14 helps to achieve objective 22 and that 22 helps to achieve 18. However, the transitive nature of the map means that 14 may help to achieve directly any elements which it reaches via a path of one or more arrows, e.g objectives 22, 18, 23, 6, 1, 16, 38, 19, 25, 5.

Cycles. There are a number of cycles on the map indicated by multiple objectives in a box. These denote highly interdependent clusters of objectives which tend to reinforce each other.

Objective groupings. The Intent Structure may be partitioned (Figure 3) into a number of sub-systems as indicated by the shaded areas around groups of the objectives. It can be seen that the sub-systems broadly agree with the groups into which the objectives were originally classified following the NGT.

3.4 Uses of the Intent Structure

Within the context of the training development team, the uses of such an Intent Structure include the following:

- Making explicit the multiple objectives of the team and their management implications.
- Clarifying thinking, through asking the team systematically to think through the complex interactions between the objectives.
- As a way of explaining the purpose of the team to those within the training development division, the Board and outside agencies.
- As a way of assessing and reporting progress. Many objectives may be followed at the same time and effort may be switched between them.
- As a base from which to change objectives as new ideas are developed or as circumstances change.
- As a basis for resource allocation. Given limited resources, the structure can assist in deciding on the allocation of resources to those activities which will be most productive.
- To assist in organizational design. The Intent Structure can provide a basis for developing an appropriate organizational design.

4. CONCLUSIONS

The five components consisting of: participant group; facilitator; methods; computer and peripheral equipment; and decision support room, provided a context for effective group work. The idea generation and idea structuring methods in the form of Nominal Group Technique and Interpretive Structural Modelling enabled participants to pool their content knowledge and work efficiently. The methods provided a process which focussed debate, encouraged structured argument and clarified thinking. This enabled products to be generated in the form of objectives for the team and an Intent Structure showing the interrelations between the objectives. The resulting learning and team building may also be regarded as products of the workshop. The usefulness of these various products in the subsequent work of the team was later confirmed by the team manager.

REFERENCES

Broome, B.J. and Keever, D.B. (1986) Facilitating group communication: the interactive management approach. Paper presented at the annual convention of the Speech Communication Association, Chicago, November, 1986.

Christakis, A.N. and Keever, D.B. (1984) Management's quest for new solutions. Unpublished paper, The Centre for Interactive Management, George Mason University, Virginia, USA.

Delbecq, A.L., Van de Ven, A.H. and Gustafson, G.H. (1975) **Group techniques for program planning**. Scott, Foresman and Company, Glenview, Illinois, USA.

Janes, F.R. (1988) Interpretive Structural Modelling: a methodology for structuring complex issues. **Trans. Inst. Meas. and Cont.** Vol. 10, No.3, 145-154

Moore. C.M. (1987) **Group techniques for idea building** Sage Publications, London, England.

Warfield, J.N. (1984) Progress in interactive management. **Proc. 6th Int. Cong. World Organisation of General Systems and Cybernetics**, AFCET: Paris, xxix-xxxv.

Warfield, J.N. (1976) **Societal systems: planning, policy and complexity**, John Wiley & Sons Inc, New York, USA.

Figure 2: Intent Structure : Training Development Team

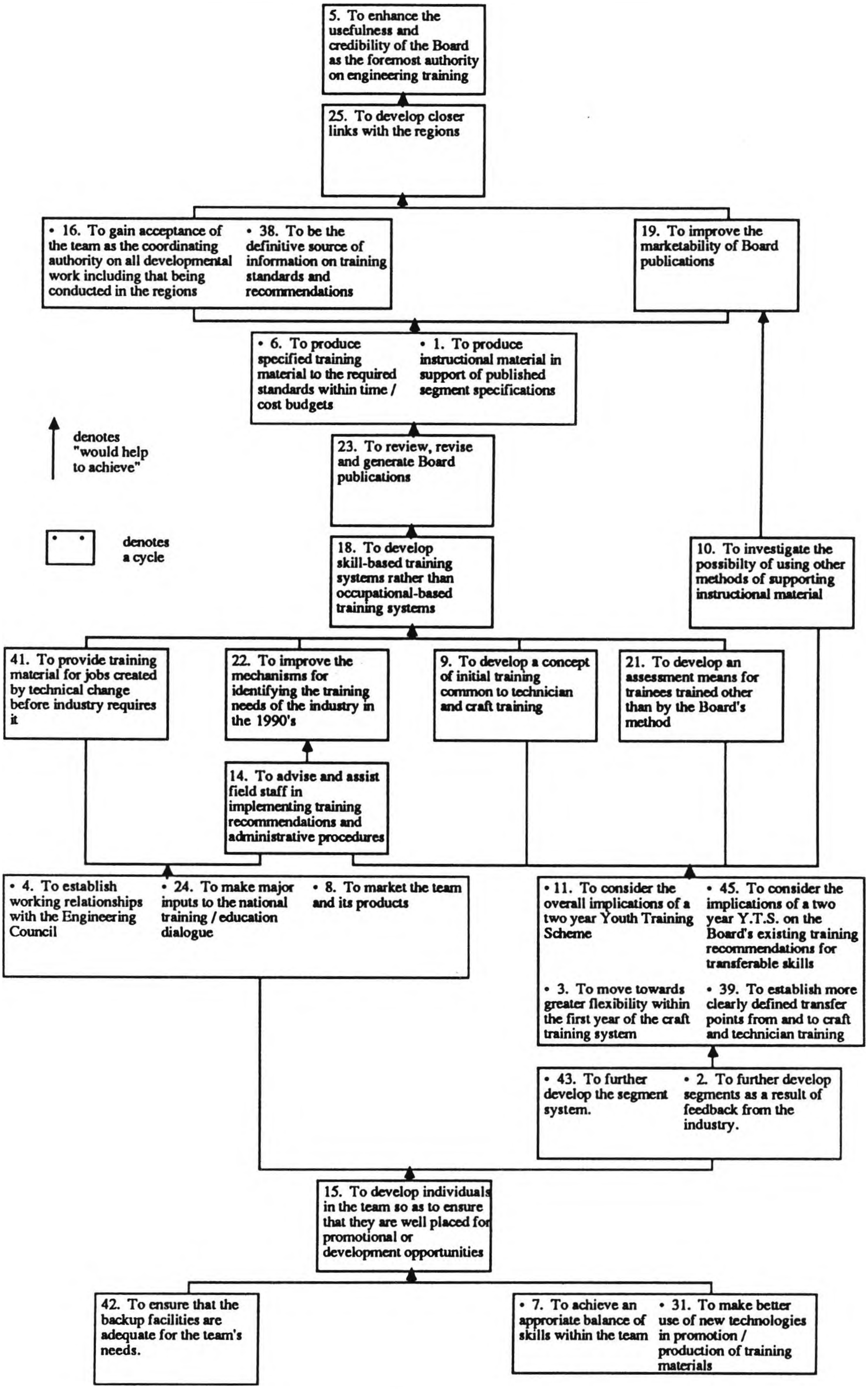
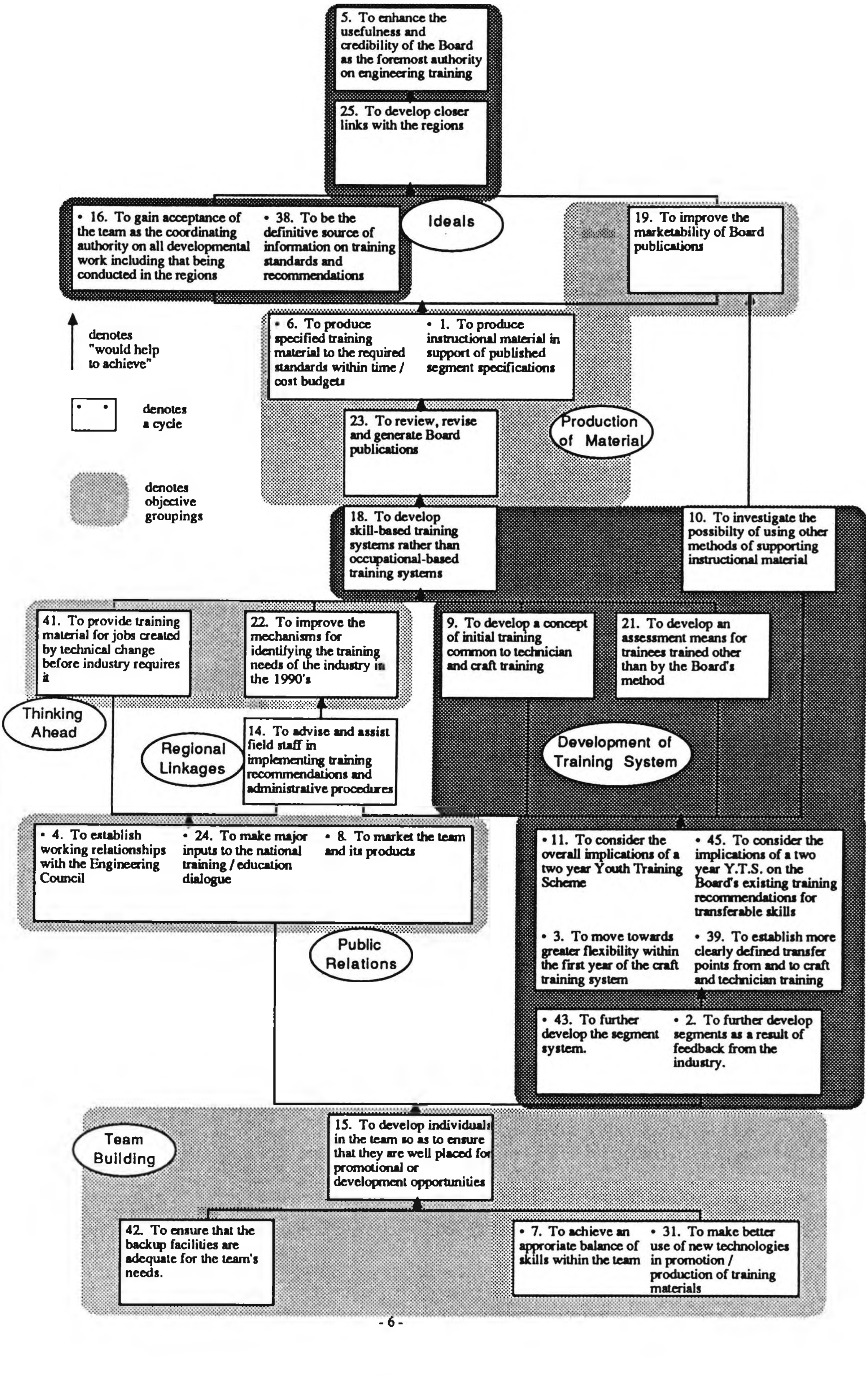


Figure 3: Sub-systems in Intent Structure



SUPPORTING PAPER I

Janes, F.R. (1987b). Products, services and priorities for the Engineering Industry Training Board. Technical Report No. DSS/FRJ/248, Dept. of Systems Science, City University, London. 24pp.

(Appendix C of this report has been included)

PRODUCTS, SERVICES AND PRIORITIES

for

THE ENGINEERING INDUSTRY TRAINING BOARD

(A report on a two-day Business Planning Workshop for Regional Managers of the EITB held at City University on September 1st and 2nd, 1987).

F.R. Janes

Department of Systems Science
City University
Northampton Square
London EC1V 0HB

November, 1987

Technical Report DSS/FRJ/248

Table of Contents

1. Summary

Regional managers of the Engineering Industry Training Board participated in a Business Planning Workshop at City University. This was designed to enable them collectively to formulate their ideas on future priorities for the EITB from the viewpoint of regional managers.

The programme of meetings involved participants in generating and prioritising a list of products and services which they, as regional managers, thought that the EITB should be delivering on behalf of the engineering industry over the next 3 - 5 years. The methods of computer-aided interactive management were used for this purpose, with the City University team acting as facilitators throughout, leading the group through a series of processes specifically designed to promote the efficient generation and structuring of ideas by groups.

On day one, an idea-generation method was used to help participants in generating, clarifying and editing a list of over 30 such products and services. A preliminary ranking was developed for the items using a voting procedure. The items were then classified into categories. On day two, the six main categories were set in order of importance with the help of a computer to produce a priority structure. The products and services within each category were then examined to develop a separate priority structure for each of the categories. Finally, drawing upon the priorities agreed at this stage, the group formulated a tentative mission statement for the EITB.

The planning workshop has given a clear picture of the products, services and priorities which regional managers think the EITB should be directing its efforts towards. This should provide valuable information for those concerned with strategic planning for the organisation.

2. Terms of Reference

This report has been produced for Mr. G.F. Ball (1) of the Engineering Industry Training Board by Mr. F.R. Janes (2) of City University.

At the suggestion of Mr. Ball, the Department of Systems Science at City University submitted a proposal for a Business Planning Workshop. This took place over two days, 1st and 2nd September, 1987, in the Decision Support Laboratory at City University. A group eight participants from the EITB were actively involved, including six regional managers together with representation from EITB Headquarters (Appendix A).

The aim of the workshop was to enable the regional managers collectively to formulate their ideas on the products and services which they thought the EITB should be delivering on behalf of the engineering industry over the next 3-5 years. It was considered that this would provide important information from those working closely with the Industry as to the needs of the Industry. The resulting information could then be used by those concerned with strategic planning for the EITB to take into account the views of regional management when designing the EITB's next corporate business plan. The remainder of this report describes the process by which this aim was achieved and the results of the planning workshop.

---

(1) General Manager - Regional Operations
(2) Senior Lecturer and Director of Systems Science

3. Future EITB Products and Services

3.1 Method Used : Nominal Group Technique (NGT)

On the first day, the group participated in an idea-generation method called Nominal Group Technique. NGT may be used to help a group to generate, clarify, edit and obtain a preliminary ranking of a set of ideas related to a specific issue or problem. In this case the ideas generated were the products and services which the group thought that the EITB should be delivering on behalf of Industry.

Steps of Nominal Group Technique

1. Clarification of a trigger question to focus the idea generation.
2. Silent generation of ideas in writing in response to the trigger question.
3. Round-robin recording of ideas, whereby the ideas of participants are recorded on a flip chart and displayed.
4. Serial discussion of ideas for clarification, whereby each item is discussed in turn with the group in order to clarify and edit it.
5. Voting in order to enable participants to express their value judgements with regard to the importance of the ideas generated.

3.2 Resulting Products and Services

The trigger question posed to the group was:

"What products and services should the EITB deliver on behalf of Industry over the next 3-5 years?"

A total of 38 ideas for products and services were generated during the NGT and are listed in Table 1. The numbers appearing before the objectives reflect the sequence in which the ideas were presented by the participants and are not of any other significance. For simplicity of cross referencing this original numbering scheme has been retained throughout the report. During discussion and clarification in step 4 of the NGT, certain ideas were identified as being income generators for the EITB and were given the label 'i.g.'. Other ideas were identified as being policy statements rather than a product or service. These have been picked out in italics. Idea 34 was deleted as it duplicated other ideas.

3.3 Explanation of Voting Scores

Following clarification of the products and services generated, the participants were asked in step 5 of the NGT to select individually the eight items which they considered to be most important. They were then asked individually to rank their eight selected items, assigning an '8' to the most important and a '1' to the least important and so on. The voting scores are listed alongside the items in Table 1.

The voting scores should not be taken as an accurate ranking. They provide a rough and ready initial assessment of the participants' judgements concerning relative importance of the products and services.

3.4 Classification of Products and Services into Categories

Following completion of the NGT, the entire set of products and services was classified into categories as shown in Table 2. The headings given to the various categories are listed below:

A Training, Technology, Resources and Support Facilities.
B Standards Based Training Systems.
C Supply of People.
D Company Specific Services,
E Information and Research.
F Industry Representation and Support.
G Ways and Means.

Thus for example, item 11 from the NGT list in Table 1, which is concerned with providing a service to assist engineering companies to exploit new technologies, is classified under category D above concerned with the provision of services to specific companies. The sequence of letters A--------G used to label the categories is of no particular significance and simply relates to the sequence in which the categories were identified by the participants.

At the start of the second day, the group reconsidered the classification and discussed whether to include further headings, particularly those concerned with Grants and Initiatives and also Public Relations. After some debate both these headings were rejected and the group confirmed its original classification.

4. Setting Priorities Amonst Products and Services

4.1 Method Used : Interpretive Structural Modelling (ISM)

In order to prioritise the products and services, the group participated in a process called Interpretive Structural Modelling. This enables participants to examine the interrelations between the elements in a complex problem through a process of structured argument using a computer equipped with ISM software.

In this case the problem elements were the various products and services derived from the NGT session. They were being structured using a criterion of 'importance' from the viewpoint of how regional managers should be allocating their resources. The ISM process required the group to respond to a series of paired comparisons put by the computer as questions in the following form:

'Is
31. Improving the calibre and skill of the Industry's training staff
more important than
21. Marketing and selling evaluated training materials
given the existing level of resources?

Each question was discussed and argued by the participants under the guidance of a facilitator. The answer to each question fed into the computer was based on the votes of the particpants, a majority vote being used whenever they were not unanimous. As the process proceeded the computer built up a number of structural models, in this case priority structures, showing the group's perceptions of the importance of the various products and services. When assessing importance, participants were asked to assume that the existing level of resources would be maintained with no increase or decrease.

4.2 The Priority Structures Produced

Seven separate priority structures were produced. The first one ranked the main category headings into which the products and services had been classified (Table 3). The other six dealt with the individual products and services in each category. These are shown in Tables 4,5,6 and 7. As they were produced, each structure was displayed, discussed and agreed by the group.

In each case the arrows between the boxes in the tables denote the expression 'is more important than'. Thus in Table 3, the provision of Company Specific Services was seen as being the most important activity with Information and Research being regarded as the lowest priority. Where two or more activities appear in a single box this signifies that they are of equal importance. For example, in Table 4 this applies to items 11 and 20 and also to items 1 and 9, the latter two being the highest priority activities in the structure. The other tables may be interpreted in a similar way.

Table 8 gives an overview of Tables 3 to 7 on one sheet. The category headings are ranked across the top in order of priority with the individual priority structure for each category shown underneath the appropriate heading. Care should be exercised when interpreting the priorities. Thus, whilst category A is shown as generally a higher priority than category F, it should not be automatically assumed that the lower level items under A, e.g. 21, 15, 30, 26 are a higher priority than the top level items in F, e.g. 18 and 3.

With regard to interpretation of all the structures it should be remembered that they represent priorities from the viewpoint of regional managers taking a 3 - 5 year time horizon and assuming that the existing level of resources will be maintained.

It will be noticed that the ordering in the priority structures differs somewhat from the initial tentative rankings provided by the NGT voting scores (Table 1). This is a measure of the learning that took place when the participants had an opportunity to reflect upon and argue the relative merits of the various products and servies. It may also be noticed that there are some minor changes in the wording of certain items when the ISM structures are compared with the list of products and services generated in the NGT session. For example, item 36 was expanded in the ISM session (Table 6) to incorporate item 4 from the NGT list. Similarly, item 8 was amended during the ISM (Table 7) to incorporate item 37 from the NGT. Again, such changes are a natural part of the argument, discussion and learning that arises during a typical ISM session.

4.3 Uses of the Priority Structures

The uses of such priority structures include the following:

- Clarifying thinking through asking participants systematically to think about the relative importance of their products and services.

- Making explicit the multiple products and services which regional managers think the EITB should be delivering to Industry.

- Providing information to those concerned with developing the EITB's Corporate Business Plan as to which products and services regional managers think are important.

- As a base from which to change priorities as new ideas for products and services are developed or as circumstances change.

- As a basis for resource allocation. Given limited resources, the structures can assist in deciding on the allocation of resources to those activities which are seen as most important.

- To assist in organisational design. The structures can provide a starting point for designing an appropriate organisational structure to implement the agreed priorities.

5. Tentative Mission Statment for the EITB

5.1 Method Used

As a final phase to draw the Planning Workshop to a conclusion at the end of the second day, participants were asked to work in two separate groups and respond to the question:

"Based on the products and services produced so far, what should we be focussing our energy on in order to be a significantly better organisation in three year's time?"

The products of each group (see Appendix C) were then discussed and combined into a single statement as shown below.

5.2 Tentative Mission Statement

Mission of EITB

To be the professional and valued training service to the engineering industry.

Requirements to Achieve Mission

- To have survived.
- To minimize statutory interventionist role and maximise professional acceptance.
- To align service to the overall requirements of companies in - scope to the EITB.
- To demonstrate a significantly improved training service in the field of company problem resolution.
- To be the engineering lead body and to be accepted as such.
- To be seen by the Industry as relevant and necessary to the Industry.
- To be truly representing the Industry's interests in the national arena (the natural choice).

Operational Framework

- Have a business plan which incorporates an operating strategy based upon the findings of this Planning Workshop in order to develop a realistic programme of activities in line with resources available.
- Be able to measure the performance now and in the future (concentrate on key measures only).

Organisational and Human Resource Issues

- Realistic support structure, including decentralisation of administration, finance, development and public relations, leading to cost centre management.
- Appraisal of staff against mission with a realistic staff development programme (including on-the-job coaching).
- Rationalisation of structure of executive committee and roles and responsibilities.

Footnotes

- o Requirement for coherent corporate view of EITB's role.
- o Less ad-hoc, more pro-active, long-term planning.
- o Highly visible initiatives (small number, tangible, physical).

Examples of Potential Measures of Improved Performance

- o Disappearance or significant reduction of 'Gang' as a destructive element.
- o Value for money through income generation.
- o The percentage increase in adult training (e.g. on segments) as opposed to ab-initiatory.

6. Conclusions

The major results of the Planning Workshop are summarised below:

- An explicit statement by Regional Managers as to their perceptions of what products and services the EITB should be providing for Industry over the next 3-5 years.

- A classification of the products and services into categories showing major groupings of activity.

- Priority structures giving:

  - a ranking of the categories of products and services in terms of importance,
  - a ranking of the individual products and services within each category in terms of importance.

- A tentative mission statement for the EITB from the viewpoint of Regional Managers.

- This report on what occurred and the results of the Planning Workshop for discussion by senior management and participants.

- A better understanding by Regional Managers and others involved in the Workshop as to what they think the EITB should be trying to achieve.

- Team building amongst participants and some planning momentum.

- A basis for future planning and organisational design.

The Planning Workshop has enabled Regional Managers as a group to state clearly what they see as the priorities for the EITB over the next 3 - 5 years with regard to the engineering industry. This report should provide an important source of ideas and information to those at Headquarters responsible for developing the next EITB Coorporate Business Plan and will thus enable the views of Regional Managers to be taken into account when the plan is formulated.

Table 1 : Products And Services Generated In The N.G.T Session. (See Section 3)

Steps of N G T

1 Clarification of trigger question
2 Silent generation of ideas in writing
3 Round-robin recording of ideas
4 Serial discussion of ideas for clarification
5 Voting

Trigger Question

"What products and services should the EITB deliver on behalf of Industry over the next 3-5 years ?"

	Resulting Products and Services	Voting	Total
1	Provide companies with a training consultancy service that identifies training requirements according to a company's business activities [i.g.]	8,8,8,7,8,8,6,8	61
2	Provide a comprehensive and valued system of integrated engineering skills training. i.e. Industry will pay for it	4,6,6,1,8,6,8	31
3	Influence national developments in education and training to the best advantage of the Industry (e.g. NCVQ, TVI, GCSE)		
4	Establish standards of training	5,2	7
[5	*Provide a focus and facilities for local issues]*		
6	Develop training materials with the Industry on a demand led basis [i.g.]	1,3	4
7	Establish authority of EITB as the engineering lead body (Including certification)	5,4,3,6	18
8	Mount local initiatives to alleviate identified skill shortages (e.g. local labour market basis including adult retraining)	3,5	8
9	Provide training expertise to companies that will enable them to meet their identified needs [i.g.]	7,7,7	21
[10	*Create a higher profile for HRD in general and EITB in particular]*		

Key

[i.g.] Indicates an income generator

Italics Indicates a policy statement

Shadow Indicates a deleted item

Resulting Products and Services		Voting	Total
11	Provide a service to assist engineering companies to exploit new technologies. (e.g. advisory service, training courses audit, process consultancy)	5,2,4,5,6	22
12	Pilot new training techniques. (e.g. Interactive video)	3	3
13	Take measures to influence the supply of suitably qualified young people to meet the needs of companies (Careers activities, teacher retraining, Insight)	4,2	6
14	Provide an information service covering the EITB's knowledge and expertise [i.g]	7,2	9
15	Provide direct training of engineering skills [i.g.]		
16	Provide an advisory service to company management on the impact of change on its human resources [i.g.]	6,5,7,4	22
17	Provide a centre for advanced training technology awareness [i.g.]	3,1,3	7
18	Represent the Industry's interests in the national arena (e.g. government, agencies and institutions)	2,1	3
19	Provide financial incentives where appropriate (e.g. Pacemaker, Enhanced Regional Dimension)	5,5	10
20	Provide a business skills training service for engineering companies [i.g.]		
21	Market and sell evaluated training materials [i.g.]	4	4
22	Encourage market-led development of work competencies through working with companies. (e.g. company based segments)	3	3
23	Control the monitoring and validation service for all transferable skill training [i.g.]	3,4,6,2,7	22
24	Facilitate the focus for the meeting of a collective training need (e.g. MSc course in several universities, local collaborative projects) [i.g.]	1	1
25	Provide a contract training officer service [i.g.]		
26	Develop and promote exemplary schemes of management training and development [i.g.]		
27	Conduct research on human resource related subjects [i.g.]		
28	Provide a direct training service (e.g. Team building courses, management development courses) [i.g.]	7,1,4	12

Resulting Products and Services		Voting	Total
29	Support the work of other Institutions to assist them in providing a service required by the Industry		
30	Market and sell EITB training products in non-scope organisations [i.g.]		
31	Improve the calibre and skill of the industry 's training staffs [i.g.]	1	1
32	Assist firms to access more readily educational and research facilities in FE/HE		
[33	*Influence an increase in what the Industry effectively spends on training]*		
[34	**Influence the supply of young people entering the Industry]**		
35	Assist Industry to maximise financial benefit of national schemes		
36	Establish codes of best training practices	1,2	3
37	Mount national initiatives to alleviate identified skills shortages		
38	Establish chairs in manufacturing systems technology	2	2

A Training , Technology, Resources and Support Facilities

- 17 Provide a centre for advanced training technology awareness [i.g.]
- 26 Develop and promote exemplary schemes of management training and development [i.g]
- 12 Pilot new training techniques (e.g. Interactive Video)
- 38 Establish chairs in manufacturing systems technology
- 21 Market and sell evaluated training materials [i.g.]
- 15 Provide direct training of engineering skills [i.g]
- 6 Develop training materials with the Industry on a demand led basis [i.g.]
- 30 Market and sell EITB training products in non-scope organisations [i.g.]
- 36 Establish codes of best training practices
- 31 Improve the calibre and skill of the Industry's training staffs [i.g]

B Standards Based Training Systems

- 2 Provide a comprehensive and valued system of integrated engineering skills training i.e. Industry will pay for it
- 7 Establish authority of EITB as the engineering lead body (including certification)
- 4 Establish standards of training
- 23 Control the monitoring and validation service for all transferable skill training [i.g]
- 22 Encourage market led development of work competencies through working with companies (Company based segments)

C Supply of People

- 37 Mount national initiatives to alleviate identified skills shortages
- 8 Mount local initiatives to alleviate identified skills shortages (e.g. local labour market basis including adult retraining)
- 13 Take measures to influence the supply of suitably qualified young people to meet the needs of companies (careers activities, teacher retraining, Insight)

D Company Specific Services

- 1 Provide companies with a training consultancy service that identifies training requirements according to a company's business activities [i.g.]
- 9 Provide training expertise to companies that will enable them to meet their identified needs [i.g]
- 11 Provide a service to assist engineering companies to exploit new technologies. (e.g. advisory service, training courses audit, process consultancy)
- 20 Provide a business skills training service for engineering companies [i.g.]
- 16 Provide an advisory service to company management on the impact of change on its human resources [i.g.]
- 28 Provide a direct training service (e.g. team building, management development courses) [i.g]
- 25 Provide a contract training officer [i.g.]

E Information and Research

- 27 Conduct research on human resource related subjects [i.g.]
- 14 Provide an information service covering the EITB's knowledge and expertise [i.g]

F Industry Representation and Support

- 18 Represent the Industry's interests in the national arena (e.g. Government, Agencies and Instititutions)
- 35 Assist Industry to maximise financial benefit of national schemes
- 3 Influence national developments in education and training to the best advantage of the Industry e.g. NCVQ, TVI, GCSE
- 24 Facilitate the focus for the meeting of a collective training need (e.g. MSc course in several universities, local collaborative projects) [i.g]
- 29 Support the work of other institutions to assist them in providing a service required by the Industry
- 32 Assist firms to access more readily educational and research facilities in FE/HE

G Ways and Means

- 19 Provide financial incentives where appropriate (e.g. Pacemaker, Enhanced Regional Dimension)

Table 2 : Classification Of Products And Services Into Categories

Table 3 Priority Structure For Categories Of Products and Services

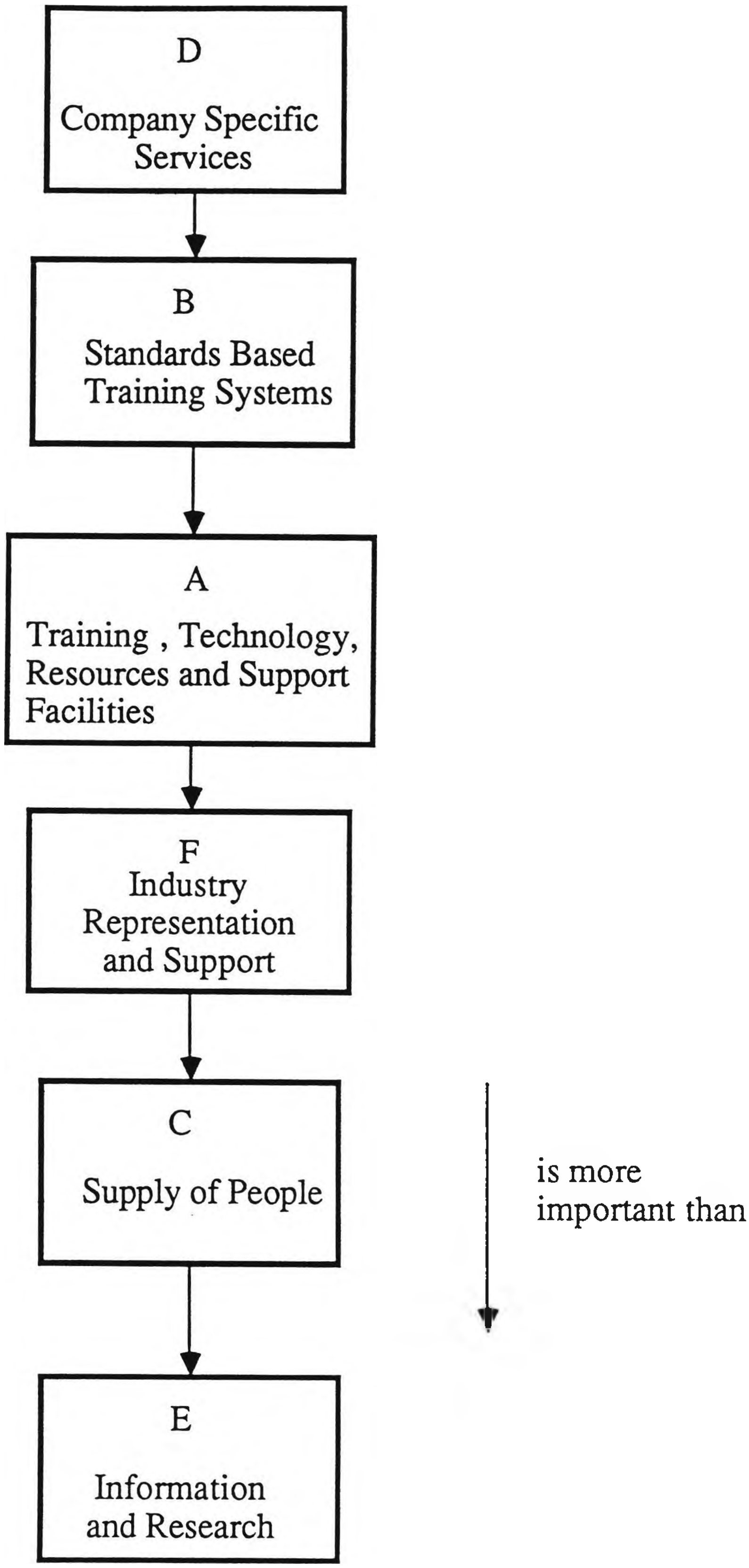


Table 4 : Priority Structure For Company Specific Services

D

Company Specific Services

1 Provide companies with a training consultancy service that identifies training requirements according to a company's business activities [i.g.]

9 Provide training expertise to companies that will enable them to meet their identified needs [i.g]

28 Provide a general direct training service (e.g. team building, management development courses) [i.g]

11 Provide a service to assist engineering companies to exploit new technologies. (e.g. advisory service, training courses audit, process consultancy)

20 Provide a business skills training service for engineering companies [i.g.]

16 Provide an advisory service to company management on the impact of change on its human resources [i.g.]

25 Provide a contract training officer [i.g.]

is more important than

i.g. = income generator

Table 5 : Priority Structure For Standards Based Training Systems

B

Standards Based Training Systems

7 Establish authority of the EITB as the engineering lead body (including certification)

is more important than

2 Provide a comprehensive and valued system of integrated engineering skills training i.e. Industry will pay for it

22 Encourage market-led development of work competencies through working with companies (national and company standards)

23 Control the monitoring and validation service for all transferable skill training [i.g]

i.g. = income generator

Table 6 : Priority Structure For Training, Technology, Resources and Support Facilities

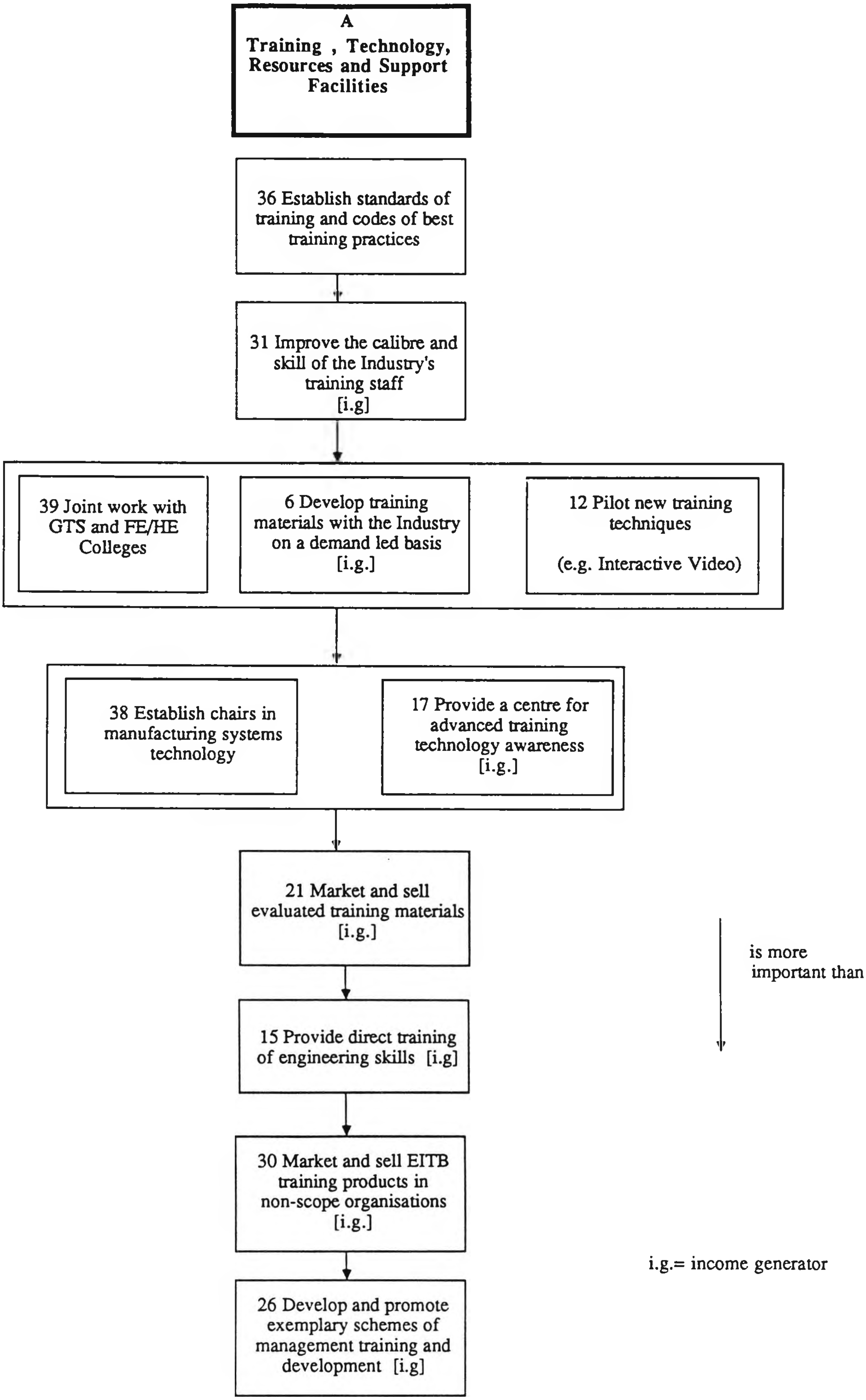


Table 7 : Priority Structure For Industry Representation, Supply Of People, Information and Research

F
Industry Representation and Support

18 Represent the Industry's interests in the national arena (e.g. Government, Agencies and Instititutions)

↓

3 Influence national developments in education and training to the best advantage of the Industry (e.g. NCVQ, TVI, GCSE)

↓

35 Assist Industry to maximise financial benefit of European and national schemes

↓

29 Support the work of other national institutions to assist them in providing a service required by the Industry

↓

24 Facilitate the focus for the meeting of a collective training need (e.g. MSc course in several universities, local collaborative projects) [i.g]

↓

32 Assist firms to access more readily educational and research facilities in FE/HE

C
Supply of People

8 Mount initiatives to alleviate identified local and national skills shortages

↓

13 Take measures to influence the supply of suitably qualified young people to meet the needs of companies (careers activities, teacher retraining, Insight)

E
Information and Research

14 Provide an information service covering the EITB's knowledge and expertise [i.g]

↓

27 Conduct research on human resource related subjects [i.g.]

↓ is more important than

i.g.= income generator

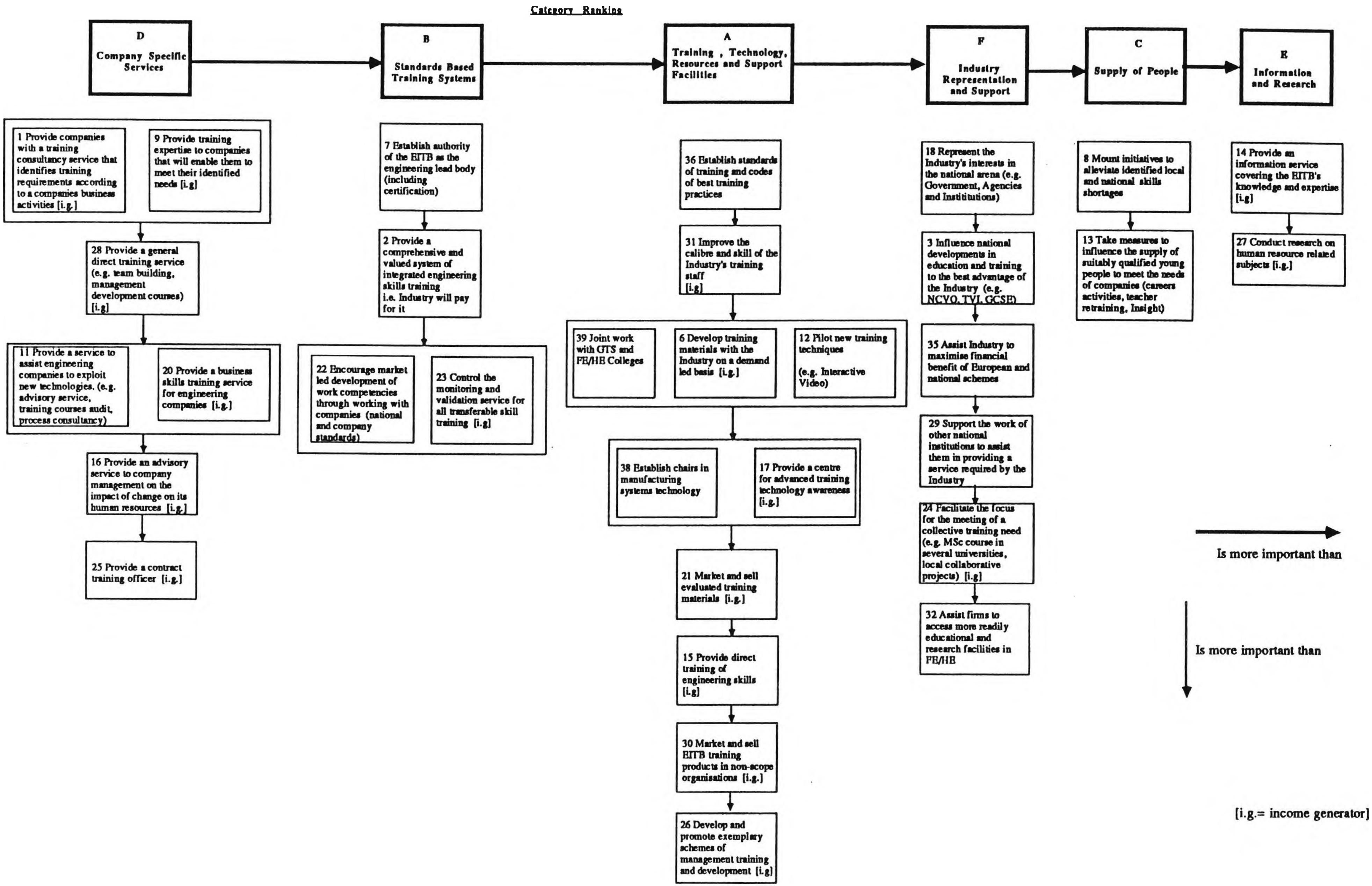


Table 8 : Overview Of Category Ranking And Priorities Within Each Category

Appendix C

Mission Statements Produced by Each Group

Participants worked in two separate groups each producing its own mission statement. The products of each group were combined after discussion to give the tentative mission statement in section 5. The separate statements produced by each group are reproduced below.

1. Group A's Statement

In order to be a significantly better organisation we need:

- o to have survived,
- o to be able to measure the performance now and in the future,
- o to have a business plan which incorporates an operating strategy based upon the findings of this Planning Workshop.

The above operational strategy should be based upon being able:

- o to demonstrate a significantly improved training service in the field of company problem resolution,
- o to be the engineering lead body and to be accepted as such,
- o to be seen by the Industry as relevant and necessary to the Industry.
- o to be truly representing the Industry's interests in the national arena (the natural choice),
- o less ad-hoc, more pro-active, long-term planning,
- o highly visible initiatives (small number, tangible, physical).

Potential measures of improved performance include:

- o disappearance or a significant reduction of the 'Gang' as a destructive element,
- o value for money through income generation,
- o the percentage increase in adult training (e.g. on segments) as opposed to ab-initiatory.

2. Group B's Statement

Requirement for coherent corporate view of EITB's role:

Mission To be the professional and valued training service to the engineering industry.

Requirements:

- o service aligned to the overall requirements of companies in scope to the EITB,
- o minimise statutory interventionist role and maximise professional acceptance,
- o develop a realistic programme of activities in line with resources available to enable the achievement of objectives recognised by Industry.

To do this we must develop our operation, organisation and resources including:

- o realistic support structure including decentralisation of administration,
- o appraisal of staff against mission with a realistic staff development programme (including on-the-job coaching)
- o rationalisation of structure of executive committee and roles and responsibilities.

FILE: RJRJ
DISK: ROSS JANES

SUPPORTING PAPER J

Janes, F.R. and M'Pherson, P.K. (1985). Planning exercise for the Management Support Department of the Metropolitan Police. Technical Report No. DSS/FRJ-PKM/241, Dept. of Systems Science, City University, London. 25pp.

PLANNING EXERCISE

for

THE MANAGEMENT SUPPORT DEPARTMENT

of

THE METROPOLITAN POLICE FORCE

(A report on a three-day planning exercise held at The City University on March 25th, April 2nd and 9th, 1985).

F. R. Janes

P. K. M'Pherson

Department of Systems Science
The City University
Northampton Square
London EC1V OHB

May, 1985

Technical Report No. DSS/FRJ-PKM/241

TABLE OF CONTENTS

* Abbreviations used in this report:

M.S. The Management Support Department
NGT Nominal Group Technique
ISM Interpretive Structural Modelling

1. SUMMARY

Senior management of the Management Support Department (M.S.) of the Metropolitan Police, together with some representatives from other departments, met on three separate days at The City University to initiate strategic planning for the Department.

The programme of meetings involved participants in, firstly, developing an appropriate set of accomplishments for M.S. over a five-year time horizon and, secondly, examining how these accomplishments were interrelated. The methods of computer-aided interactive management were used for this purpose with The City University team acting as facilitators throughout, leading the group through a series of processes specifically designed to promote the efficient generation and structuring of ideas.

On day one, an idea-generation method was used to help participants in generating, clarifying, editing and producing a preliminary ranking of a set of over 60 potential accomplishments for the Department. These were subsequently classified into groups representing different areas of activity. On day two, a subset of 32 of these potential accomplishments was structured with the help of a computer to produce an Intent Structure, which shows how they would influence one another. The various hierarchical levels within the Intent Structure were subsequently identified and labelled. On day three, the same set of accomplishments was structured again, this time to set them in order of importance, so producing a Priority Structure. The Intent and Priority Structures were interpreted and their uses discussed. Finally, the group formulated a set of six goals for M.S.

The planning exercise and products resulting from it give a clear picture regarding the group's thinking on the role and functions of M.S. This provides a basis for subsequent design activities to formulate alternative structures for M.S. as an organization.

2. TERMS OF REFERENCE

This report has been produced for Mr C. B. J. Sutton[1] of the Metropolitan Police by Mr F. R. Janes[2] and Professor P K M'Pherson[3] of The City University

At the suggesiton of Chief Superintendent A. Wright of the Force Policy Analysis Unit at New Scotland Yard, the Department of Systems Science at The City University submitted a proposal for a planning exercise designed to assist the Metropolitan Police Force in strategic planning for the newly formed Management Support Department (M.S.).

The exercise took place over three days, March 25th, April 2nd and 9th, 1985, at The City University and was followed by a presentation of results at New Scotland Yard on April 12th. A group of twelve participants from the Force were involved (Appendix II), including senior management representing activities within M.S., together with some representation from other departments outside M.S.

The original aim of the work was stated as: 'The planning exercise will be designed to assist the Metropolitan Police in producing and structuring the objectives for the new Department being set up to deal with management services/support'. The remainder of this report describes the process by which this aim was achieved and the products resulting from the planning exercise.

---

(1) Assistant Commissioner (Management Support Department).
(2) Senior Lecturer and Director of Systems Science.
(3) Head of Department of Systems Science and Pro-Vice-Chancellor.

3. GENERATION OF OBJECTIVES FOR M.S.

3.1. Method.

On the first day, the group participated in an idea-generation method called Nominal Group Technique. This was used to generate, clarify, edit and obtain a preliminary ranking of a set of objectives for M.S.

3.2. Nominal Group Technique (NGT): Steps.

NGT involes the following steps:

1. Silent generation of ideas in writing in response to a trigger question.

2. Round-robin recording of ideas, whereby the ideas of participants are recorded on a flip chart and displayed.

3. Serial discussion of ideas for clarification, whereby each item is discussed in turn with the group in order to clarify and edit it.

4. Voting in order to enable participants to express their value judgements with regard to the importance of the ideas generated.

3.2.1 Trigger question.

The question posed to the group was:

'Irrespective of the structure declared on block change day, what should a Management Support Department in the Metropolitan Police be trying to achieve over the next 5 years?'

3.2.2 Ideas generated.

A total of 68 ideas were generated during the NGT and are shown in Table 1. They may be considered as a set of objectives for M.S., where the word 'objectives' is used in its broadest sense to denote potential accomplishments over the five-year period specified in the trigger question.

The numbers appearing before the objectives reflect the sequence in which the ideas were presented and are not of any other significance. For simplicity this original numbering scheme has been retained throughout the report. During discussion and clarification (step 3), certain ideas were deleted as they were judged to be redundant, e.g., they duplicated other ideas. These items (Numbers 15, 17, 24, 47, 58, 63, 66) are not shown here but are included in Appendix III.

3.2.3 Explanation of voting.

Following clarification of the ideas generated, the participants were asked to select individually the eight which they considered to be most important. They were then asked individually to rank their eight selected items, assigning an '8' to the most important and a '1' to the least important and so on. The voting scores are listed alongside the ideas, in Table 1.

The voting scores should not be taken as an accurate ranking. They provide a rough and ready initial assessment of the participants' judgements concerning relative importance of the objectives. Given time constraints this enables the facilitators to select a subset of items to be structured in a reasonable amount of time.

3.3. Classification of Objectives.

Following the NGT, the entire set of objectives was classified into groups (Table 2). Group F is largely concerned with the internal functioning of M.S. itself, whilst the other groups A,B,C,D,E are concerned with the role M.S. could play regarding the Force and other agencies.

Thus, for example, objective No. 3 from Table 1, 'To provide an independent quality control of Force Performance to influence Force strategy', is classified in group C concerned with monitoring and evaluation of the Force. Certain objectives appear in more than one group. For example, No. 32 'To encourage the evolution of good management attitudes and motivation' appears under both B (a) and under F(c).

4. STRUCTURING THE OBJECTIVES.

4.1. Method.

In order to examine the relationships amongst the objectives, the group participated in a process called Interpretive Structural Modelling (ISM). This is a computer-aided method which helps participants to examine the interactions between the elements in a complex problem. It enables a group to pool their thinking and reach agreement on the structure of a problem. In this case two ISM sessions were carried out on separate days, taking the objectives developed during the NGT as the elements to be structured. The resulting Intent and Priority Structures are outlined below.

4.2. Intent Structure.

An Intent Structure shows how the accomplishment of one objective or goal might contribute to the achievement of another. In this case 32 of the objectives were selected for structuring on a basis of the NGT voting scores. The ISM process required the group to respond to a series of questions put by the computer of the form:

WOULD ACCOMPLISHING THE OBJECTIVE
2. To establish an integrated
Force planning system.

HELP TO ACHIEVE THE OBJECTIVE
20. To identify and analyse
policy options.
?

As with the NGT, a five-year time horizon was assumed. As the process proceeds the computer builds up an ISM 'map', portraying the group's perceptions of the interrelations between the objectives. This can be displayed at any stage, examined by the group and amended as desired. Figure 1 shows the completed 32 element map (Intent Structure 'B'). Appendix IV shows the intermediate map of 15 elements extracted at the half-way stage (Intent Structure 'A').

4.2.1 Interpretation of Intent Structure.

The boxes in the map contain the objectives with the original numbering scheme as in Table 1. The arrows between the boxes represent the relation 'would help to achieve'. The Intent Structure thus shows what helps to achieve what.

Paths. A sequence of objectives connected by arrows is known as a path on the map. For example, the path 43 ⟶ 12 ⟶ 11 is explicitly shown. This may be interpreted as a statement that objective 43 helps to achieve objective 12 and that 12 helps to achieve 11. However, the nature of the map means that 43 may help to achieve directly any elements which it reaches via a path of one or more arrows, e.g., objectives 12, 11, 29, 18. A similar interpretation may be made regarding the interrelations between the other objectives on the map.

Cycles. There are a number of cycles on the map indicated by the black dots. Consider, for example, the cycle between objectives 7 and 19. This implies both that 7 helps to achieve 19 and that 19 helps to achieve 7. The large cycle of six objectives in the middle of the map shows a highly interdependent group of elements needing careful integration to make them all function together.

Levels. The Intent Structure may be partitioned into a number of broad levels as indicated on the right hand side of the map. For example, the 'Enabling Framework' level shows those objectives which, if accomplished, would provide a framework enabling M.S. to provide 'Force Evaluation and Services' at the level above. The latter group is broadly concerned with the monitoring and evaluation of Force performance and with the provision of services to the Force. It can be seen that these levels broadly agree with the groups into which the objectives were originally classified following the NGT session (Table 2).

4.3. Priority Structure.

A Priority Structure was developed to show the group's ranking of the objectives in order of importance. The same 32 elements were structured as for the Intent Structure. In this case, the ISM process required the group to respond to a series of questions about the objectives put by the computer of the form:

IS

32. To encourage the evolution of good management attitudes and motivation

MORE IMPORTANT THAN

5. To interpret and present Force policy understandably to the Force.

?

A five-year time horizon was assumed and it was suggested that each question be considered on a basis of 'if M.S. could only achieve one of the two objectives in the question, which would it be?'

The computer builds up an ISM map as the group supplies answers to the questions. This can be extracted, displayed and amended by hand at any stage as required. Figure 2 shows the completed 32 element Priority Structure.

4.3.1 Interpretation of Priority Structure.

The arrows between the boxes in the map denote the expression 'is more important than'. Thus No. 32 was seen as the most importance objective at the top of the eleven different levels of priority. The black dots alongside a group of objectives in a box indicate that those objectives were seen as being equally important.

It will be noticed that the ordering in the Priority Structure differs somewhat from the initial tentative rankings provided by the NGT voting scores (Table 1). This is a measure of the learning that took place when the participants had an opportunity to reflect upon and argue the relative merits of the various objectives.

During the development of the Priority Structure, it was decided that objectives Nos. 4 and 21 were too narrowly focussed. The wording of these was modified accordingly in the Priority Structure but the original wording and meaning are retained in the Intent Structure.

4.4. Uses of Intent and Priority Structures.

Within the context of M.S., the uses of such Intent and Priority Structures include the following:

- Making explicit the multiple objectives of M.S. and their management implications.
- Clarifying thinking through asking participants systematically to think through the complex interactions between the objectives.
- As a way of explaining the purpose of M.S. to those within the Department, the Force and outside agencies.
- As a way of assessing and reporting progress. Many objectives may be followed at the same time and effort may be switched between them.
- As a base from which to change objectives as new ideas are developed or as circumstances change.
- As a basis for programme planning. The levels and groupings which emerge from the structures and the interrelations between the objectives provide useful information for this purpose.
- As a basis for policy analysis. Given limited resources, the structures can assist in deciding on the allocation of resources to those activities which will be most productive.
- To assist in organizational design. Particularly in the case of a new department such as M.S., the Intent and Priority Structures can provide the starting point for designing an appropriate organizational structure (see section 6.2).

5. GOALS FOR M.S.

5.1. Method.

At the end of the third day, participants were split into two groups and each group was asked to formulate independently a set of goals for M.S. using the information contained in the Intent and Priority Structures.

The groups were presented with the following focussing question:

> 'Using the information produced so far, what are the major goals of M.S.?'

A plenary session was then held when the resulting ideas put forward by each group were displayed (Appendix V). After discussion, the participants agreed on a single set of six goals which encapsulated the work of both groups.

5.2. Agreed Goals.

The agreed goals are stated below. No interpretation should be put on the order in which they occur as the group did not wish to prioritize them.

Management Support Department - Goals

To provide the development of good management practice, quality of service and professionalism at all levels by:

- Enhancing the ability of the Force to think and act in a corporate manner.
- Stimulating the improvement of internal and external communications and the Force image.
- Co-ordinating the provision of comprehensive research, information and statistical resources.
- Developing a strategic/corporate planning framework.
- Enhancing the decision-making process through the provision of better policy formulation processes.
- Providing frameworks for monitoring and evaluating performance.

6. CONCLUSIONS

6.1. Summary of Results of Planning Exercise.

The major results of the planning exercise are summarized below:

- An explicit statement by senior management of M.S. as to their perceptions of its goals and objectives for the next five years.
- A classification of the objectives into subsets showing major groupings of activity.
- Intent and Priority Structures, showing the interrelations between the objectives and providing a ranking in terms of importance.
- Recommendations as to possible ways of moving forward.
- This report on what occurred and the results of the planning exercise for discussion by senior management within M.S. and the Force.
- A better understanding by those involved in the planning exercise as to what they think M.S. should be trying to achieve.
- Team building amongst participants and some planning momentum.
- A basis for future planning and organizational design of M.S.

6.2. Recommendations for the Future

- This report should be circulated to senior management within the Force and within M.S. to obtain reactions and any suggestions for change in order to allow planning to progress.
- M.S. should establish a long-range planning and management team to examine goals, objectives, organizational design and programme planning for the Department.
- Future work, following on directly from this recent planning exercise, should involve the synthesis of alternative organizational designs for M.S. to meet the goals and objectives established. The Intent and Priority Structures could form a basis for this work.
- Alternative organizational designs would be evaluated using criteria related to the Intent and Priority Structures. A recommendation would be made regarding the best alternative for implementation.

No.	Objective	Voting
1.	To be responsive to forced changes: technology, social, legislative.	7,3,7,4
2.	To establish an integrated Force planning system.	3,8,5,6,8,4,7
3.	To provide an independent quality control of Force performance to influence Force strategy.	4,8,8,7
4.	To provide regular information and advice to Policy Committee on environmental changes.	6,5,2
5.	To interpret and present Force policy understandably to the Force.	1,6,3,6,4
6.	To create an M.S. corporate support framework to enable the Force to function more efficiently and effectively at the strategic level.	6,8,3
7.	To clarify the lines of management decision making and planning processes within the Force.	1,6,3,
8.	To provide comprehensive research support for all levels of the Force.	1,6,3,1,7,5,1
9.	To provide clear lines for passing advice to and receiving advice from the Force on Force developments.	
10.	To establish contacts between departments to ensure consultation and coordination.	4
11.	To seek out good practice with potential; to research and develop it.	7
12.	To evaluate effectiveness and efficiency resulting from changes in Force organization.	6
13.	To liaise with the Home Office, other Forces and other organizations regarding research and development.	
14.	To establish a fully integrated information strategy.	4,6,7,7,1,4,6, 4,2,2
16.	To coordinate and, where appropriate, prepare Force strategic communications for internal and external presentation.	
18.	To assist both senior and subordinate decision makers to assess both the quality and quantity of service to the public.	2,5
19.	To provide administrative control of information and committee demands in and out of the Force.	1
20.	To identify and analyse policy options.	3,3
21.	To provide recommendations to Policy Committee on matters of Force "image".	2,5,5
22.	To concern itself primarily with the observance of the policy goals of the Force.	8,4
23.	To provide a source of information about all relevant research.	
25.	To house the statistical units for the Force.	1
26.	To support the Resource Centre for management.	3
27.	To coordinate an effective system of ascertaining the public's perception of the Force.	
28.	To provide a focus of liaison with Force staff associations on Force policy and planning.	
29.	To ensure that the Force has policies where policies are needed.	7,5,6,2
30.	To provide an effective secretariat to service Policy and other major Force Committees.	1
31.	To actively promote corporate thinking at all levels and incidentally reduce unnecessary departmental friction.	7,4,7,5
32.	To encourage the evolution of good management attitudes and motivation.	8,8
33.	To establish a primary centre within M.S. for informing the public of Metropolitan Police needs and aspirations.	3
34.	To establish and/or enhance links at Force level with other agencies.	
35.	To ensure M.S. supports the Force as a whole.	7,5,2,8
36.	To avoid giving the impression that M.S. appears to be running the Force.	
37.	To provide a problem-solving support facility for divisional policing.	

Table 1: Objectives Generated in NGT Session (See Section 3.2.2)

		Voting
38.	To ensure Force orders/regulations support the principles of the reorganization	5
39.	To provide a mechanism to align planning with resources, estimating and budgeting.	2
40.	To ensure that Force policies are effectively integrated.	2
41.	To monitor and review all current Force research initiatives.	1,1
42.	To provide facilities to help operational management.	
43.	To ensure development, coordination and quality of all research and development.	1
44.	To establish a centre for encouraging and tapping all creativity in civil and police personnel.	
45.	To improve the management support input at each area headquarters.	
46.	To encourage honesty and openness in our relationships with the public at all levels of the Force.	
48.	To establish a system for monitoring organizational stress and advising on remedial measures.	
49.	To provide a balance between the need to obtain information and the imposition of necessary burdens in cost or manpower.	
50.	To liaise with the public and private sectors tokeep the Force in forefront of new managerial techniques.	4
51.	To earn credibility and respect for M.S.	8
52.	To be aware of policing initiatives nationally/internationally and to disseminate the Metropolitan effort on a reciprocal basis.	
53.	To establish mechanisms for face to face consultation within the Force at all levels.	
54.	To undertake long-term speculative research.	
55.	To establish the Metropolitan Police externally as a creative force in tune with social change.	8,2
56.	To monitor success/failure in crime prevention and detection with a view to influencing legislative and judicial policy.	3

		Voting
57.	To develop awareness within M.S. of shop-floor thinking within the Force and deal sensitively with it.	
59.	To encourage frank and open discussion without regard to rank or status withinM.S. and the Force.	5
60.	To assess, promote and maintain Force morale.	2
61.	To coordinate the preparation and revision of Force manuals, publications and forms.	
62.	To carry out its role without doing tasks best done by others.	
64.	To establish an M.S. with the necessary resources to undertake the objectives set.	8,3,5
65.	To support in-service training.	
67.	To actively help push down the decision making process in accordance with the reorganization philosophy.	4
68.	To employ and manage consultants to best effect.	

Table 1 (continued)

Table 2. Classification of Objectives Generated in NGT Session (see Section 3.3.)

A. POLICY SUPPORT

(a) Policy Making and Planning (2) (6) (7) (20) (28) (29) (39) (40)

(b) Services to Policy Committee (4) (21) (30)

B. SERVICES TO FORCE

(a) Promoting Good Management Practice (32) (38) (42) (44) (48) (50) (52) (59) (65) (68)

(b) Information/Liaison within Force (5) (9) (10) (14) (16) (19) (28) (49) (53) (57) (61)

(c) Support at Operational/Divisional Level (37) (42) (45)

(d) Organizational Change (12) (38)

(e) Responding to Forced Change (1) (4)

C. MONITORING AND EVALUATION OF FORCE

(a) Internal Functioning of Force (12) (48) (57) (60)

(b) Force Performance (3) (18) (56) (25)

D. PUBLIC RELATIONS

(a) Communicating with Public (16) (33) (46) (55)

(b) Force Image (21) (27)

(c) Linkages with Other Agencies (34)

E. RESEARCH SUPPORT

(a) Provision of Information (23) (25) (52)

(b) Research Coordination and Monitoring within Force (41) (43)

(c) Doing Research (8) (54)

(d) Liaison with Other Agencies regarding Research and Development (13)

F. FUNCTIONING OF MANAGEMENT SUPPORT DEPARTMENT

(a) Supporting Force as a Whole (2) (6) (14) (31) (35)

(b) Management and Decision Making within Department (7) (67)

(c) Good Management Practice (32) (44) (48) (50) (59) (65) (68)

(d) Resources to Support Department (26) (39) (64)

(e) Harmonization within Department (10) (31) (35) (59)

(f) Coordination with Other Departments (9) (10)

(g) Image of Department (36) (51)

(h) Limitation of Role (22) (62)

Figure 1: Intent Structure 'B' (see Section 4.2)

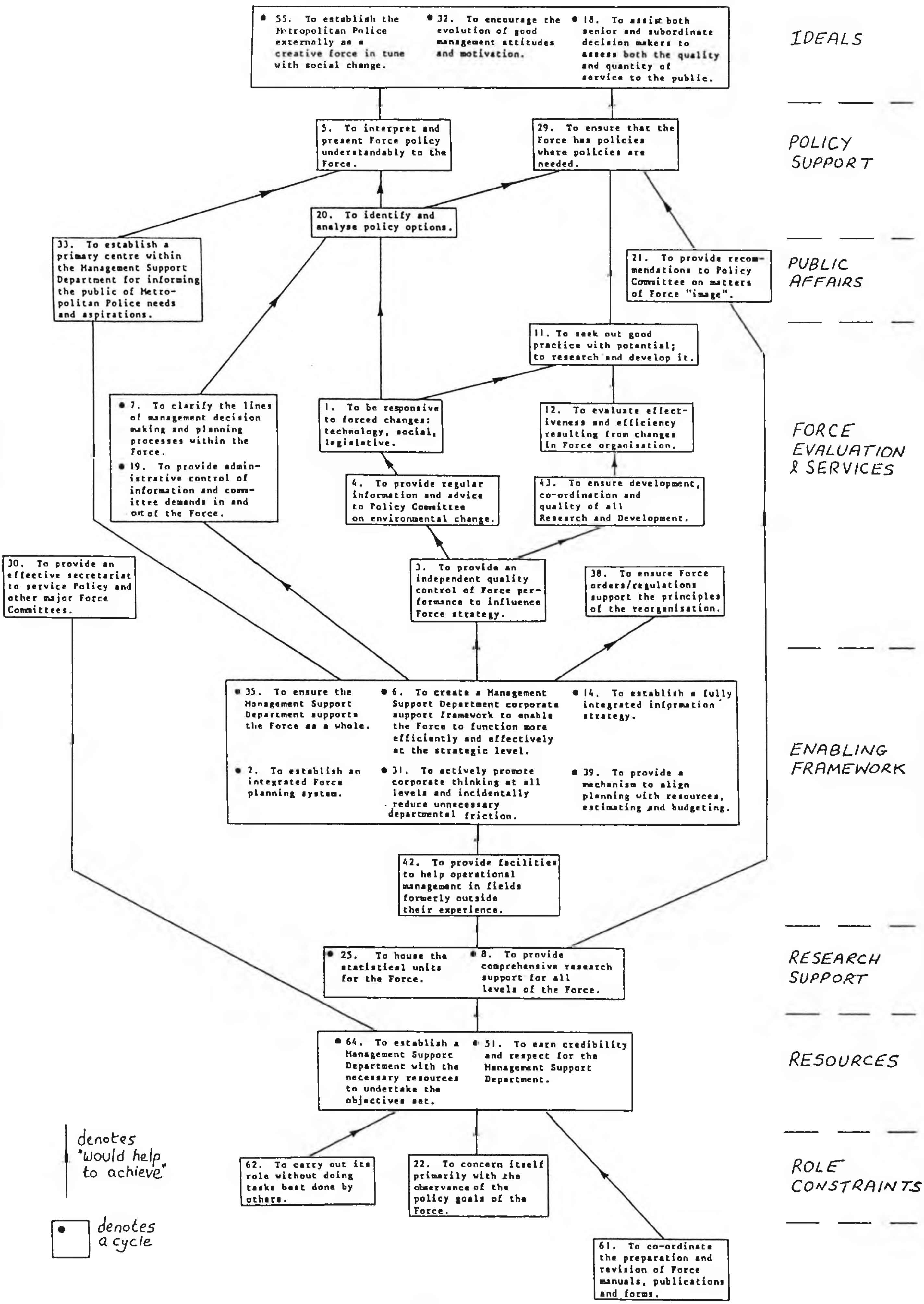


Figure 2: Priority Structure (See Section 4.3)

32. To encourage the evolution of good management attitudes and motivation.

↓

- 55. To establish the Metropolitan Police externally as a creative force in tune with social change.
- 21. To project and enhance Force image.

↓

- 51. To earn credibility and respect for the Management Support Department.
- 35. To ensure the Management Support Department supports the Force as a whole.
- 31. To actively promote corporate thinking at all levels and incidentally reduce unnecessary departmental friction.

↓

64. To establish a Management Support Department with the necessary resources to undertake the objectives set.

↓

- 2. To establish an integrated Force planning system.
- 39. To provide a mechanism to align planning with resources, estimating and budgeting.

↓

- 1. To be responsive to forced changes: technology, social, legislative.
- 8. To provide comprehensive research support for all levels of the Force.

↓

- 11. To seek out good practice with potential; to research and develop it.
- 43. To ensure development, co-ordination and quality of all Research and Development.

↓

- 4. To provide regular information and advice on environmental change.
- 20. To identify and analyse policy options.
- 29. To ensure that the Force has policies where policies are needed.
- 5. To interpret and present Force policy understandably to the Force.
- 19. To provide administrative control of information and committee demands in and out of the Force.
- 22. To concern itself primarily with the observance of the policy goals of the Force.
- 6. To create a Management Support Department corporate support framework to enable the Force to function more efficiently and effectively at the strategic level.
- 3. To provide an independent quality control of Force performance to influence Force strategy.
- 33. To establish a primary centre within the Management Support Department for informing the public of Metropolitan Police needs and aspirations.
- 18. To assist both senior and subordinate decision makers to assess both the quality and quantity of service to the public.

↓

- 14. To establish a fully integrated information strategy.
- 7. To clarify the lines of management decision making and planning processes within the Force.
- 25. To house the statistical units for the Force.
- 30. To provide an effective secretariat to service Policy and other major Force Committees.
- 42. To provide facilities to help operational management in fields formerly outside their experience.

↓

- 61. To co-ordinate the preparation and revision of Force manuals, publications and forms.
- 12. To evaluate effectiveness and efficiency resulting from changes in Force organisation.
- 38. To ensure Force orders/regulations support the principles of the reorganisation.

↓

62. To carry out its role without doing tasks best done by others.

| denotes "is more important than"

[•] denotes "equally important"

SUPPORTING PAPER K

Janes, F.R. (1987c). Setting priorities for highway schemes in Hertfordshire using interpretive structural modelling. Technical Report No. DSS/FRJ/246, Dept. of Systems Science, City University, London. 7pp.

SETTING PRIORITIES
FOR HIGHWAY SCHEMES IN HERTFORDSHIRE
USING INTERPRETIVE STRUCTURAL MODELLING

(A report produced for the Highways Department of Hertfordshire County Council on a one-day modelling project undertaken at the City University on April 7th 1987).

F.R. Janes

Department of Systems Science
The City University
Northampton Square
London EC1V 0HB

May 1987

Technical Report No. DSS/FRJ/246

CONTENTS

1. Summary

Staff from Hertfordshire County Council involved in ranking capital highway schemes participated in a one-day meeting at the City University to prioritize 47 highway schemes using a 'value for money' criterion.

The 47 schemes were all major capital schemes listed in the County Council Report 'Transport Policies and Programmes 1987-88'. With the help of a computer and focussed argument, the participants initially prioritized 25 of the schemes using the Interpretive Structural Modelling software under the guidance of a facilitator. These 25 schemes had been selected as being representative of the complete list of 47. After agreeing this initial priority structure, the remaining 22 schemes were each discussed in turn and added to the model to produce an enlarged 47 element priority structure.

Whilst the broad pattern of the ISM priority structure has similarities with the ranking produced by the Council's own method, there is a significant movement in the priority given to certain schemes. However, such changes are to be expected given the prioritizing criterion used which explicitly takes costs into account. The ISM method may thus be seen as providing an alternative way of prioritizing to the Council's own ranking method.

2. Terms of Reference

This report has been produced for Mr. P.W. Bellinger, Assistant County Surveyor of the Highways Department of Hertfordshire County Council.

At the request of Mr Bellinger, the Department of Systems Science at the City Unviersity ran a one-day planning meeting designed to assist the Highways Department in setting priorities for highway improvements and new projects. The meeting took place on 7th April 1987 in the University's Decision Support Laboratory. A group of six participants from HCC were actively involved (Appendix). They represented design and construction, traffic, planning, safety, public transport and finance. Two Assistant County Surveyors acted as observers.

3. Settng Priorities Using Interpretive Structural Modelling (ISM)

3.1. Selection of Major Capital Schemes to be Prioritized

A total of 47 schemes were selected for prioritizing. These were taken from the Approved Programme and Reserve List of Major Capital Schemes of the County Council Report entitled 'Transport Policies and Programmes 1987-88'. From the Approved Programme (Table 1 in the Report), the schemes listed under 'Three-Year Programme' and 'Preparation List' were included. All the schemes in the Reserve List (Table 3) were included.

The 47 schemes were then grouped into 25 blocks each containing between one and four schemes. The groupings were based on the cost of each scheme and the existing ranking score derived using the County Council's approved method. Thus where, say, three schemes had a similar cost and ranking score they were initially treated as one block. The 25 blocks thus represented a complete spectrum of cost and ranking scores.

3.2 The ISM Process

Interpretive Structural Modelling is a method which helps participants to examine the interrelations between the elements in a complex problem or situation. It enables a group to pool their thinking and reach agreement on the structure of a problem.

In this case a computer-assisted ISM session was carried out taking the major capital schemes as the elements to be structured using a 'value for money' criterion. The ISM process required the group to respond to a series of pairwise comparisons put by the computer in the following form:

> "Taking into account all the benefits and capital costs is (scheme A) better value for money than (scheme B)?"

The term 'value' in the question was interpreted as relating to all the relevant quantitative and qualitative impacts on the County. Each question was discussed and argued by the participants under the guidance of a trained facilitator. The answer to each question fed into the computer was based on the votes of the participants, a majority vote being used whenever they were not unanimous. As the process proceeded the computer built up a structural model, in this case a priority structure, showing the group's perceptions of the ranking of the schemes. The structure was displayed and discussed at various stages.

3.3 The Priority Structure Produced

During the ISM session 25 schemes were initially prioritized, one from each of the blocks referred to in section 3.1. The resulting priority structure (figure 1) was displayed, discussed and agreed by the group. It has 12 levels of priority each containing from 1 to 5 schemes. The arrows between the boxes in the figure denote the relation 'is better value for money than'. Thus the A4145 West Watford Relief Road is seen as giving best value for money. Multiple schemes listed within a box indicate schemes at the same level of priority.

The remaining 22 schemes from the original list of 47 were each in turn positioned by hand in the priority structure, following discussion about their relative value for money compared with those schemes already prioritized. Figure 2 shows the final agreed priority structure including all 47 schemes. This has 14 levels of priority each containing from 1 to 13 schemes.

In many respects the broad pattern of the ISM priority structure has much in common with the ranking scores produced using the County Council's approved method. For example the top eight schemes based on the ranking scores appear in the top 11 schemes in the ISM priority structure. However, in certain cases there is a significant shift in ordering, resulting from costs being explicitly taken into account in the 'value for money' criterion. For example, the A1170 Ware Relief Road moves from joint 13th in the ranking scores to joint 3rd in the ISM priority structure.

4. Conclusions

The ISM session provided a structured process for participants concerned with setting priorities for highway schemes. The process promoted highly focussed discussion and argument regarding the relative merits of the various schemes based on a value for money criterion.

The ordering of schemes in the ISM priority structure has a broad pattern similar to the ranking scores produced by the County Council's approved method. However, within this broad pattern there is a noticeable shift up and down of various schemes. This is only to be expected given the criterion used, which explicitly takes costs into account.

The ISM process may thus be regarded as providing a useful alternative method for examining priorities amongst highway schemes.

Figure 1. Interim Priority Structure (25 HCC Highway Schemes)

A4145 West Watford Relief Road

A414 North of Harlow to M11 (HCC Section)

- A4008 Watford M1 Link Road
- A1059 Dane St/Station Road Bishops Stortford
- A1170 Ware Relief Road

St. Albans Railway Route

- A505 Baldock By-Pass
- A121 Cheshunt Link Road

Welwyn Garden City Distributor Road

A41 Apsley Diversion

- A414 Stanstead Abbotts to Harlow
- A5135 Elstree Way Dualling
- U302 Six Hills Way Stevenage Dualling
- C137 Essex Road Improvement Hoddesdon
- A602 Tonwell By-Pass to A10 Ware

- A120 Little Hadham By-Pass
- A1184 Bishops Stortford S.W. Distributor Road
- B462 Radlett Northern By-Pass
- B4505 Bovingdon By-Pass
- A120 Standon By-Pass

A4146 Waterend By-Pass

- \- Rear Services Road Rickmansworth
- A507 Baldock By-Pass to Cottered By-Pass
- \- Rowley Lane to Mead Lane Hertford

B556 Roestock Flyover to Coursers Lane

denotes 'Is better value for money than'

denotes schemes at equal level of priority

Figure 2. Final Priority Structure (47 HCC Highway Schemes)

A4145 West Watford Relief Road

↓

A414 North of Harlow to M11 (HCC Section)

↓

- A4008 Watford M1 Link Road
- A1059 Dane St/Station Road Bishops Stortford
- A1170 Ware Relief Road

↓

St Albans Railway Route

↓

- A505 Baldock By-Pass
- A121 Cheshunt Link Road

↓

Welwyn Garden City Distributor Road

↓

A411 Eastern Relief Road Watford

↓

A41 Apsley Diversion

↓

- A414 Stanstead Abbotts to Harlow
- A5135 Elstree Way Dualling
- - Bishops Stortford Goods Yard Link
- A412 North Watford Relief Road
- C137 Essex Road Improvement Hoddesdon
- - Hertford Northern Relief Road
- A602 Watton at Stone By-Pass to Bragbury End
- A414 Cole Green By-Pass
- A5135 Elstree Northern By-Pass
- A4146 Kodak to Queensway Hemel Hempstead
- U302 Six Hills Way Stevenage Dualling
- A602 Tonwell By-Pass to A10 Ware
- A5183 King Harry Lane Junction

↓

- A120 Little Hadham By-Pass
- A1184 Bishops Stortford S.W. Distributor Road
- A4008 Pinner Road Relief Road
- A6129 Stanborough Rd Dualling Welwyn Garden City
- A602 Watton By-Pass to Tonwell By-Pass
- A4147 Redbourn Road Hemel Hempstead
- B462 Radlett Northern By-Pass
- B4505 Bovingdon By-Pass
- A120 Standon By-Pass

↓

- A4145 Tolpits Lane Phases I and II
- A507 Cottered By-Pass
- A412 "The Narrows" Rickmansworth
- A4146 Waterend By-Pass

↓

- A120 Bishops Stortford By-Pass Dualling
- A4125 Hampermill Link Watford
- A414 Hertingfordbury Road Phase II
- Works Road Extension Letchworth

↓

- Rear Service Road Rickmansworth
- Rowley Lane to Mead Lane Hertford
- A507 Cottered By-Pass to Buntingford By-Pass
- A507 Baldock By-Pass to Cottered By-Pass
- Wellstones Improvement Watford

↓

B556 Roestock Flyover to Coursers Lane

↓ denotes 'Is better value for money than'

[• • •] denotes schemes at equal level of priority

SUPPORTING PAPER L

Jeffery, R.J. and Janes, F.R. (1989). The use of interpretive structural modelling in planning for a community speech therapy service. Proceedings 33rd Annual Meeting of the International Society for the Systems Sciences. ed. P.Ledington, Edinburgh, July, 1989. 2, 314-319.

(This supporting paper includes an extract from an article by Slate (1990) as an appendix)

THE USE OF INTERPRETIVE STRUCTURAL MODELLING IN PLANNING FOR A COMMUNITY SPEECH THERAPY SERVICE

R. J. Jeffery and F. R. Janes
Interactive Management Unit
Department of Systems Science
City University
London, England

ABSTRACT

This paper describes how Interpretive Structural Modelling was used by a group of five Speech Therapists with the aid of an expert facilitator to develop a map of their requirements for a high quality community speech therapy service. The work took place at the Interactive Management Unit of City University, London. Using computer aided Interpretive Structural Modelling, the participants produced a structure showing how the various requirements were interrelated. The structure had five clearly defined sub-systems: communication, facilities for service, therapy development, organisation of service and external credibility of service. The group then produced a priority structure showing the relative importance of all the requirements. This was broken down into two separate structures, one showing requirements achievable with present resources, and the other requiring additional resources. The paper describes the conclusions that were drawn from the work and how the product was implemented to produce an operational policy for the new community speech therapy service.

1 BACKGROUND TO THE APPLICATION

In August 1986 a Chief Speech Therapist for Elderly Care was appointed within West Lambeth District Health Authority. This was a new post designed to improve provision for the elderly. Staffing consisted of approximately 1.5 full-time posts. Work was therefore organised largely on a crisis response basis. By the end of 1987, the number of staff had increased to five and it became evident that the way in which work was handled required some forward planning and organisation. At the request of the Chief Speech Therapist, the Interactive Management Unit of the Department of Systems Science[1] organised a planning workshop to examine the requirements of the service.

The aims of the workshop were to enable the participants collectively to structure their ideas of the requirements of a community speech therapy service for the elderly and to set priorities amongst the requirements. It was considered that this would help the development of the team as the whole and provide information to the team leader when deciding how to allocate time and resources.

Prior to the Interpretive Structural Modelling sessions, Nominal Group Technnique [Delbecq et al 1975], a group idea generation technique,was used to produce the list of requirements.

In order to examine the relationships amongst the requirements, the team participated in a process called Interpretive Structural Modelling (ISM) [Warfield 1976; Janes 1988], under the guidance of a facilitator. This is a computer-aided method which helps participants to examine the interrelations between the elements in a complex issue. It enables a group to pool their thinking and reach agreement on the structure of the issue. In this case ISM was used to produce two types of model, a Requirements Structure and a Priority Structure, taking the requirements developed during the Nominal Group Technnique process as the elements to be structured. The resulting structures are outlined below.

1. City University London. EC1V OHB. GB

2 Developing a Requirements Structure

A Requirements Structure shows how the accomplishment of one requirement might contribute to the achievement of another. In this case, given the limited time available, 21 of the requirements were selected for structuring on a basis of the Nominal Group Technique voting scores. The ISM process requires the group to respond to a series of questions put by the computer of the form:

WOULD
1 To have efficient client transport
HELP TO ACHIEVE THE REQUIREMENT
21 To maintain reliability of service ?

After discussion of the question, the group responds with a 'Yes' or a 'No' answer, taking the results of a vote when the participants are not unanimous. The response is fed into the computer which draws logical inferences from the answers as the process proceeds. Gradually, the computer builds up an ISM 'map', portraying the group's perceptions of the interrelations between the requirements. The map can be displayed at any stage of the process, examined by the group and amended as desired. The Requirements Structure in Figure 1 shows the completed 21 element map.

Interpretation of the Requirements Structure
The boxes in the map contain the requirements with the original numbering scheme developed using Nominal Group Technique. The arrows between the boxes represent the relation "would help to achieve". The Requirements Structure thus shows what helps to achieve what.

Paths. A sequence of requirements connected by arrows is known as a path on the map. For example the path 15 -> 8 -> 10 is explicitly shown. This may be interpreted as a statement that requirement 15 helps to achieve requirement 8 and that 8 helps to achieve 10. However, the nature of the map means that 15 may help to achieve directly any element which it reaches via a path of one or more arrows, e.g. requirements 8, 5, 4, 10, 21, 13, 20, 6, 7, 16, 3. A similar interpretation may be made regarding the interrelations between the other requirements on the map.

Objective groupings. The Requirements Structure may be partitioned into a number of labelled blocks as indicated by the shaded areas (Fig 1). For example the "Communication" block shows those requirements which if accomplished would significantly contribute to communication between staff and other involved groups. This block feeds directly into two blocks of requirements labelled "Organisation of service" and "Facilities for service" respectively.

Uses of the Requirements Structure
Within the context of a community speech therapy service, the uses of such a Requirements Structure include the following:

- Making explicit the multiple requirements of the service and their interrelations.
- Clarifying group thinking through asking the team to consider systematically the complex interactions between their requirements.
- As a way of explaining the requirements of the speech therapy service to those within the Health Authority.
- As a base from which to change priorities as new ideas are developed or as circumstances change.
- As a basis for programme planning. The groupings which emerge from the structure and the interrelations between the requirements provide useful information for this purpose.
- As a basis for policy analysis. Given limited resources, the structure can assist in

deciding on the allocation of resources to those activities which will be the most productive.

3 Developing a Priority Structure

In order to examine the relative importance of specific requirements with regard to each other, ISM was used to produce a ranking of a subset of the elements. The subset was selected on the basis that they all had significant resource implications. This was done according to the criterion "is a higher priority than". Thus the questions were phrased by the computer in the form:

IS
19 To have suitable accommodation for therapy
A HIGHER PRIORITY THAN
12 To have geographical organisation of work ?

During the ISM session, 20 requirements were prioritised into 12 levels. Three elements were not prioritised because the group considered them not directly comparable with other elements. The completed structure is shown in Figure 2. The arrows between the boxes in the figure denote the relation "is a higher priority than". Thus "To maintain the required records in good order" is a higher priority than "To have an efficient and effective referral system". Multiple requirements listed within a box indicate those of equal priority.

Once the structure had been obtained, it was decided to group the requirements into those which could be developed using existing resources and those which could only be achieved with additional resources. The requirements were then split into two separate Priority Structures (Figure 3) using the ranking developed in the original structure (Figure2).

4 Summary of Results of Planning workshop

The major results of the planning exercise are summarised below:

- An explicit statement by the participant group as to their perceptions of the requirements for a high quality speech therapy service.
- A Requirements Structure, showing the interrelations between the requirements as perceived by the group.
- A Priority Structure, showing the relative importance of the requirements.
- A better understanding by those involved in the process as to what the group should be trying to achieve.
- A report on what occurred and the results of the work for discussion within the Health Authority.
- A basis for future planning.

5 Implementation and Operational Policy Development

The Interactive Management Unit contacted the team leader at regular intervals to monitor progress. After six months her conclusions were:

- The **physical products** (requirements and priority structures) had provided accurate, relevant maps from which to implement policy.
- The **process products** (team commitment and identification with the process) had ensured the continuity of the planning process.

Major results following the workshop :

- Development of an operational policy document.

- Development of a procedures document.
- Development of a treatment strategy:

Intensive treatment	Two week block every 3 months.
Intermediate treatment. . .	Once a week for 6 weeks.
Maintenance treatment . . .	Once a fortnight for 6 months.
Self help	Groups encouraged to continue meeting amongst themselves with occasional help from a therapist.

- Reduction in workload through the treatment strategy.
- Increased funding: the identification of specific requirements that contributed greatly to the overall reliability of the service, but were not achievable without additional resources, enabled the Chief Therapist to argue successfully for additional funding.
- Increased team awareness: the individuals within the team are aware of how their efforts contribute to the overall service, are aware of what resources are available to them, and have a strong sense of team spirit.
- Greater job satisfaction: the integration of effort, the involvement in the planning process and the success of the results have significantly enhanced the job satisfaction of the individual therapists.

6 Conclusions

The physical products enabled a group to identify the important influences on their operational effectiveness and subsequently to effect a major improvement to their service delivery.

The commitment, team spirit and enthusiasm produced through the ISM sessions have provided the momentum that enabled the changes to be effected.

7 Refferences

Delbecq, A.L. et al. 1975. *Group techniques for program planning*, Scott, Foresman and Company, Glenview, Illinois, USA

Janes, F.R. 1988. Interpretive Structural Modelling: a methodology for structuring complex issues. *Trans Inst Meas & Cont*, **10**(3), 145-154.

Warfield, J.N. 1976. *Societal Systems: planning policy and complexity*, John Wiley and Sons, Inc, New York, USA.

Figure 1. Community Speech Therapy Service Requirements Structure

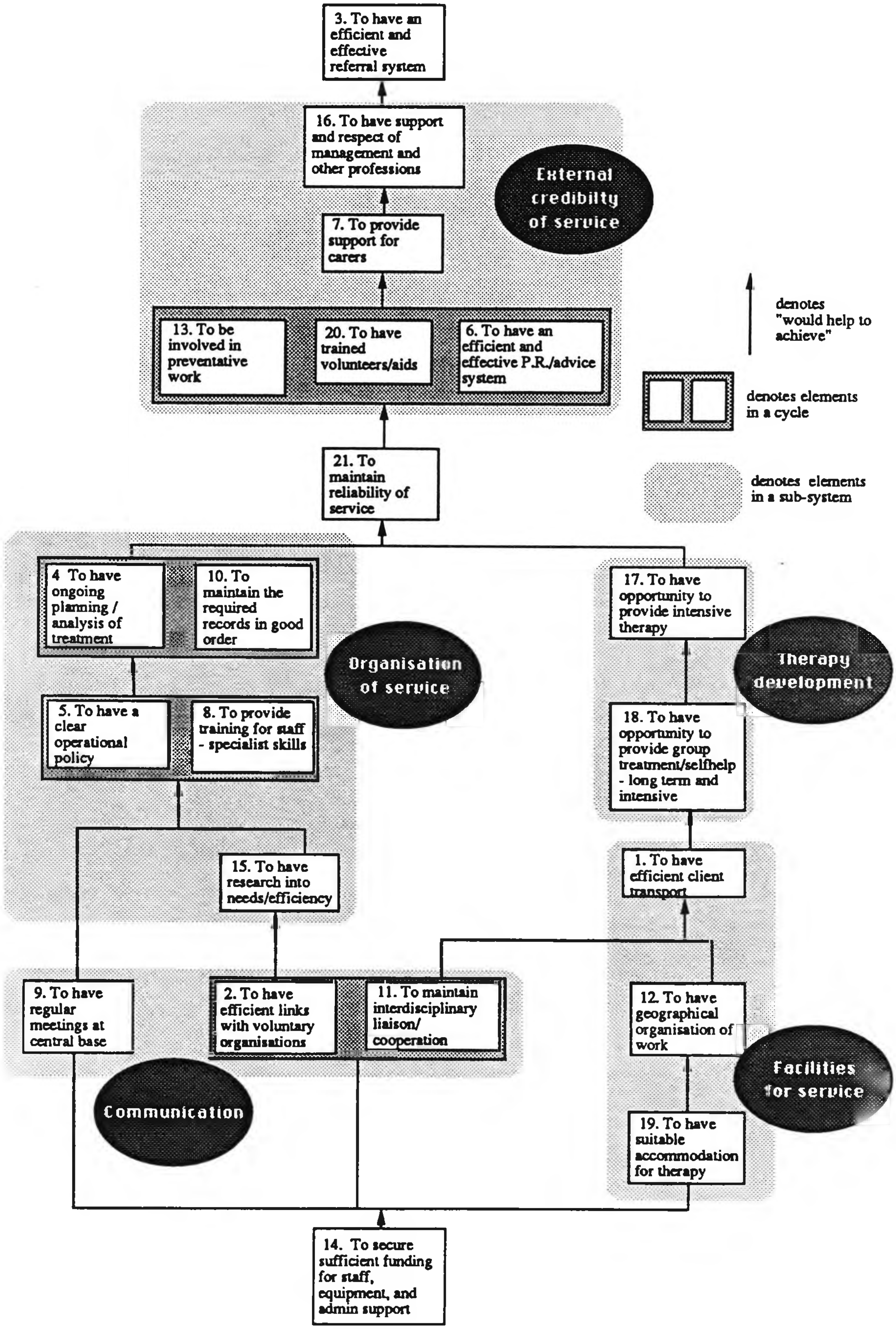


Figure 2. Community Speech Therapy Service Priority Structure

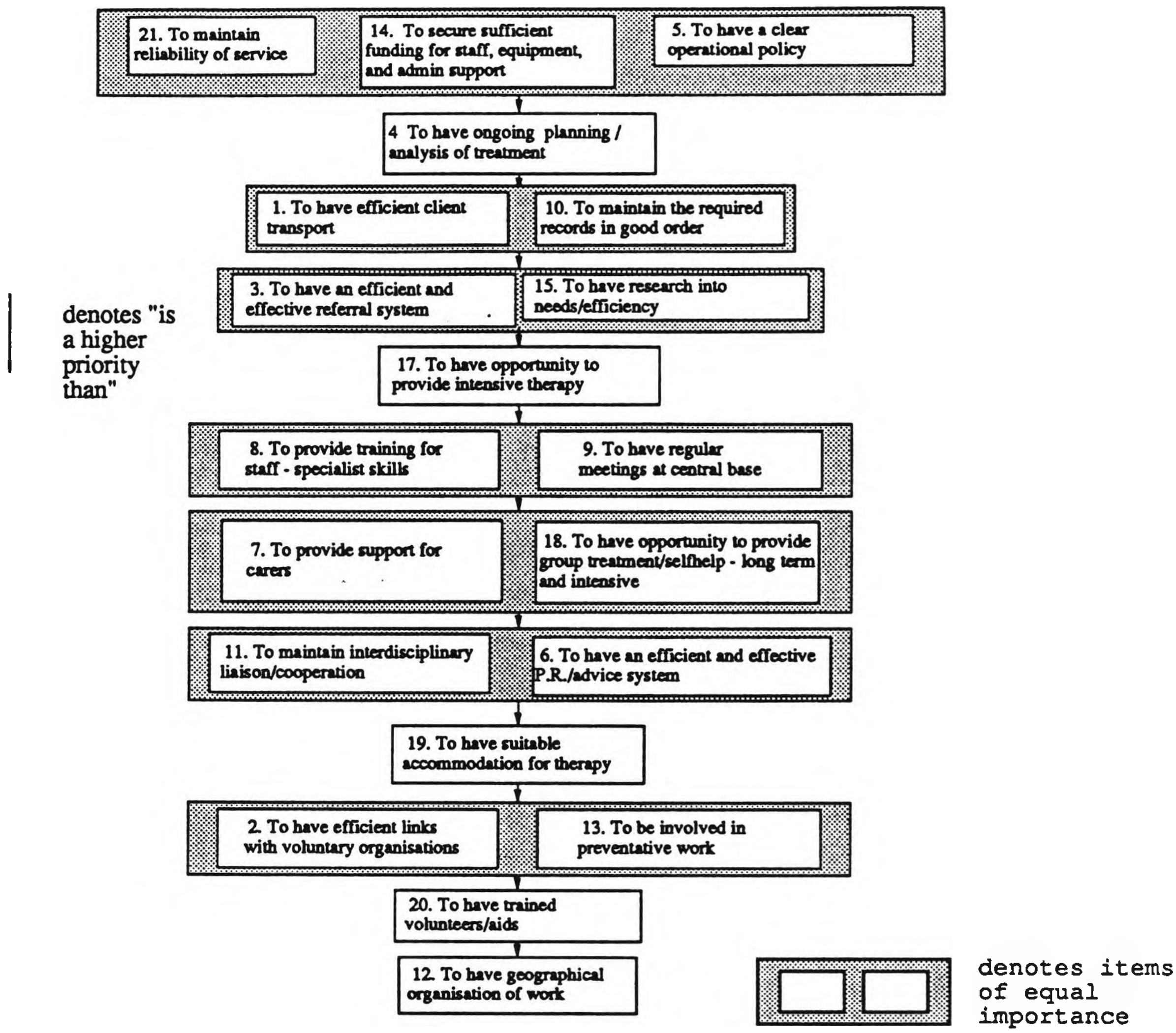
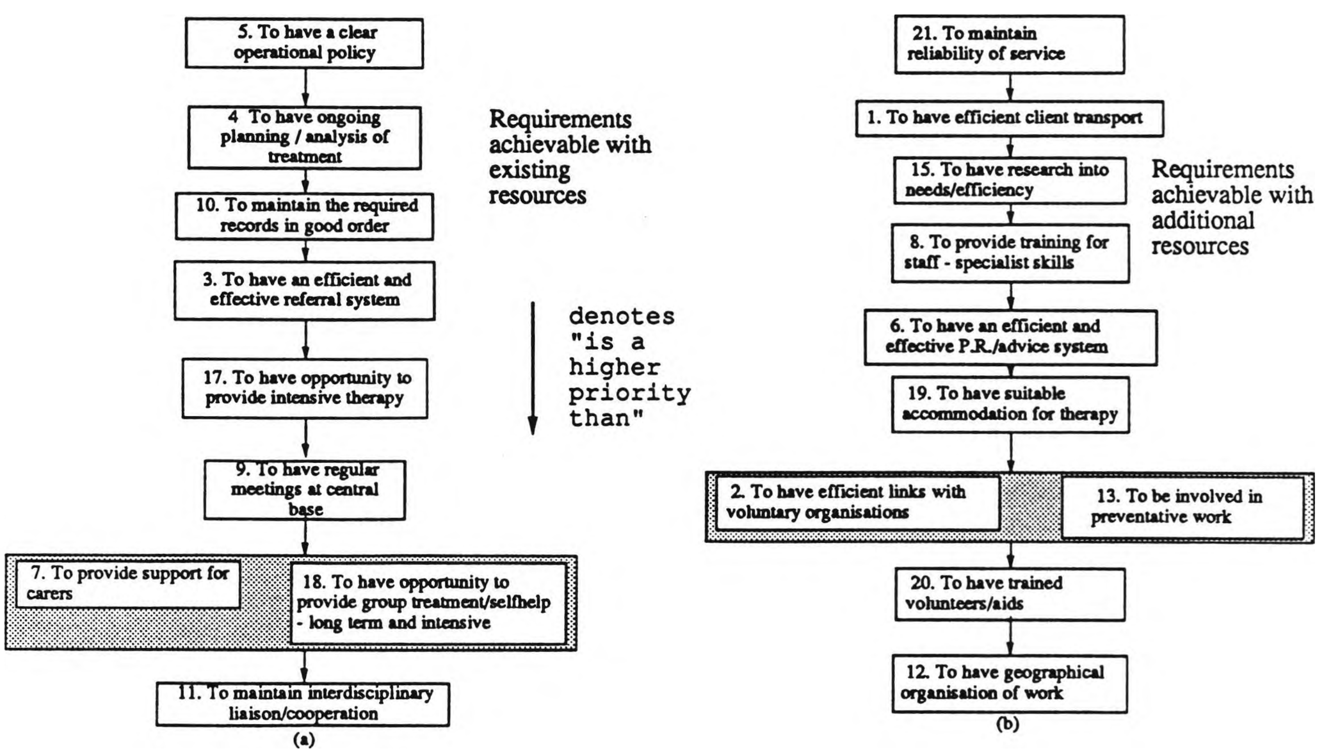


Figure 3. Community Speech Therapy Service. Priority Sub-groups



Restructuring the system

West Lambeth speech therapy staff knew their service needed changing – but not how to go about it. Deborah Slate shows how Interpretive Structural Modelling, a systematic planning approach, helped them create a group therapy based practice for elderly clients.

THE WEST Lambeth speech therapy unit recently formed and piloted a group therapy based system for elderly patients in the community.

We had always identified the need to cater for the different requirements people have at varying stages of their speech or language handicap. We did not want to have a "stagnant pool" which became uselessly routine.

The goals, as our team of five defined them two years ago, were to change the service to suit the clients' needs, to deliver an accessible, streamlined service and to make our jobs more fulfilling. The systematic planning technique we used to achieve these aims helped give us a team identity and a co-ordinated collective approach. Ultimately, we were also to gain a sense of achievement from the exercise.

In 1988, the speech therapy team working with elderly people had grown from two people to five. This increase allowed us to step back for long enough to see if things could be done better. We each had our own opinions of what needed changing and how.

In the preceding six months, we had made serious forays into the territory of change, but none had proved wholly successful or satisfactory. In the summer of 1988, I tried a new tactic. I used an approach which I had discovered as part of my MSc in Human Communication at the City University in London.

The approach is called Interpretive Structural Modelling, and is based on principles of systems planning and analysis. Like many successful approaches, it is simple in concept and uses well-known management tools, aided by – but not always requiring – computer backing.

The first step was an idea-generating exercise, Nominal Group Technique, which is basically a brainstorm approach to a specific question. Ours was: "what do you need to provide a good community speech therapy service?"

Each person wrote her ideas down, then presented and clarified them to the group in discussion. The idea was then recorded on a collective list. This allowed the most junior members of staff to present their ideas without fear of censorship, as each idea has equal value when they are all recorded.

Priority

The next step was for each group member to prioritise the ideas in terms of their "top ten", and then rank them in order of priority. The prioritised ideas were then taken forward to the final stage. This was when a computer came in handy.

The West Lambeth team was very fortunate at this point, as our unit general manager agreed to fund a trip to the Interactive Management Unit (IMU) in the systems science department of City University, which helped us structure our ideas.

The unit's computer technology enabled us to consider each idea against another and make a decision on whether idea one "helped achieve" idea two, and so on.

Each comparison afforded structured debate, and when no agreement could be achieved a vote was taken. This allowed participants to feel that they had all contributed equally.

The end product of all this was a flow diagram or intent structure to which all had contributed and which all therefore owned.

It showed what was to be achieved and in what order. This simple, concrete product, from two afternoons of debate, has enabled us to restructure our service, to write our departmental operational policy, to make a bid for more resources, and to keep the team going through subsequent external changes, both large and small.

The diagram also helped explain why our earlier attempts at change had failed. One of the things it worked on was our referral system, and now we could see that many other things had to be done before we could hope for a positive result from changing referral.

We could also see that the ideas naturally clustered into groups which could be collectively named. This provided us with the basis for our operational policy.

Bids for increased resources were made, using the intent structure to illustrate how a change in one area would facilitate change in others. One of our successes on this front was to gain more alternative transport for patients.

But perhaps the most important change was the starting of a group therapy system.

After our planning workshops, we developed the idea of three main active groups plus one "self-help" group, motivated primarily by the clients, with facilitation from the therapist.

There would be an intensive therapy group session which the client would attend every day for ten days. This would run once every three months. An intermediate group would require attendance once a week for three months, and a maintenance group would run with attendance once a fortnight for six months.

The three-tier or cascade system allows clients to be assessed individually and introduced into the group system at whichever level is appropriate. At any time, a client can be reviewed and replaced in the system at the right level.

During 1988/89 we ran one of each of the groups with great success, but found we had difficulty sustaining the cascade.

All involved felt that, once established, the principle would work very well, but that establishing the system required the full-time application of one person.

The latest move has been to make a bid for development money from a regional fund. Hopefully, this will give us one person who can set up and evaluate the system and, if it is successful, we can then run it with our permanent staff.

I could not have wished for a better result from what was a small investment in terms of time and money. The whole experience has taught, and is still teaching us, a great deal.

Acknowledgements:
The author would like to thank Heather Campbell, Cristina Reyburn, Sara Carr and Helen Thomas.

Deborah Slate is a district speech therapist at West Lambeth health authority.

Extract from:
Slate, D. (1990). Restructuring the system. Therapy Weekly, 1 March, 1990, 16 (13), p12.

SUPPORTING PAPER M

Jeffery, R.J., Janes, F.R. and Hammer, K.A. (1989). Priorities for a community-based speech therapy service for people with learning difficulties in Hounslow and Spelthorne District Health Authority. Technical Report No. DSS/RJJ-FRJ-KH/259, Dept. of Systems Science, City University, London. 23pp.

PRIORITIES

for

A COMMUNITY BASED SPEECH THERAPY SERVICE FOR PEOPLE WITH LEARNING DIFFICULTIES

in

HOUNSLOW AND SPELTHORNE DISTRICT HEALTH AUTHORITY

(A report on a two-day planning workshop held
at the City University on April 12th and April 18th, 1989)

R.J. Jeffery, F.R. Janes & K.Hammer.

Interactive Management Unit
Department of Systems Science
City University
Northampton Square
London EC1V OHB

April, 1989

Technical Report No. DSS/RJJ-FRJ-KH/259

CONTENTS

FIGURES

APPENDICES

Abbreviations

IMU Interactive Management Unit
ISM Interpretive Structural Modelling
NGT Nominal Group Technique

1. SUMMARY

A group of six speech therapists involved in speech therapy for people with learning difficulties within Hounslow and Spelthorne District Health Authority, met on two separate afternoons in the Decision Support Laboratory of the Department of Systems Science to structure a list of solutions to the obstacles preventing an effective service delivery.

The programme of the workshop was designed to examine how the solutions to obstacles preventing an effective Speech Therapy service were interrelated. The methods of computer-aided interactive management were used for this purpose with the staff of the Interactive Management Unit acting as facilitators throughout, leading the group through a series of processes specifically designed to promote the efficient structuring of ideas.

Prior to the workshop, the team leader of the speech therapists had conducted 2 idea generation sessions with the group to produce lists of obstacles and solutions (Appendices 2 and 3).

On day one of the workshop, 21 of these potential solutions were structured with the help of a computer to produce a structure which shows how they would influence one another. Various categories or groupings within the solutions Structure were subsequently identified and labelled.

On day two, 26 solutions were structured according to their relative priority on the basis of a two year time span and their being achievable by the team itself. Finally this ranking was divided into two lists, one of the solutions attainable with existing resources and the other of the solutions requiring additional resources.

The workshop and products resulting from it give a picture regarding the participants' thinking on the solutions and priorities for an effective speech therapy service. This provides information for subsequent planning and development.

2. TERMS OF REFERENCE

This report has been produced for Ms. B. Cowell[1] of the Hounslow and Spelthorne Speech Therapy Service by Mr R.J. Jeffery, Mr. F.R. Janes and Mr K. Hammer of the Interactive Management Unit[2].

At the suggestion of Ms. Cowell, the Interactive Management Unit (IMU) organised a planning workshop for the staff of the Speech Therapy Service. This was designed to examine the interrelations between solutions to problems encountered by the service and to set priorities for the service. The workshop took place over two afternoons on April 12th and April 18th, 1989, in the Decision Support Laboratory of the IMU. A group of six speech therapists from Hounslow and Spelthorne District Health Authority took part.

The aims of the workshop were to enable the participants collectively to structure their ideas on solutions to the problems of the effective implementation of a speech therapy service for people with special needs. Then to set priorities amongst the solutions. In addition to providing management information to the group leader such as for deciding how to allocate time and resources, the methods used in the planning workshop were designed to improve inter-group communications and group identification, and to promote team building amongst the participants.

---

[1]Manager Speech Therapy Learning Difficulties Team. Hounslow and Spelthorne District Health Authority.

[2]Department of Systems Science, City University.

3. GENERATION OF OBSTACLES AND SOLUTIONS TO AN EFFECTIVE SPEECH THERAPY SERVICE

3.1. Method

Prior to the workshop, the group of speech therapists, with the team leader acting as facilitator, participated in an idea-generation method called Nominal Group Technique. This may be used used to generate, clarify, edit and obtain a preliminary ranking of a set of ideas. The technique was used twice. Firstly, it was used to generate a set of obstacles to their work (Appendix 2). In the light of this review of the obstacles a second session generated a set of solutions for delivering a high quality speech therapy service (Appendix 3).

3.2. Steps of Nominal Group Technique (NGT)

1. Silent generation of ideas in writing in response to a trigger question.

2. Round-robin recording of ideas, whereby the ideas of participants are recorded on a flip chart and displayed.

3. Serial discussion of ideas for clarification, whereby each item is discussed in turn with the group in order to clarify and edit it.

4. Voting, in order to enable participants to express their value judgements with regard to the importance of the ideas generated.

The trigger question posed to the participants for first considering the obstacles to the delivery of an effective Speech Therapy Service was:
"What obstacles do you anticipate in meeting the communicative needs of people with learning difficulties in the Hounslow and Spelthorne district?"

The trigger question then posed for the consideration of overcoming the obstacles was:
"What are ways of overcoming the obstacles to meeting the communicative needs of people with learning difficulties".

A total of 35 obstacles and 29 solutions were generated during the two NGT sessions and are shown in Appendices 2 and 3.

4. STRUCTURING THE SOLUTIONS

4.1 Method

In order to examine the relationships amongst the solutions, the team participated in a process called Interpretive Structural Modelling (ISM). This is a computer-aided method which helps participants to examine the inter-relationships between the elements in a complex issue. In this case ISM was used to produce two types of model, a Solution structure and a Priority structure, taking the solutions developed during the second NGT as the elements to be structured.

4.2 Developing a Solution Structure

The ISM process required the participants to respond to a series of paired comparisons put by the computer as questions in the following form.

WOULD

53 Agreeing a team statement of purpose

STRONGLY CONTRIBUTE TO

11 Promoting the role of the learning difficulties speech therapist ?

Each question was discussed and argued by the participants under the guidance of a facilitator. The answer to each question fed into the computer was based on the votes of the participants, a majority vote being used whenever they were not unanimous. As the process proceeded the computer built up a structure showing the group's perceptions of the importance of the various solutions. When assessing the importance, participants were reminded that they were considering the work of the service over the next two years.
The map can be displayed at any stage of the process, examined by the group and amended by hand as desired. The Solutions Structure in Figure 1 shows the completed 21 element map.

4.3. Interpretation of the Solutions Structure

The boxes in the map (Fig 1) contain the solutions with the original numbering scheme as in Appendix 3. The arrows between the boxes represent the relation 'would strongly contribute to'. The Solutions Structure thus shows what helps to achieve what.

4.3.1. **Paths.** A sequence of solutions connected by arrows is known as a path on the map. For example the path 22 -> 18 -> 1 is explicitly shown. This may be interpreted as a statement that requirement 22 helps to achieve requirement 18 and that 18 helps to achieve 1. However, the nature of the map means that 22 may help to achieve directly any element which it reaches via a path of one or more arrows, e.g. solutions 18. 1. 35. 4. 8. 11. A similar interpretation may be made regarding the interrelations between the other solutions on the map.

4.3.2. **Objective groupings**. The Solutions Structure may be partitioned into a number of labelled blocks as indicated by the shaded areas (Fig 1). For example the 'Intelligence' group shows those solutions which if accomplished would significantly contribute to the information needs of the staff and other involved groups. This block feeds directly into two groups of solutions labelled 'Service Provision' and 'Service Delivery' respectively. When reading Figure 1 it should be remembered that any given block helps to achieve any other block which it can reach via a path on the map. Thus, for example, 'Service Resources' helps to achieve the block 'Service Delivery'.

4.4 Uses of the Solutions Structure

Within the context of a community based speech therapy service for people with learning difficulties, the uses of such a Solutions Structure include the following:

- Making explicit the multiple solutions of the service and their interrelations.

- Clarifying group thinking through asking the team to consider systematically the complex interactions between their solutions.

- As a way of explaining the solutions for the speech therapy service to those within the Health Authority.

- As a base from which to change priorities as new ideas are developed or as circumstances change.

- As a basis for programme planning. The groupings which emerge from the structure and the interrelations between the solutions provide useful information for this purpose.

- As a basis for policy analysis. Given limited resources, the structure can assist in deciding on the allocation of resources to those activities which will be the most productive.

Figure 1 : Solution Structure

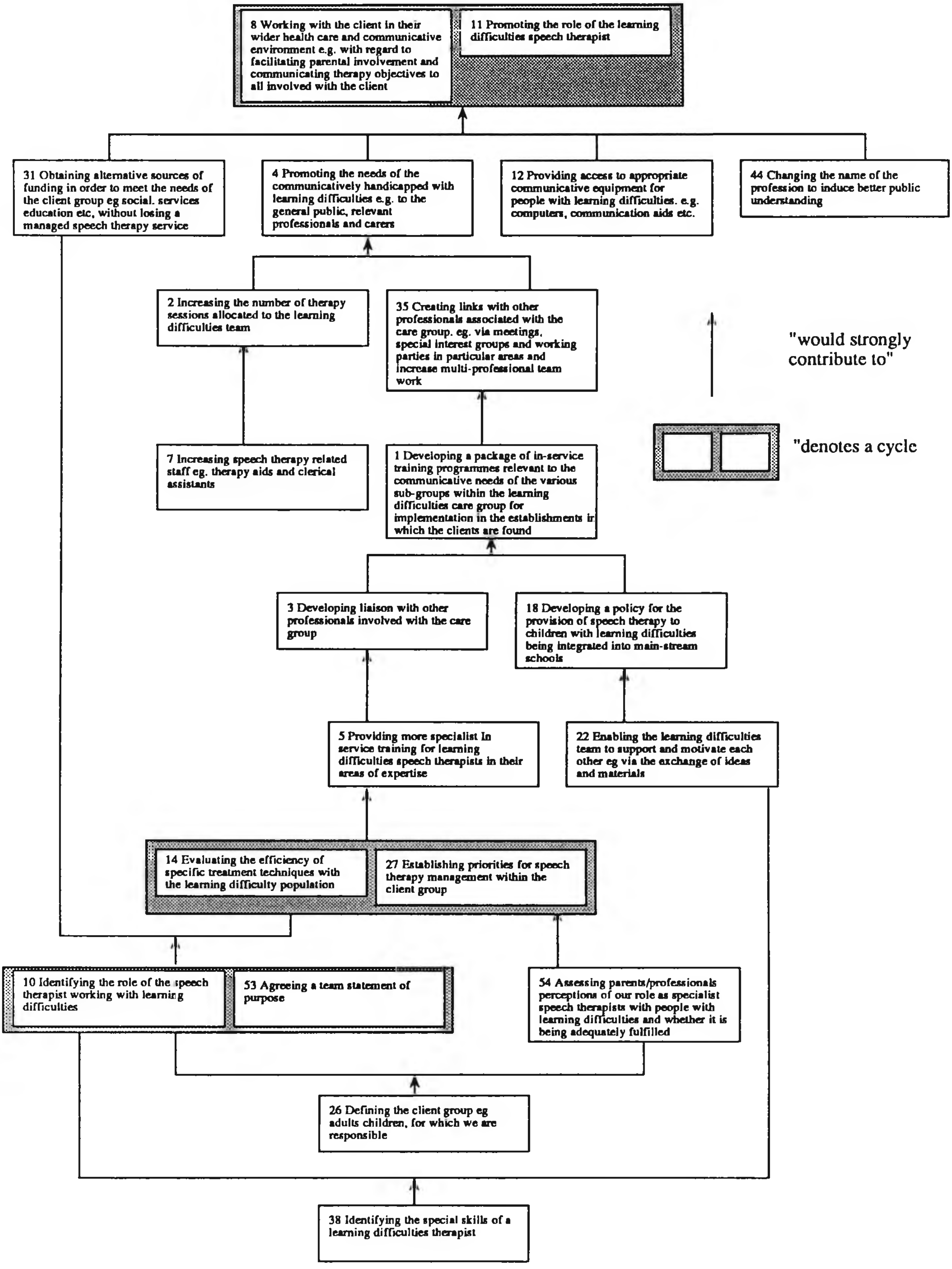
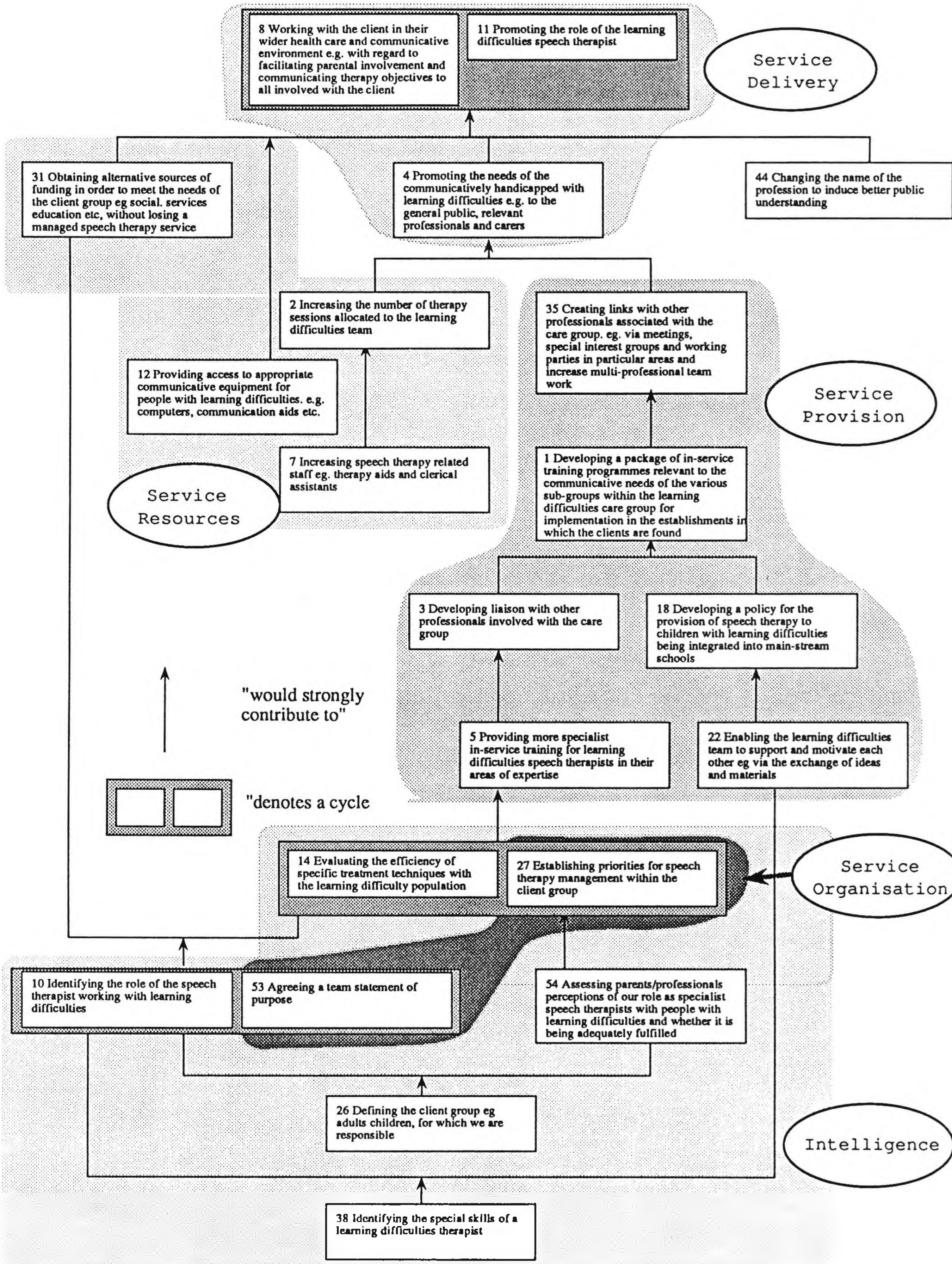


Figure 1a : Solution Structure with Sub-systems.



5. SETTING PRIORITIES AMONG THE SOLUTIONS

5.1 Method

In order to examine the relative importance of specific solutions with regard to each other, ISM was used to produce a ranking of the elements. This was done according to the criteria "is more important than". Thus the questions were phrased by the computer in the form:

IS

53 Agreeing a team statement of purpose

MORE IMPORTANT THAN

11 Promoting the role of the learning difficulties speech therapist

As the process proceeded the computer built up a priority structure showing the group's perceptions of the importance of the various solutions. When assessing priority participants were reminded that they were considering the service over the next two years.

5.2. Developing a Priority Structure

During the ISM session, 26 solutions were prioritised into 16 levels. The completed structure is shown in Figure 2. The arrows between the boxes in the figure denote the relation 'is more important than'. Thus ' Each Therapist setting personal objectives (28)' is a higher priority than 'Creating links with other professionals associated with the care group (35)'. Multiple solutions listed within a box indicate those of equal priority.

Once the structure had been obtained, it was decided to group the solutions into those which could be developed using existing resources and those which could only be achieved with additional resources. The solutions were then split into two separate priority structures (Figure 3) using the ranking developed in the original structure.

Figure 2 : Priority Structure of Solutions

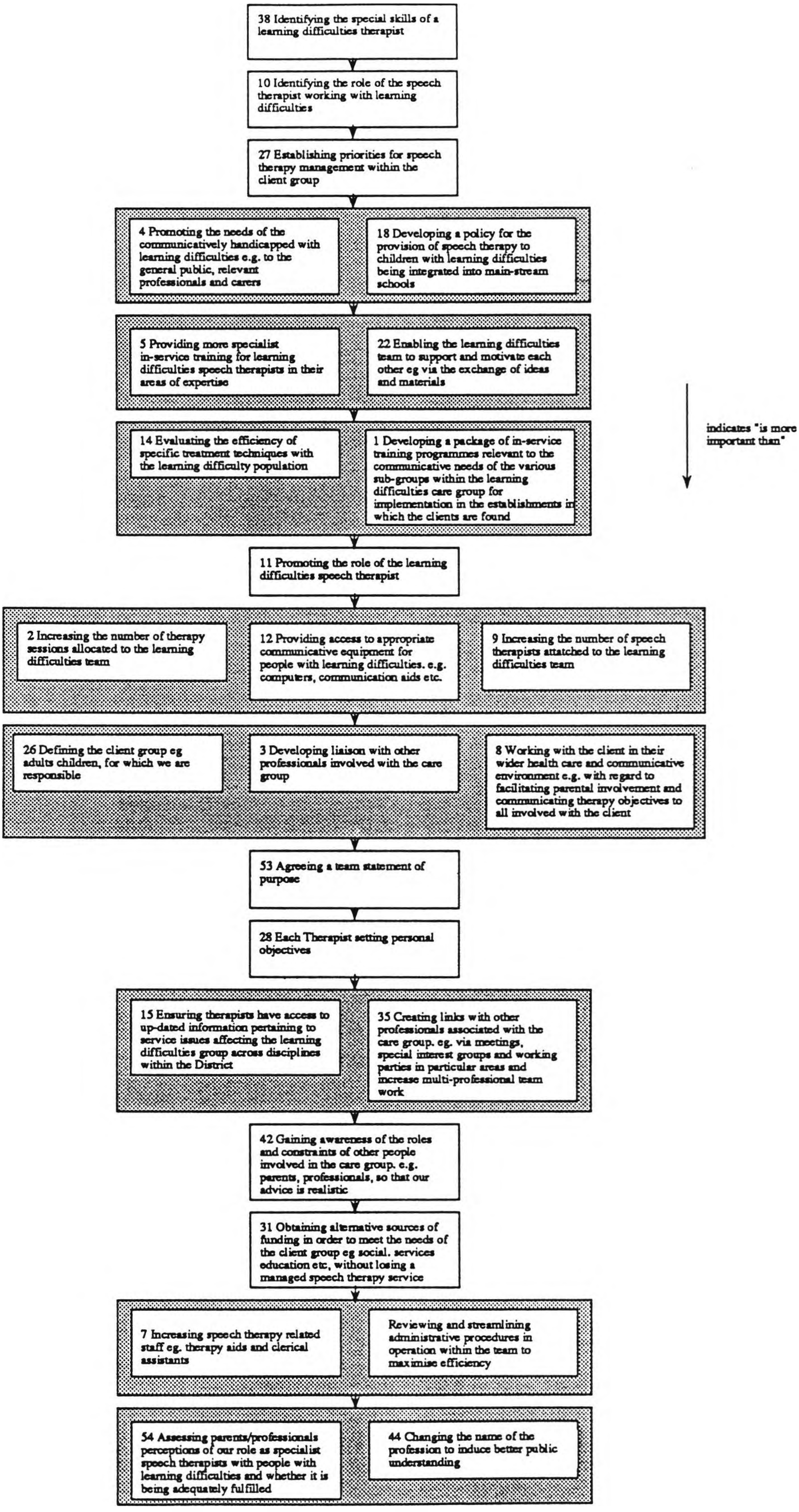


Figure 3a : Priority Structure of Solutions Achievable With Current Resources

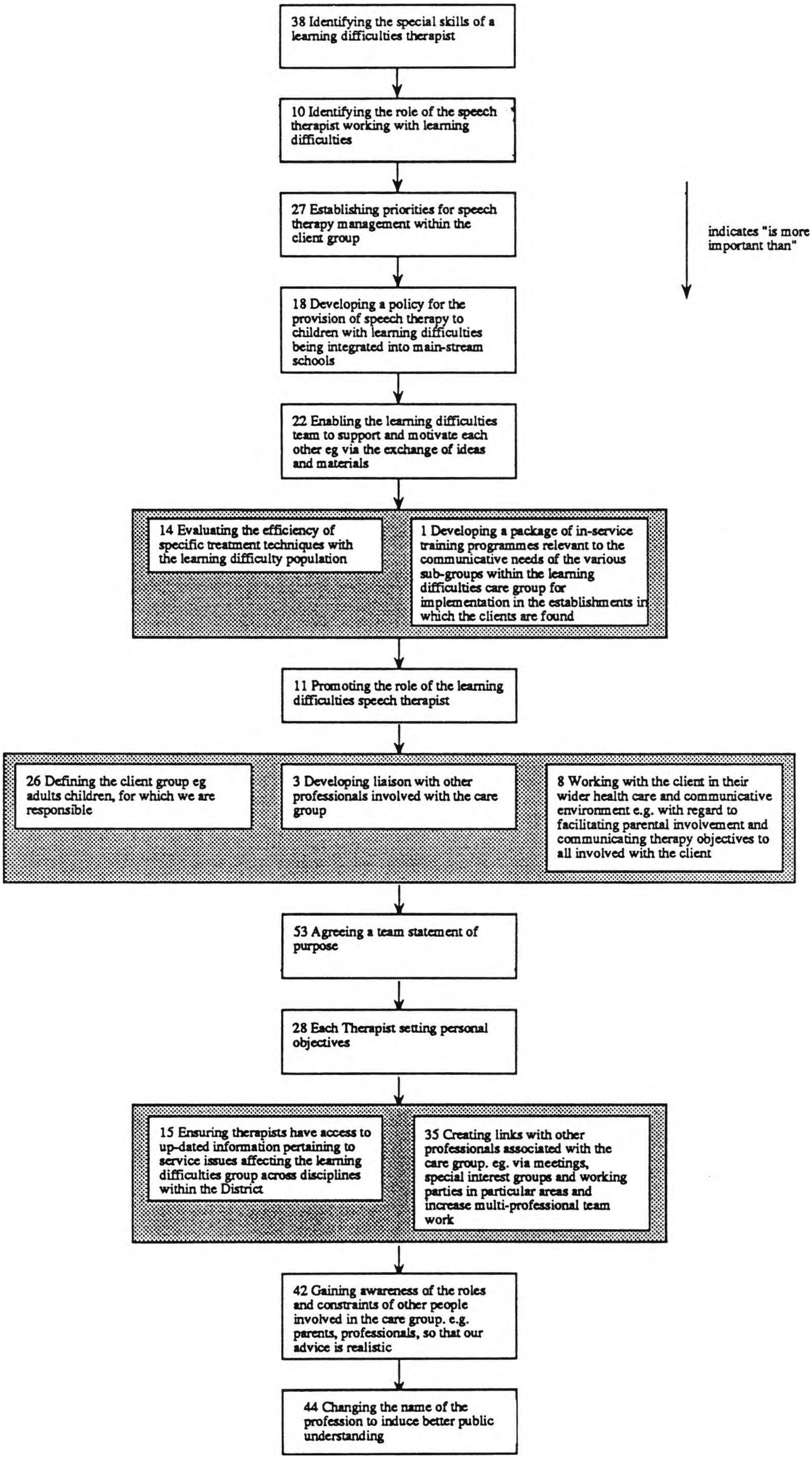
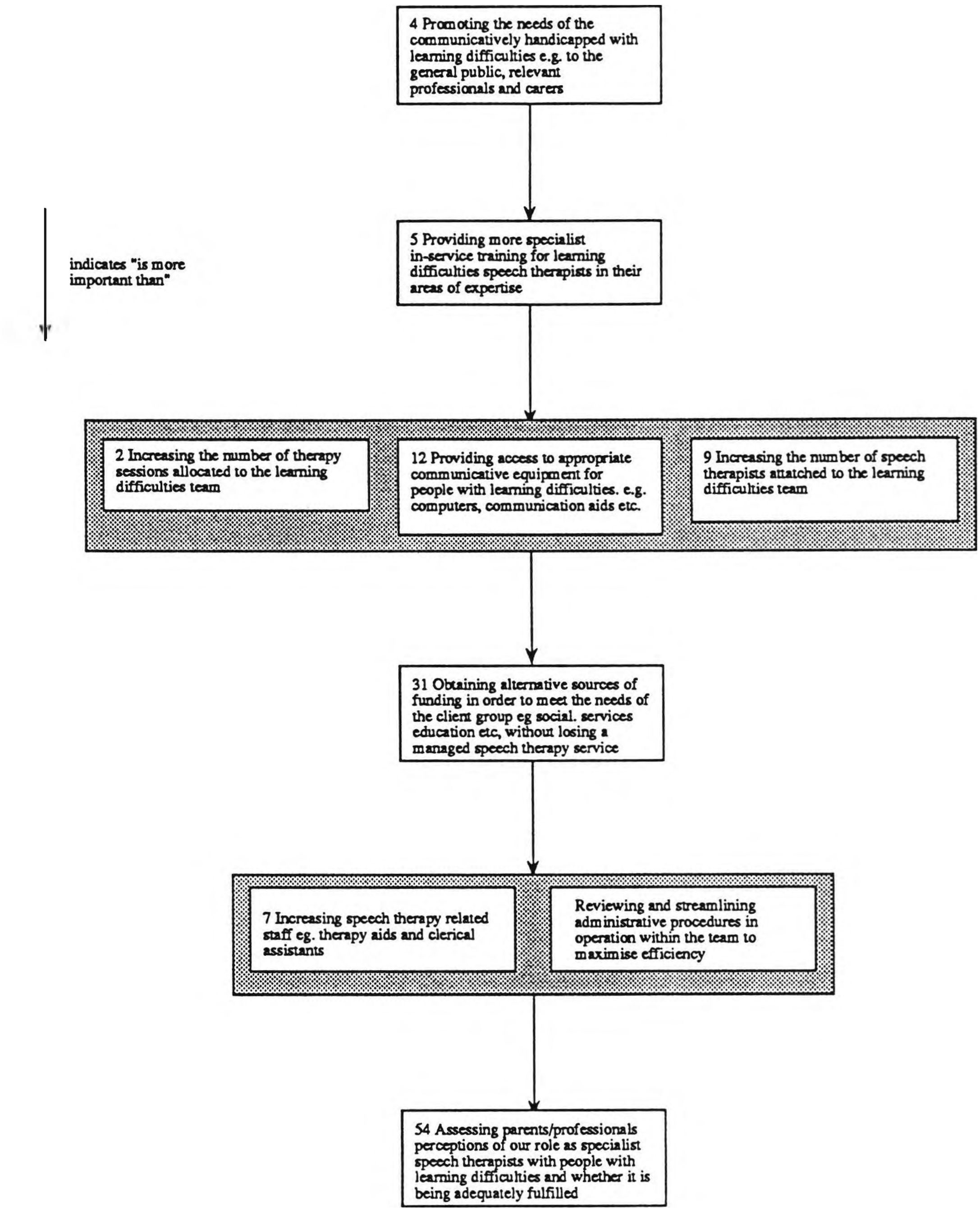


Figure 3b : Priority Structure of Solutions Requiring Significant Additional Resources



6 CONCLUSIONS

6.1 Summary of Results of Planning workshop

The major results of the planning exercise are summarised below:

- An explicit statement by the participant group as to their perceptions of the solutions for a high quality speech therapy service.

- A Solutions Structure showing the interrelations between the solutions as perceived by the group, including a classification of the solutions into categories showing major areas of activity.

- A Priority Structure, showing the relative importance of the solutions. This was subsequently separated into two priority structures, showing those requiring new resources and those that could be achieved with the existing resources.

- A better understanding by those involved in the process as to what the group should be trying to achieve and where the priorities lie.

- Some team building and planning momentum.

- A basis for future activities and for allocation of resources.

- A report on what occurred and the results of the work for discussion within the Service and the Authority.

6.2 Issues Highlighted during the Workshop

Referring to Figure 1. one can see that fundamental to the operation of a high quality speech therapy service are knowledge and information. This is illustrated in the solutions structure, with the group of solutions labelled "Intelligence" strongly contributing to all other groupings. Subsumed within this group and equally fundamental is the pair (53 and 27) labelled "Service Organisation". The contributions of this group of solutions are shown to not only feed to the next group, Service Provision, but through them to the final group, Service Delivery. For example "Identifying the role of the speech therapist working with learning difficulties" contributes to all the other solutions that can be tracked along the connective lines rising above this solution.
From the priorities structure, Figure 2, it can be seen that "Establishing priorities for speech therapy management within client group" has a high priority, along with identifying the role and the special skills of the therapists. This structure can

provide the basis for discussions about planning decisions. This would be further assisted by Figure 3a. which displays the priorities of the solutions that are achievable with the current resources. The six solutions forming the "Service Provision" group (Figure 1) aim to create a better "Service Delivery" by training (solutions 5 and 1) and by more cooperation (22.18,3,35), of which all but solution 5 could be commenced within the current resources. Figure 3b displays the group's present priorities for the solutions that would require additional resources.

During discussion periods mention was made of the possibility of using simple questionaires to collect information on patient responses, on the contributions of the patient's 'help circle' and on other significant matters of frequent interest. When a set of data are available it might be possible to obtain the help of a research assistant. Evaluating and Assessing (solutions 14 and 54) could be served by standard questionaire or report forms.
An area of concern which emerged during the workshop was the need for more, and for better utilisation, of *existing* special equipment. For example those benefiting from school equipment were unable to take it home, where they spend all evenings and 204 days of the year. Another concern voiced was the need for speech therapy was being identified and referred early enough by other services.

6.3 Recommendations

- This report should be circulated for discussion within the Hounslow Speech Therapy Service and to relevant people in the District Health Authority.

- The priorities established in the planning workshop (figure 2) should be referred to when making decisions about the allocation of resources.

- Responsibilities for achieving the objectives should be allocated amongst staff.

- Staff in the Service should be made aware of how their various tasks contribute to the objectives of the Service.

- The Speech Therapy Team Manager should place greater emphasis on influencing Health Authority policy in those areas where it affects the Service.

- Action should be taken soon to begin implementing those objectives listed as high priority which do not appear to require significant new resources. These include:

- Identifying the special skills of a learning difficulties therapist
- Identifying the role of the speech therapist working with learning difficulties
- Establishing priorities for speech therapy management within the client group
- Developing a policy for the provision of speech therapy to children with learning difficulties being integrated into main-stream schools
- Evaluating the efficiency of specific treatment techniques with the learning difficulty population

• Effort should be made to persuade the Health Authority to allocate more resources to achieving those objectives which require significant new resources. These include:
    - Promoting the needs of the communicatively handicapped with learning difficulties
    - Providing more specialist in-service training for learning difficulties speech therapists in their area of expertise
    - Provide access to appropriate communicative equipment for people with learning difficulties

• The situation should be reviewed in six months time to assess whether the stated priorities and recommendations are being implemented.

SUPPORTING PAPER N

Janes, F.R. (1985a). "Proposals for a decision support room." Unpublished document. Department of Systems Science, City University, London. 6pp.

The City University

Department of Systems Science

PROPOSAL FOR A DECISION SUPPORT ROOM

1. INTRODUCTION

The department's rapidly growing involvement in the management field indicates the need to establish adequate facilities for management-related activities in Walmsley House. The opportunity to do so arises with the space available in the building. It is proposed that part of these facilities should be the provision of a Decision Support Room for problem solving and decision making. This paper outlines various aspects regarding the purpose, design and operation of such a room.

2. PURPOSE OF THE DECISION SUPPORT ROOM

The primary purpose of the room would be to provide a professional setting where management development courses and related departmental consultancy activities could be oonducted particularly in the field of Computer-Aided Interactive Management. However, the room would be designed to provide multi-purpose facilities for various other departmental uses as well.

2.1. Computer-Aided Interactive Management: Ingredients

A great deal of planning and managing is done in the context of meetings. It is estimated that managers are involved in 17 million meetings/day (over 4 billion/year) in the USA. Many Senior Managers spend over 70% of their time in meetings.

To make meetings concerned with management and planning more effective, five major ingredients are desirable:

- Participant Group - with knowledge relevant to the problem.
- Methodologies - for intelligence, design and choice activities associated with problem solving and decision making.
- Group Facilitator - to guide group through steps of methodologies used.
- Computer and Peripheral Equipment - with software and display facilities relevant to methodologies.
- Decision Support Room - specially designed and equipped for effective group work.

Taken together these provide the framework for computer-aided interactive management.

The participant group is often the <u>only</u> ingredient at many such meetings. The other four ingredients are all there to help the group manage its time effectively and efficiently and to make the most of the knowledge and expertise of the participants. Better planning and managing should result.

2.2. Teaching Activities

The department is now in a position to offer a variety of management courses and training seminars for professional managers in the areas of problem solving and decision making. These would cover three of the key management functions associated with:

- Intelligence - methods for identifying, defining, shaping and structuring complex problems.
- Design - generation and synthesis of alternative options, solutions and designs.
- Choice - decision making to evaluate, rank and choose between alternatives.

The methods of computer-aided interactive management would be used to take groups through these intelligence, design and choice phases in tackling complex problems.

The department also has the expertise to offer short courses in such areas as engineering management, systems design, risk assessment, management of technological change, health-care management and conflict management. The decision support room could provide a base for carrying out all these activities.

It is envisaged that the facilities would also be used for a certain amount of normal university teaching, for example, the BSc degree elective in Management Problem Solving and Decision Making and the Postgraduate Diploma course for Senior Managers in the Construction Industry. The Conflict Management Research Group may also find the proposed facilities appropriate for conflict mediation sessions. However, priority of use would be given to activities which earn money for the department and university.

2.3. Consultancy Services

The decision support room would also be well equipped for providing consultancy services. Such services would be offered to both public sector and private sector managers. It is envisaged that the contacts made amongst participants on the short courses offered would lead to such consultancy work, once they discover how relevant recent developments in problem-solving and decision making are to their requirements for managing complex problems.

The kind of consultancy work envisaged would typically involve bringing a group of managers to the department in order to work in the decision support room for a period of one or two days on a complex problem which they wish to resolve. Staff in the department would take the group through a series of well-defined steps as part of a structured problem-solving process. Depending on the particular content of the problem, this might include the use of:

- Idea generation methods such as Nominal Group Technique
- Computer-assisted problem structuring methods such as Interpretive Structural Modelling.
- Methods for the design of alternative problem solutions such as Options Field/Options Profile.
- Decision-making methods such as trade-off analysis.

Typical applications for such group problem-solving work would be:

- Priority setting regarding budget expenditures and project proposals.
- Objectives setting for organizations.
- Strategic planning and programme planning.
- Decision making with multiple conflicting objectives.
- Problem clarification and structuring.
- Systems and organizational design.

2.4 Research and Development

The decision supportroom would also provide a research and development laboratory for extending the potential of existing methodologies and the development of new methodologies related to the "management of complexity" theme. This could involve staff and research students in working in such areas as:

- Applications of Interpretive Structural Modelling.
- Strategic and tactical planning.
- Investigating the structural properties of complex systems.
- Multiple-objective decision making.
- Applications of graph theory, matrix theory and set theory in dealing with human-activity systems.
- Development of user-friendly computer software for problem structuring, decision making and the associated computer graphics.
- Methods for systems and organizational design.
- Behavioural aspects of group processes and group decision-making.

3. FACILITIES REQUIRED FOR A DECISION SUPPORT ROOM

Figure 1 shows the proposed layout for a decision support room to be located in Walmsley House.

3.1 Features of Room

Although apparently simple in design, each feature of the room serves a distinct function and is highly desirable if the department wishes to offer short courses and consultancy services of the kind outlined, in an effective and efficient manner. This is particularly the case if professional managers and others are to be charged significant fees for the services provided. From figure 1, it can be seen that the room includes the following features:

- moveable tables to provide flexible layouts for large and small group work
- swivelling chairs so that all participants can easily see all wall surfaces
- stackable seating for observers
- flip charts
- wall space for displaying flip-chart sheets
- magnetic boards with whiteboard surfaces for displaying structures produced
- computer hardware and display facilities
- cork wall surfaces
- overhead projector and slide projector
- overhead projector screen
- storage space
- work table

3.2 Computing facilities

Computer facilities giving access to appropriate computer software would be an essential feature of the room. Currently, the department has the Interpretive Structural Modelling software, which is available for use on the PRIME computer. Plans are well ahead to develop a version of this software for a personal computer. This should be available in 1985/86. It is envisaged that various other software packages would also be purchased for problem structuring and decision making.

Equipment requirements would include:

- computer terminal linked to a mainframe computer such as the PRIME
- personal computers
- printer (with sound proofing) to give hard copy of the computer output

- Modem and telephone line
- large-screen display facility (so that all participants can read questions posed by the computer, see displays, etc.)
- a transportable terminal, so that demonstrations and, on occasion, the work itself can be carried out in the premises of client organizations.

4. STAFFING

The decision support room would require the following staff:

- Director To be drawn from the academic staff and be responsible for management of the facilities, for marketing, for organizing short courses and organizing consultancy services. He would also do much of the teaching of the problem-solving and decision-making courses and undertake key roles in the consultancy work. He would draw upon departmental expertise to assist with both the teaching and consultancy activities.

- Secretary A part-time secretary would be required to undertake administrative work throughout the year and to be available full-time whilst courses were in progress.
- Computer Operator Research students/assistants could be paid to assist whilst short courses were in progress. They could also be paid to improve software and develop new programmes associated with the work.
- Facilitators The sort of group problem-solving work proposed requires facilitators who are expert in the steps and process of the methodologies, familiar with the computer software and who are skilled at working with with people. Initially, this work would be undertaken by the director and other departmental staff. However, it is envisaged that others, including postgraduate students, would be recruited and trained to assist.

5. FINANCES

Clearly, significant financial support would be required initally to set up the decision support room. This would involve money for both building work and the purchasing of equipment. Whilst the cost of the facilities proposed are relatively low when compared with, say, equipping an engineering laboratory, a significant amount of building work would be necessary to bring the existing space up to a suitable standard.

On the other hand, monies would be generated both from the short courses and the consultancy work. This would provide income for both the department and university.

F R JANES

14 March 1985

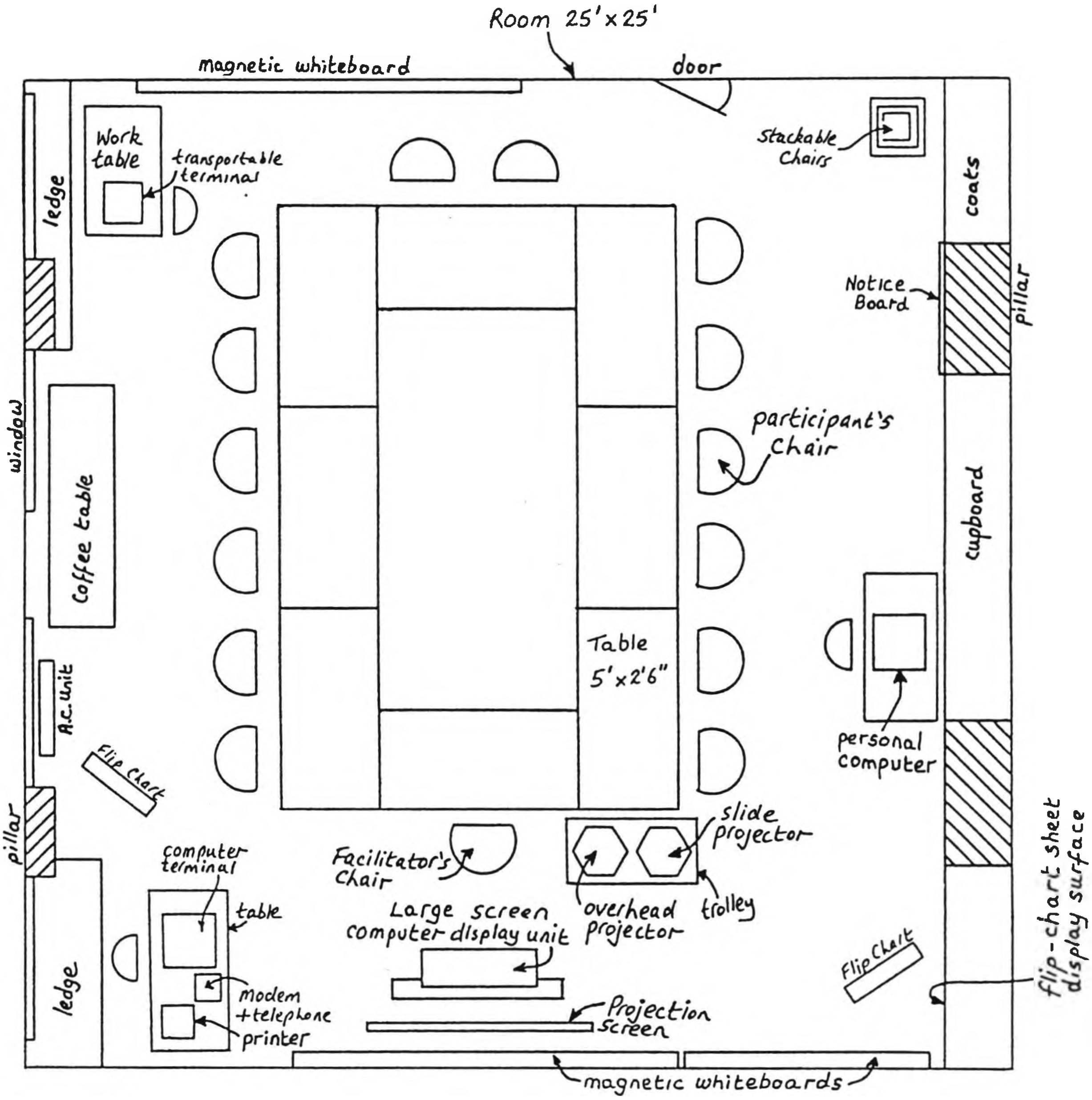


Figure 1. Decision Support Room
Proposed Layout for W208/W209

SUPPORTING PAPER P

Roberts, P.C., and Janes, F.R. (1989). Designing for reduced operating costs - modelling the linen services function. Health Service Estate. No. 66, May, 1989, 35-37.

DESIGNING FOR REDUCED OPERATING COSTS — MODELLING THE LINEN SERVICES FUNCTION

The first of the DROC interim reports on computer modelling work carried out by the Systems Science Department of City University

Peter Roberts MA, MInstP, Visiting Professor, City University; & Ross Janes BTech, MSc, CEng, MIEE, FInstMC, Senior Lecturer, City University.

Introduction

Issue No 62 of *Health Service Estate* contained an account of a modelling exercise concerned with the design of out patient departments. After this feasibility study to demonstrate the usefulness of modelling selected processes, the decision was made to commission a project on linen services with the intention of producing a computer model that could be generally available. Linen services was chosen to be the first of a series of such micro models which, when integrated into a macro model of total hospital functioning, will enable the cost implications of design decisions to be explored.

The Consultative Group

A working group was formed of staff from the Health Building Directorate, experts in the linen services function and members of the Systems Science Department. Starting from lists of relevant factors, this group was able to construct casual diagrams defining the relationships among all the variables which play a significant part in the linen services function. It was then possible to build a dynamic model portraying the flows of linen items

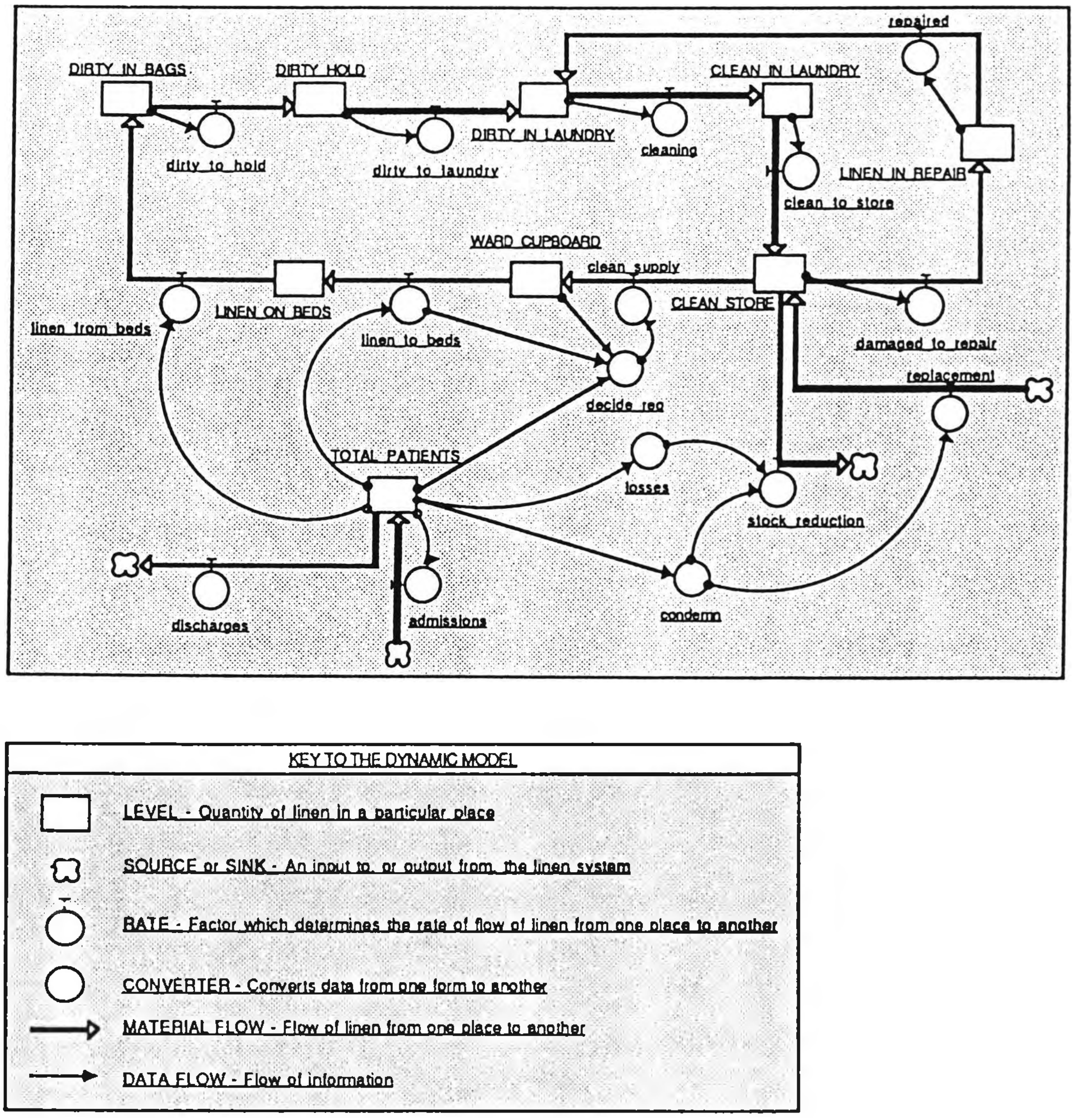


Figure 1. Dynamic model showing flows of linen.

throughout the hospital. The model was constructed using the program STELLA on an Apple Macintosh. Figure 1 shows the structure of the model, with flows of clean linen passing from the laundry to the central linen store and thence to the wards and the beds. Dirty linen travels the same route in the opposite direction and 'stocks' of linen are held at those points in the diagram associated with rectangles. When the group was satisfied that this model was a good match with reality, a second model was constructed using relationships from the first but generating output costs. This second (cost) model was based on a spreadsheet format and used a package that can be run on any IBM compatible micro.

The Cost Model

The cost model contains six types of variables:

(1) Logistic factors defining the scale of the operation, such as the throughput of patients and the number of wards.

(2) Design factors such as the distance travelled in conveying linen to and from wards.

(3) Factors defining operational practice—'exchange trolley' or 'top—up' systems.

(4) Cost factors such as the price of a sheet, the laundry cost of it and staff wages.

(5) Policy factors such as the bed change interval.

(6) Output factors which consist of aggregated costs expressed both as running costs and in present value form to contain both capital and running costs.

Figure 2 shows a page of the spreadsheet. In the first column is the row number followed by the names of the variables in the second and the appropriate units in the third. The fourth column is used for a 'base set' of data, supplied with the program. The user can then insert changes to the base set in the fifth and subsequent columns, observing corresponding changes which occur in the output values.

	A	B	C
1	PARAMETER NAMES	UNITS	EXAMPLE VALUES
2	LOGISTICS		
3	Throughput total	num/yr	36000.00
4	Mean stay time	days	5.00
5	% incontinent	%	15.00
6	Incontinent stay time	days	8.00
7	Bed change interval	days	1.50
8	Incontinent change interval	days	0.50
9	Trolley exchange system	num	1.00
10	Top-up system	num	0.00
11	Total travel (tug)	m	2000.00
12	Total travel (walk)	m	400.00
13	Transit speed (tug)	m/sec	1.50
14	Transit speed (walk)	m/sec	1.00
15	Trolley clean capacity	num	3.00
16	Trolley soiled capacity	num	1.50
17	Replenish time	sec	250.00
18	Soiled load time	sec	30.00
19	Trolley exchange time	sec	80.00
20	Lift (transit and waiting)	sec	120.00
21	Number of wards	num	20.00
22	Wards reached by lift	num	6.00
23	Number of tugs	num	2.00
24	Number of porters	num	3.00
25	Train size	num	4.00
26	% duvets	%	10.00
27	% disposable linen	%	2.00
28	Laundry turnaround time	days	4.00

Figure 2. Example spreadsheet.

Validation

Data were obtained from a London teaching hospital and from a provincial nucleus district general hospital, in order to check both input variable values and output variable values. Acceptable agreement was obtained on input values but there were significant differences between some of the model output values and the corresponding recorded hospital operating figures. Ultimately, it emerged that excess resources had been employed on linen services—and corrective action was taken (prompted by the discrepancy between the two sets of figures). This could be regarded as the first useful outcome of the model.

User Trials

It was considered essential to ensure that the model was sufficiently user friendly, so that it would be readily used by anyone who could benefit from it. To achieve this end, the software was supplied, accompanied by the user guide, to two 'guinea pigs' who were asked to attempt running and using the model aided only by the manual and screen instructions. Both subjects reported that the model was relatively easy to set up and use; favourable comments were made on the menu system. A number of constructive suggestions for amendments to the user guide were volunteered and these have subsequently been incorporated.

Documentation

The user guide contains a comprehensive list of variable definitions and assumptions used in defining the relationships of the model. In addition, a report of the project was prepared (Development and Application of Computer Modelling to Assess Operating Costs of Alternative Hospital Designs. Model 1: Linen Services. Technical report DSS/PCR-FRJ-CMP/251) and program documentation for the dynamic and the cost model supplied. Arrangements have been made for program maintenance to be undertaken by Lensar Ltd.

SUPPORTING PAPER Q

Roberts, P.C., Janes, F.R. and Pope, C.M. (1988). Development and application of computer modelling to assess operating costs of alternative hospital designs. Model 1: linen services. Commissioned Technical Report for the DoH - Research Contract W87/IS/1010A. No. DSS/PCR-FRJ-CMP/251, Dept. of Systems Science, City University, London. 24pp.

(Appendices A and B together with the first three pages of Appendix C of this report have been included)

Development and Application of Computer Modelling to Assess Operating Costs of Alternative Hospital Designs.

Model 1 : Linen Services

(A report produced for the Health Building Directorate of the Department of Health)

P.C. Roberts, F.R. Janes

Department of Systems Science

C. M. Pope

Lensar Ltd

Technical report
DSS/PCR-FRJ-CMP/251

September 1988

CONTENTS

Abbreviations

DROC	Design for Reduced Operating Costs
DGH	District General Hospital
LTH	London Teaching Hospital

1 EXECUTIVE SUMMARY

Drawing on the combined expertise of members of a consultative group, the linen services function in current NHS hospitals has been simulated using a computer program. Using the results of that simulation, a cost model has been constructed using the 'spreadsheet ' format. All the factors which affect final costs are listed with the values to be taken in some chosen context displayed. The internal relationships of the spreadsheet enable subtotals (e.g. porter time, nurse time, laundry cost, linen replacement cost etc.) to be calculated and total costs to be displayed. Alternative operating practices and alternative designs can be tested by inserting appropriate values for the relevant variables in the spreadsheet.

The model has been tested by using data from particular hospitals to see how closely the calculated costs agree with actual costs. The ease of use of the model has been tested by making the model program and an operational manual available to selected individuals who attempt to understand and run the model without outside assistance. Software documentation has been supplied so that program maintenance can be carried out and future modifications be added.

Throughout the course of the project, close liaison has been maintained with members of the consultative group and with staff responsible for the linen service function. Attention has been paid to the prospect of integrating this model within a suite of micro models covering many aspects of hospital functioning, so that a macro model incorporating salient features of the micro models can be constructed.

2 INTRODUCTION

In recent years, a considerable amount of effort has been expended on the control of capital expenditure on health building, via CAPRICODE, the Health Building notes and other guidance. However, the whole-life operating costs of a hospital dwarf the initial capital costs by orders of magnitude. Even when discounting methods are applied, operating costs are still much more significant than initial construction costs. The issue came to a head when the Public Accounts Committee (PAC) expressed concern that new hospitals were costing more to operate than the old hospitals which they replaced. In fact, it has been shown that most of this extra cost is accounted for by the increased throughput and more sophisticated case mix of new hospitals. However, control of demand and medical sophistication is difficult and emotive, whereas cost cutting due to better design is something that nobody objects to.The linen model is the first in a series of models being developed by the City University / Lensar team as part of this programme. The intention is to develop a collection of models of hospital processes which simulate the operation of the hospital in cost terms. Since the efficiency of each of the processes is to some extent dependent on the design of the hospital, the models will provide a relationship between design elements and operating costs.

This project follows on from a feasibility study[1] completed in September 1987, a part of which was described in an article[2]. In the study it was recommended that specific activities within hospitals be described by micro models and that those micro models be assembled to form a macro model. By this means it would be possible to analyse the detailed effects of changes in design on operating costs. For example the transport of supplies such as ward linen or meals for patients is affected by the lengths of connecting corridors, the means of access to upper floors and the siting of supply centres - features which are determined by design. As a consequence of that work, it was decided to conduct a pilot study on the linen services function in hospitals. The study was specified in January 1988 with the following objectives:

(1) To construct a quantitative computer model of the linen service function.

(2) To carry out simulations of possible hospital designs and associated hospital policies (in respect of linen) in order to demonstrate how operating costs can be assessed.

(3) To supply a computer program, software documentation and project report.

Two separate models have been constructed - a dynamic model and a cost model. The dynamic model enables simulation of the flows and stocks of linen in a hospital to be carried out and thereby makes it possible to calculate the relationships connecting quantity of linen in circulation with turnaround time and bed change frequency. The cost model (making use of these relationships) allows detailed accounting of all associated costs to be performed.

---

1 The Use of Quantitative Computer Models to Determine Operating Costs of Alternative Hospital Designs. P.C.Roberts & F.R.Janes, Technical Report,DSS/PCR-FRJ/247, Dept. of Systems Science, City University, London, 1987, 23pp.

2 Designing for Reduced Operating Costs: The Design of Out Patient Departments. P. Roberts, R.Moss & R.Janes, Health Service Estate, No 62, April 1988, p35-40.

3 MODEL CONSTRUCTION

3.1 Work of the consultative group

A joint working group was established. The members (listed in Appendix 1) were drawn from the City Univerity project team, members of the Health Building Directorate and experts on the various aspects of the linen service function. The first task of this group was to list all the factors which are involved. The idea-generation technique of IDEAWRITING was used to assist in making the list comprehensive. Members of the group first attempt separately to compile lists of all the factors and then continue by inspecting each others lists in order to catalyse the search process and make it so thorough that the inadvertent omission of a factor is virtually eliminated. In the second stage the factors are categorised under headings:

Distribution
Storage
Manpower
Topography
User policy
Provisioning policy
Others

Examples of two of the categories:

DISTRIBUTION

* availability of suitable transport
* policy - topping up/exchange trolley/requisition
* policy on portering
* shortest turnaround time possible
* how to deal with weekends and long holidays
* distribution to users
* frequency of delivery
* transportation/delivery system
* extent of mechanised handling

TOPOGRAPHY

* type of building - high/low rise
* distance from laundry
* distances from storage to final place of use
* covered routes
* nature and location of lifts and ramps
* chutes for dirty linen
* hygiene/fire risk

From the categories of factors it was possible to construct influence diagrams (or more correctly signed digraphs) showing how the separate factors were causally linked to one another. In the construction of these diagrams, factors that had been named in general terms were replaced by those which were quantifiable, so that the meanings of arrows used to connect factors and labeled with +ve or -ve signs were clear and unambiguous. Diagrams dealing with the following themes were drawn :

Demand
Distribution - trolley exchange
Distribution - top-up
Stock maintenance
Stock setting

An example of one of these diagrams is shown overleaf. The area under consideration is distribution using the trolley exchange method. The variable 'total transporter time' is evidently increased if either 'mean trip length' or 'number of trips' is increased, hence the arrows which link each of these variables to 'total transporter time' is labeled +ve. However, if the size of the train (number of trolleys being towed by one tug) is increased then the number of trips decreases, and this is indicated by a -ve sign on the arrow linking 'size of train' to 'number of trips'. A +ve sign means that both variables at either end of the arrow increase or decrease together, whereas a -ve sign means that they move in opposite directions with one increasing as the other decreases.

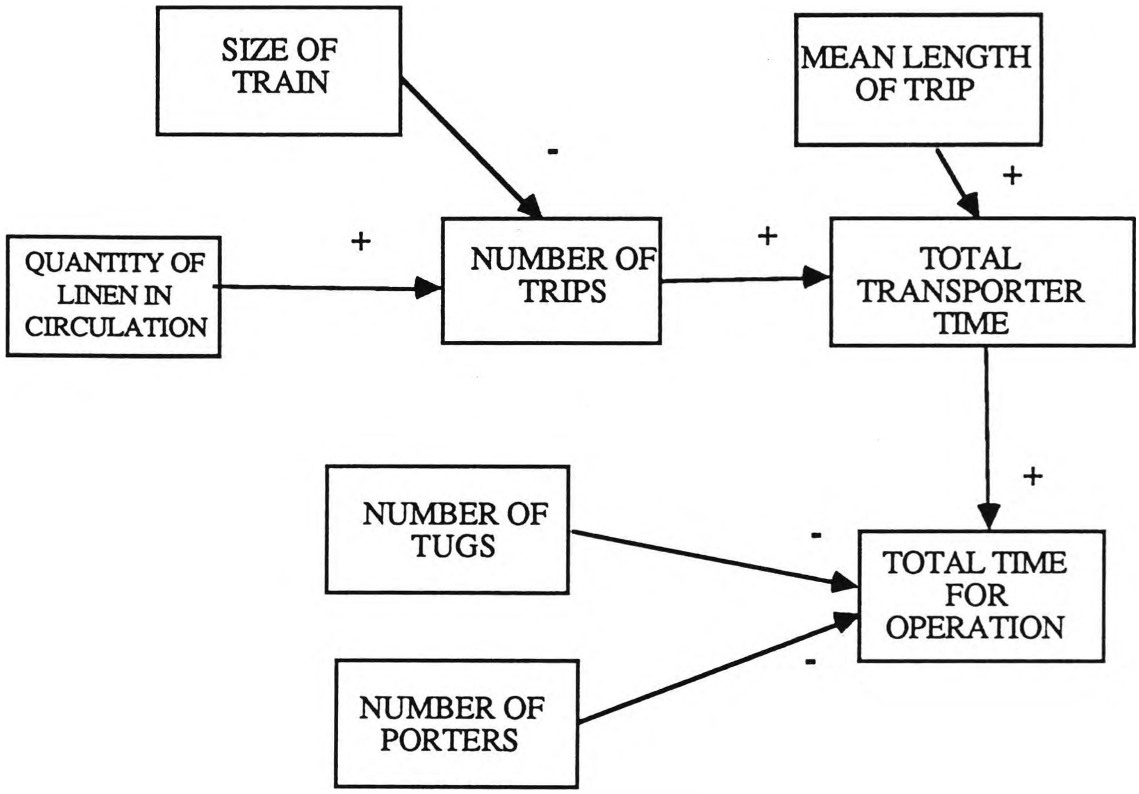


Figure 1 Example Signed Digraph

An account of the use of signed digraphs with detailed explanations of the conventions can be found in :

Introduction to Computer Simulation: A Systems Dynamics Modelling Approach. N. Roberts et al, Addison - Wesley, 1983, Chaps. 3 and 4.

From these diagrams, it was possible to construct a dynamic model simulating the flows of linen and the changes of stock levels which occur during operation. This construction process was made partly interactive, so that members of the consultative group could observe the model at various stages in its development and ensure that errors were eliminated.

When the members of the consultative group were happy that the dynamic model described the processes of linen supply accurately, a cost model was assembled and the same process of interactive monitoring with the group continued to ensure that this model was a good representation of reality.

The final phase of the group's activity was concerned with data provision. The group was expanded to contain staff directly responsible for linen services in a large teaching hospital and data from that hospital obtained for use in the cost model.

3.2 The dynamic model

In Appendix 2 specification details of the dynamic model are given. The primary purpose of this model was to provide a visual simulation of the linen function so that assumptions about the stocks and flows of linen could be checked by those familiar with the procedures used in typical hospitals. A second purpose was to establish the functional dependence of 'linen in circulation' on laundry turnaround time, bed change interval and number of occupied beds. The minimum practicable value of linen in circulation was found by reducing the simulated quantity representing linen in circulation until one or more of the stocks of linen (on the beds, in the ward cupboard, at the central linen store and at the laundry) fell below zero. The functional relationship so found was used in the cost model.

The dynamic model is essentially a tool devised for assisting the progress of the project. It was essential for determining some of the relationships employed in the cost model but it is not intended that it should be a part of the model suite available to users. However, the program has been preserved, and could be re-run if future modifications of the cost model were required.

3.3 The cost model

Details of the specification of the cost model are given in Appendix 3. The decision was taken to use a spreadsheet for this model because the form of the data and the relationships are well suited to representation in spreadsheet format. Furthermore, there are advantages in transparency and ease of modification which are obtained by using this format.

Variables which appear in the cost model are of six types :

1) Logistic factors defining the scale of the operation, such as the throughput of patients and the number of wards.

2) Design factors such as the distance travelled in conveying linen to and from the wards.

3) Factors defining operational practice - 'exchange trolley' or 'top- up' systems.

4) Cost factors such as the price of a sheet, the laundry cost of it and staff wages.

5) Policy factors such as the bed change interval.

6) Output factors which consist of aggregated costs expressed both as running costs and in present value form to contain both capital and running costs.

A part of an example spreadsheet is shown overleaf. The titles of the variables occupy the left-hand column of the spreadsheet. In the next column are the units in which the variables are measured and in subsequent columns are lists of data applicable to particular hospitals or designs for hospitals or trials of alternative operational practices etc.

In using the model it is convenient to leave a 'base set' of data in the first of the data columns and observe changes occurring in the second and subsequent columns as alternative values for variables are substituted in these columns. In the example, if the second data column contained one change - the throughput figure being altered from the one shown in the base set - then this change would immediately generate a change in the variable 'occupied beds' and this in turn would cause changes to the quantity of each of the linen items in circulation which would result in changes to the laundry costs, the capital costs and the replacement costs. The final effects would be changes to the running costs and to the present value of capital and running costs.

Changes of operational practice are carried out by altering the ones and zeros opposite the items 'exchange trolley system' and 'top-up system'. A **1** indicates that the system is in operation and a **0** that it is not. All other variables affected by a given choice of operational practice are altered appropriately when that choice is selected.

As an example of a design change, consider an alteration from the current data set with porter walk distance of 400m and tug travel of 2000m to walk-only for 2400m. Using trolley exchange the total porter time per day rises from 7500 seconds to 10,900 seconds.

	A	B	C
1	PARAMETER NAMES	UNITS	EXAMPLE VALUES
2	LOGISTICS		
3	Throughput total	num/yr	36000.00
4	Mean stay time	days	5.00
5	% incontinent	%	15.00
6	Incontinent stay time	days	8.00
7	Bed change interval	days	1.50
8	Incontinent change interval	days	0.50
9	Trolley exchange system	num	1.00
10	Top-up system	num	0.00
11	Total travel (tug)	m	2000.00
12	Total travel (walk)	m	400.00
13	Transit speed (tug)	m/sec	1.50
14	Transit speed (walk)	m/sec	1.00
15	Trolley clean capacity	num	3.00
16	Trolley soiled capacity	num	1.50
17	Replenish time	sec	250.00
18	Soiled load time	sec	30.00
19	Trolley exchange time	sec	80.00
20	Lift (transit and waiting)	sec	120.00
21	Number of wards	num	20.00
22	Wards reached by lift	num	6.00
23	Number of tugs	num	2.00
24	Number of porters	num	3.00
25	Train size	num	4.00
26	% duvets	%	10.00
27	% disposable linen	%	2.00
28	Laundry turnaround time	days	4.00

Figure 2 Example of a Spreadsheet

4 VALIDATION OF MODEL USING HOSPITAL DATA

In order to validate[3] the cost model, data were obtained for a London teaching hospital (LTH) and a provincial nucleus district general hospital (DGH). The purpose of this exercise was twofold:

i) to determine the magnitude of the input variables;
ii) to compare the results calculated by the model with those obtained in practice.

The validation process was largely successful in that it achieved the stated objectives and produced a number of interesting findings.

First, it confirmed a belief concerning the difficulties of obtaining data for this type of model. The LTH managed to supply an almost complete data set of input and output variables, but the DGH was only able to supply the inputs and a few outputs. However, both hospitals experienced some difficulty in obtaining all of the data in the appropriate form, a factor which necessitated a certain amount of pre-processing of data to calculate the inputs required by the model.

It also became apparent that a clear, unambiguous definition of the parameters used by the model is absolutely crucial to its success. An example of this was provided by the LTH where linen attendants were used for linen distribution rather than general porters. The model uses the term *porter* to mean *distribution person* but in the case of the LTH this term was interpreted literally and a value of zero given initially. This issue has been addressed by the production of a list of variables and assumptions used in the model and it is obviously vital that any prospective user of the model studies the list carefully.

The lack of two complete sets of output variables meant that the validation process was more successful in determining the magnitude of the inputs than in checking the outputs. However, it was still possible for a number of refinements to be made to improve the accuracy of the model. In addition, the data supplied by the LTH indicated two areas worthy of comment.

The first of these concerns the quantity of linen in circulation. In the case of the LTH data there was a significant variation between the calculated number of sheets in circulation and the actual number. The reason for this is that there appears to be a great deal of variation in stock holding levels between different hospitals. The cost model uses a theoretical minimum stock level derived from the dynamics model and so it is likely that the actual stock level for a given hospital will be greater than that calculated by the model. In other words, it seems unlikely that most hospitals will be operating with the very minimum level of stock as assumed in the model.

The second finding to come from the LTH data concerns porter costs. The cost of porter time given by the model is the cost of the time that porters actually spend distributing and collecting linen. From the LTH data supplied, it would appear that there is a significant amount of time when their linen attendants are neither distributing linen nor sorting it. This would appear to indicate two possibilities:

i) these staff could be used for other activities (e.g. dealing with linen for another hospital nearby);
ii) the hospital might be able to run its linen distribution system using part-time staff instead.

---

[3] Validation is the process of checking that the values calculated by the model are accurate.

It should be borne in mind that these are only general indications and there may in fact be other factors to consider before any firm conclusions can be reached. Nevertheless, the results indicate that this area warrants further investigation by the hospital concerned.

The results of the validation process were very encouraging, indicating a close agreement between calculated values and actual values in most cases. There is now a need to extend the use of the model to other hospitals and it would seem that the best way of doing so is through some form of extended user trial. This may well indicate other refinements that need to be made, but for the time being it would appear that the existing model is reasonably robust and accurate.

5 USER TRIALS

The purpose of the user trials was to evaluate the linen cost model in terms of four factors:

i) its user interface;
ii) the quality of the accompanying user guide;
iii) the accuracy of its outputs;
iv) potential applications for the model.

Two potential users were identified and were sent a pre-release copy of the software and the user guide for evaluation.

On the whole, the trials were not as successful as had been hoped. The comments received were general ones concerning the user interface, documentation and potential applications only, and no information was provided about the accuracy of the outputs.

The package appeared to have been well received by the testers, who have spoken highly of its interface, particularly the menu system. They found it so easy to use that they were able to treat the user guide as a reference document, only referring to it to check on a specific aspect of the program. A number of constructive suggestions for amendments to the user guide were also received, but these are all relatively minor and were easy to incorporate.

It was felt by one of the testers that the linen package would be very useful to those trying to decied whether to contract out laundry services. Although no other specific suggestions were made about potential applications, both testers judged the model to be a useful tool.

Appendix 1

Members of the Consultative Group

Mr A Noakes	DH Health Building Directorate
Mr P Eynon	DH Health Building Directorate
Miss Y du Heaume	DH Hotel and Dietetic services
Miss S Scott	DH Nursing Division
Mr J Halstead	Consultant

City University Project Team

Mr F R Janes	Senior Lecturer
Professor P C Roberts	Visiting Professor
Dr. C M Pope	Lensar Ltd.
Mr R J Jeffery	Interactive Management Unit
Mr G Zarkadakis	Lensar Ltd.

Liaison Officer

Mr M Woolliscroft	DH Health Building Directorate

Acknowledgements

The Department of Health and City University would like to acknowledge the help of the following people during the development and testing of the model;

Mr R Perry
Mr C Webber
Mr K Mills
Mr R Woodward
Mr A Tait

Appendix 2
Dynamic model

The program STELLA™ running on an Apple Macintosh computer was used for the assembly of a system dynamics model of linen flows and stocks in a typical hospital.

Below is a diagram of the dynamic model and a listing of the relationships used in its construction. The rectangles consist of stocks which can be of either commodities or people. Thus , number of patients is a stock and so are linen on beds and dirty linen in bags. The arrows show flows taking place and valves on the arrows indicate what determines the flow in each case. The cloud symbols stand for either a source or a sink 'outside' the system. Patient admissions and replacement linen both come from outside.

In the simulation flows consisted of pulses i.e. actual movement of linen took place rapidly but during only a short period of time. During the day a pulse of linen would move from the clean store to the ward cupboards, a pulse of linen from the cupboards to the beds and a pulse of dirty linen from the beds to storage bags. There would be additional pulses passing to and from the laundry (not necessarily on each day) and small pulses transferring to a repair loop or being condemned.

The general dynamic behaviour of the system could be observed in response to 'shocks' such as a sudden rise in admissions. Additionally, the minimum practicable quantity of linen in circulation could be found by reducing the total until one or more stocks fell to zero. The dependence of this minimum quantity on such factors as bed change frequency and laundry turnaround time could be found.

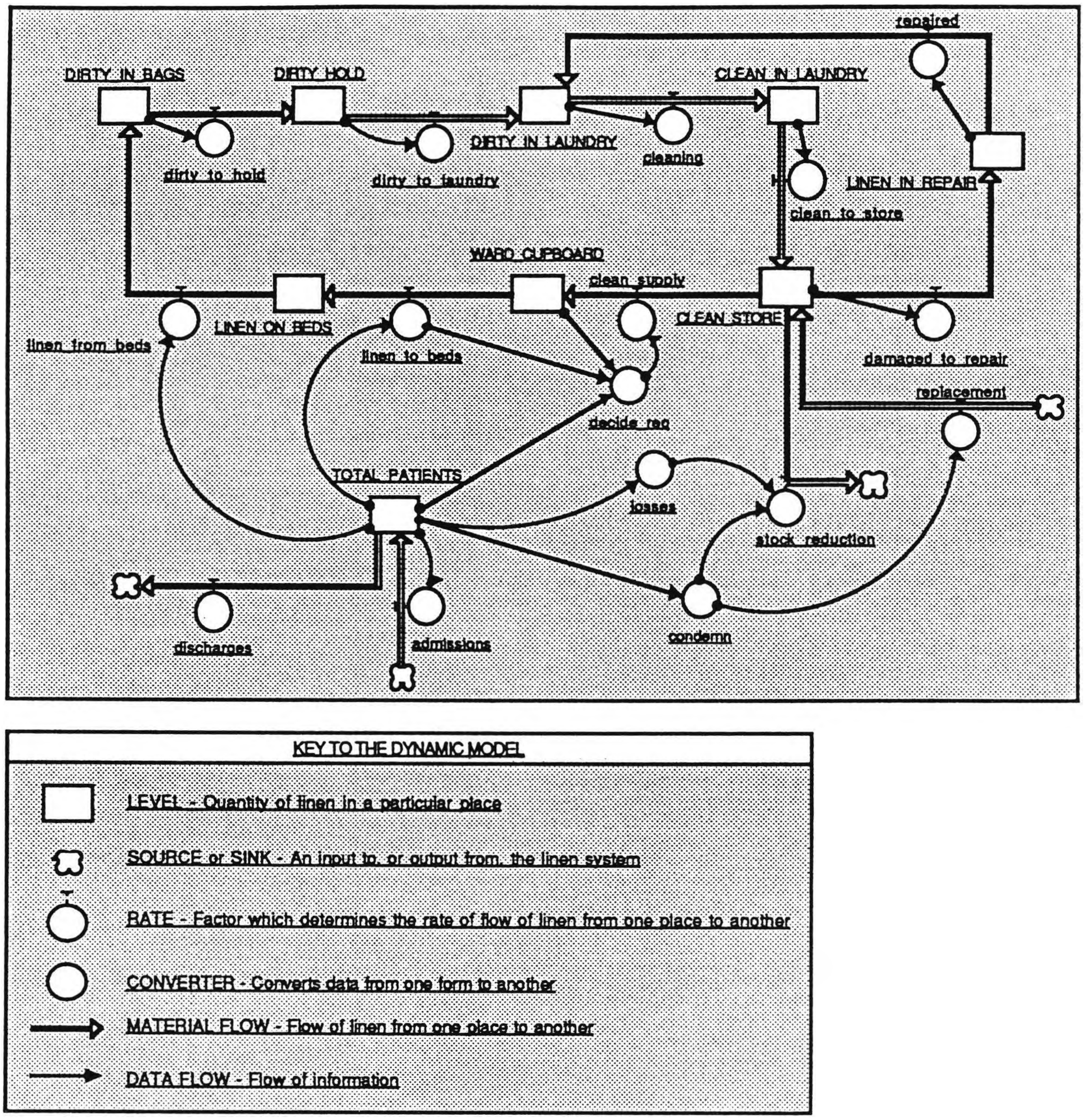


Figure 3.1 Dynamic Model

```
CLEAN_IN_LAUNDRY = CLEAN_IN_LAUNDRY + dt * ( cleaning - clean_to_store )
INIT(CLEAN_IN_LAUNDRY) = 0
CLEAN_STORE = CLEAN_STORE + dt * ( -clean_supply + clean_to_store - damaged_to_repair - stock_reduction + replacement )
INIT(CLEAN_STORE) = 4000
DIRTY_HOLD = DIRTY_HOLD + dt * ( dirty_to_hold - dirty_to_laundry )
INIT(DIRTY_HOLD) = 0
DIRTY_IN_BAGS = DIRTY_IN_BAGS + dt * ( linen_from_beds - dirty_to_hold )
INIT(DIRTY_IN_BAGS) = 300
DIRTY_IN_LAUNDRY = DIRTY_IN_LAUNDRY + dt * ( dirty_to_laundry - cleaning + repaired )
INIT(DIRTY_IN_LAUNDRY) = 2100
LINEN_IN_REPAIR = LINEN_IN_REPAIR + dt * ( damaged_to_repair - repaired )
INIT(LINEN_IN_REPAIR) = 0
LINEN_ON_BEDS = LINEN_ON_BEDS + dt * ( linen_to_beds - linen_from_beds )
INIT(LINEN_ON_BEDS) = 600
TOTAL_PATIENTS = TOTAL_PATIENTS + dt * ( admissions - discharges )
INIT(TOTAL_PATIENTS) = 575
WARD_CUPBOARD = WARD_CUPBOARD + dt * ( -linen_to_beds + clean_supply )
INIT(WARD_CUPBOARD) = 300

admissions=PULSE(int((600-MIN(600,TOTAL_PATIENTS))/3),1,2)
cleaning = PULSE(MIN(DIRTY_IN_LAUNDRY,600),0,2)
clean_supply = decide_req
clean_to_store = PULSE(CLEAN_IN_LAUNDRY,14,7)
condemn = PULSE(TOTAL_PATIENTS*.0005,1,2)
damaged_to_repair = PULSE(CLEAN_STORE*.01,14,14)
decide_req = PULSE(1.15*TOTAL_PATIENTS-WARD_CUPBOARD-linen_to_beds,0,2)
dirty_to_hold = pulse(DIRTY_IN_BAGS,1,2)
dirty_to_laundry = PULSE(DIRTY_HOLD,14,7)
discharges = PULSE(int(RANDOM*20),1,2)
linen_from_beds = PULSE(TOTAL_PATIENTS,0,2)
linen_to_beds = PULSE(TOTAL_PATIENTS,1,2)
losses = TOTAL_PATIENTS*.00001
repaired = PULSE(LINEN_IN_REPAIR,28,14)
replacement = condemn
stock_reduction = losses+condemn
```

Figure 3.2 Listing of relationships used in dynamic model

Appendix 3

Cost model

Figures 4.1, 4.2 and 4.3 give a listing of the entire spreadsheet and following that is the set of definitions and assumptions applying to the items of the spreadsheet. The terms used to describe variables are necessarily brief in order to keep the sheet to a manageable size. Thus, it is essential to define the meanings of the terms with precision.

There are a number of assumptions made in the course of constructing the spreadsheet and these have been listed. The set of definitions and assumptions has been reproduced in the users' manual so that the risk of ambiguity is reduced when the model is being run.

	A	B	C
1	PARAMETER NAMES	UNITS	EXAMPLE VALUES
2	LOGISTICS		
3	Throughput total	num/yr	36000.00
4	Mean stay time	days	5.00
5	% incontinent	%	15.00
6	Incontinent stay time	days	8.00
7	Bed change interval	days	1.50
8	Incontinent change interval	days	0.50
9	Trolley exchange system	num	1.00
10	Top-up system	num	0.00
11	Total travel (tug)	m	2000.00
12	Total travel (walk)	m	400.00
13	Transit speed (tug)	m/sec	1.50
14	Transit speed (walk)	m/sec	1.00
15	Trolley clean capacity	num	3.00
16	Trolley soiled capacity	num	1.50
17	Replenish time	sec	250.00
18	Soiled load time	sec	30.00
19	Trolley exchange time	sec	80.00
20	Lift (transit and waiting)	sec	120.00
21	Number of wards	num	20.00
22	Wards reached by lift	num	6.00
23	Number of tugs	num	2.00
24	Number of porters	num	3.00
25	Train size	num	4.00
26	% duvets	%	10.00
27	% disposable linen	%	2.00
28	Laundry turnaround time	days	4.00

Figure 4.1 Logistics

29	INPUT COSTS		
30	Blanket cost	£	8.49
31	Sheet cost	£	6.27
32	Counterpane cost	£	13.81
33	Duvet cost	£	29.10
34	Duvet cover cost	£	17.25
35	Pillow case cost	£	0.69
36	Blanket life	years	2.50
37	Sheet life	years	3.00
38	Counterpane life	years	2.50
39	Duvet life	years	10.00
40	Duvet cover life	years	3.00
41	Pillow case life	£	3.00
42	Blanket laundry cost	£	0.20
43	Sheet laundry cost	£	0.15
44	Counterpane laundry cost	£	0.27
45	Duvet cover laundry cost	£	0.25
46	Pillow case laundry cost	£	0.05
47	Change time (traditional)	sec	200.00
48	Change time (duvet)	sec	140.00
49	Change time (disposable linen)	sec	70.00
50	Porter time cost	£/hr	2.50
51	Nurse time cost	£/hr	4.50
52	Linen staff time cost	£/hr	3.50
53	Trolley cost	£	140.00
54	Tug cost	£	2300.00
55	Trolley life	years	10.00
56	Tug life	years	10.00
57	Linen store space	m2	30.00
58	Space capital cost	£/m2	100.00
59	Space running cost	£/m2/yr	15.00
60	Linen store miscalleneous	£/yr	1000.00
61	Linen store staff	num	2.00
62	Disposable cost	£	2.30
63	Beds/ward	num	28.00
64	Discount rate	%	5.00
65	Time horizon	years	10.00

Figure 4.2 Input Costs

66	OUTPUT COSTS		
67	Number of trolleys	num	80.00
68	Number of occupied beds	num	493.15
69	Incontinent occupied beds	num	118.36
70	Bed changes per year	num	177600.00
71	Laundry cost blankets	£/yr	15628.80
72	Laundry cost counterpanes	£/yr	21098.88
73	Laundry cost sheets	£/yr	49550.40
74	Laundry cost duvet covers	£/yr	4440.00
75	Laundry cost pillow cases	£/yr	8880.00
76	Cost of nurse time	£/yr	42490.80
77	Porter walk time	sec	800.00
78	Porter tug time	sec	666.67
79	Porter exchange time	sec	3200.00
80	Porter lift time	sec	3.00
81	Porter total time	sec	4669.67
82	Cost of porter time	£	843.13
83	Cost of linen staff time	£/yr	14000.00
84	Cost of tug replacement	£/yr	460.00
85	Cost of trolley replacement	£/yr	1120.00
86	Cost of running store	£/yr	1450.00
87	Cost of disposable linen	£/yr	8169.60
88	Duvets total	num	56.00
89	Sheets in circulation	num	6411.54
90	Blankets in circulation	num	4649.94
91	Counterpanes in circulation	num	2324.97
92	Duvet covers in circulation	num	410.67
93	Pillow cases in circulation	num	2301.37
94	Cost of sheet replacement	£/yr	13400.13
95	Cost of blanket replacement	£/yr	15791.18
96	Cost of counterpane replacement	£/yr	12843.12
97	Cost of duvet cover replacement	£/yr	2361.33
98	Cost of pillow case replacement	£/yr	529.32
99	Total staff costs	£/yr	57333.93
100	Total laundry costs	£/yr	99598.08
101	Linen replacement costs	£/yr	53094.68
102	Linen capital	£	122087.69
103	Transport replacement costs	£/yr	1580.00
104	Total Running Cost	£/yr	213056.69
105	PRESENT VALUE		
106	Discount factor 1 to n-1	num	7.11
107	Discount factor 0 to n-1	num	8.11
108	Present value staff	£	464863.54
109	Present value linen	£	1308184.23
110	Present value transport	£	27030.64
111	Present value store	£	14756.60
112	Total Present Value	£	1814835.01

Figure 4.3 Output Costs

Definitions and Assumptions

3. **Throughput total**
The number of patients treated per year.

4. **Mean stay time**
The average time that a patient occupies a hospital bed. It is the average for all patients and not just the total excluding incontinents.

5. **Percentage incontinent**
The percentage of the total throughput who are incontinent (not the percentage of beds occupied by incontinent patients).

6. **Incontinent stay time**
The average stay time of incontinent patients.

7. **Bed change interval**
The interval between a complete change of sheets (e.g for a bed with two sheets, this is 1 day if both sheets are changed every day, and 2 days if only one sheet is changed every day). It is assumed that the blankets and counterpane are changed half as often as the sheets.

8. **Incontinent change interval**
The bed change interval for incontinent patients.

9. **Trolley exchange system and Top-up system**
These two are normally considered together since most hospitals will either have one system or the other. Enter a 1 for the system being used and a 0 for the system that is not in use (e.g for a Top-up system, Trolley exchange should be 0 and Top-up should be 1).

11. **Total travel (tug)**
The sum of all the trips made by tug from the central linen store to each ward or department and back to the store. Allowance is made in the program for the reduction in total distance travelled when a train of tugs is used to service more than one ward on the same trip.

12. **Total travel (walk)**
The sum of all trips made on foot from the central linen store to each wardor department and back to the linen store.

15. **Trolley clean capacity**
This applies to top-up systems only. It is the capacity of each trolley used to distribute clean linen measured in wards-worth.

16. **Trolley soiled capacity**
The capacity of each trolley used to collect soiled linen measured in wards-worth. Also only applicable to top-up.

17. **Replenish time**
This applies to top-up systems only. It is the total time between stopping to replenish a ward and starting again.

18. **Soiled load time**
This applies to top-up systems only. It is the total time between stoppingto collect soiled linen from a ward and starting again.

19. **Trolley exchange time**

SUPPORTING PAPER R

Janes, F.R. (1987d). Using a subordinate relation in an ISM. Chap. 8 in Group Techniques for Idea Building, by C.M.Moore. Newbury Park, California: Sage Publications.

8

Using a Subordinate Relation in an ISM

F.ROSS JANES

This chapter describes a special problem with phrasing the relationship in an ISM session and offers suggestions for a preferred phrasing.

Chapter 5 explained that the ISM relation should always be expressed as a subordinate phrase, because that is one of the assumptions of ISM. A careful reader will note that the example of the county priority-setting exercise presented in Chapter 7 did not use a subordinate phrase. The relation was phrased:

IT IS A HIGHER PRIORITY TO
[itemA]
THAN IT IS TO
[item B]

That was done for two reasons: (1) to experiment with a different phrasing, because (2) groups tend to find the subordinate phrasing awkward. An alternative subordinate phrasing would be:

[item A]
IS A LOWER PRIORITY THAN
[item B]

The modification that was made was to reverse the order of items given by the computer, but still enter the answer given by the group. So if the choice that came up on the screen was 2 R 5 (in which 2 is the first item, R is the relationship—in the previous example that is "is a lower priority than," and 5 is the second item), the terminal operator announced it 5 R 2. If, after deliberating about that choice, the group voted yes, then yes would be entered into the computer. The assumption was that we would simply reverse the order when the computer provided the final structure.

The following is a portion of a letter to me from F. Ross Janes, who operated the terminal during the session, regarding why that should *not* have been done. He offers suggestions of what would be preferable ways to phrase the statement of the relationship. I include the letter because it is a lucid statement of a technically difficult problem.

F. Ross Janes
Department of Systems Science
The City University, London

On looking, a few days ago, at the matrix of the Commissioners' responses and the priority structure presented to them, I thought that it would be interesting to investigate the discrepancies between the two, which were puzzling me.... I decided to do a rerun of the session to check the results, and then to see if I could reconstruct what the session might have produced had the questions been phrased in the form ARB [which was what the computer asked for] rather than BRA [which was how the choice was put to the commissioners].

RERUN OF SESSION WITH COMMISSIONERS (BRA)

I reran the ISM..., feeding in the decisions actually made by the Commissioners. This produced an identical digraph.... [Figure 8.1] shows the matrix containing the Commissioners' responses to the questions BRA (the computer having actually asked for a response to ARB). Thus, for example, entry 4 R 7 (BRA) is 23N, meaning that it was the 23rd question asked to which the answer NO was given.

[Figure 8.2] simply shows the computer printout obtained from the ISM. [In Figure 8.3] the digraph... is drawn from the computer printout. This corresponds completely with *all* of the Commissioners' answers in the matrix. There are no discrepancies between the digraph and matrix, which is what one should always expect from an ISM session.

However, in simply deleting the relations in the digraph and presenting it as a priority structure, discrepancies arise. In this case there are 7 in all. I have circled them...on the matrix [Figure 8.1]. For example, to both 17 R 1 and 19 R 1, the Commissioners answered NO. In the "priority" structure shown [in Figure 8.3], elements 17 and 19 are at element 11 deleted during ISM session

BRA

B \ A	1	2	3	4	5	6	7	8	9	10	12	13	14	15	16	17	18	19
1		2N		8Y	10N		22Y							66Y	73Y			
2	1Y		4N	6Y	11N	15N	21Y	27N			51Y	56Y		65Y	72Y	79N	85Y	92N
3		3Y			13Y	19Y		32Y	39N	47Y						81N		94N
4	7N	5N					23N							70Y	75Y			
5	9N			12Y			25Y											
6	14Y	17N	16N		18N						52N							
7	20N			24Y										68Y			86Y	
8	26Y	28Y	29N		30N	31Y			34N	41N	50Y	55Y	60N					
9	33Y	36Y			37N	38Y		35N		48N								
10	40Y	45Y			44N	46Y		42N	43N									
12	49Y	53N										58N						
13		57N									54Y							
14			62Y					61Y	63Y		59Y					83N		97N
15				69N			67N				64N				77N		90N	
16				74N							71N			76Y			88Y	
17	78N			80Y	82Y													98N
18	84N													89Y	87N			
19	91N			93Y	95Y											96N		

Figure 8.1 Commissioner's Responses to the Questions BRA

level I (highest priority), whilst element 1 is at level VII. Similar, but less severe discrepancies occur with the Commissioners' responses to 5 R 1, 6 R 12, 9 R 5, 9 R 8, and 9 R 10, when comparing the matrix entries and "priority" structure. A true priority structure would be completely consistent with all the matrix entries and the digraph. In this case there is just not enough information in the matrix or digraph to give a true listing of priorities.

RECONSTRUCTION OF POSSIBLE ALTERNATIVE SESSION (ARB)

Here, I attempted to reconstruct what the...session might have been like had the Commissioners been asked what the computer requested,

PRIORITY LEVEL	ITEMS					
LEVEL NO. 1	14					
	17					
	19					
LEVEL NO. 2	3	=	14,	3		
	9	=	14,	9		
LEVEL NO. 3	5	=	17,	19,	3,	5
	8	=	3,	8		
	10	=	3,	10		
LEVEL NO. 4	2	=	9,	8,	10,	2
	6	=	9,	8,	10,	6
LEVEL NO. 5	13	=	2,	13		
LEVEL NO. 6	12	=	13,	12		
LEVEL NO. 7	1	=	6,	12,	1	
LEVEL NO. 8	7	=	5,	1,	7	
LEVEL NO. 9	4	=	7,	4		
LEVEL NO. 10	16	=	4,	16		
LEVEL NO. 11	18	=	16,	18		
LEVEL NO. 12	15	=	18,	15		

Figure 8.2 ISM Computer Print-Out

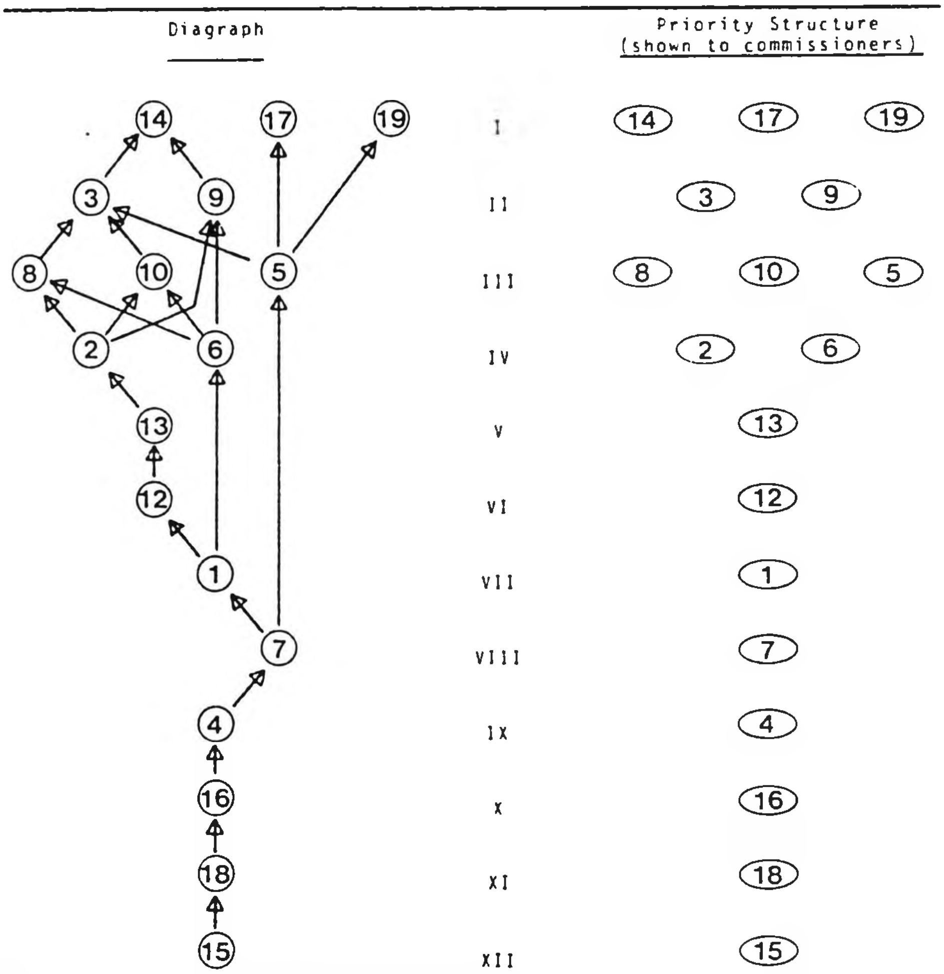


Figure 8.3 Priority Structure Shown to Commissioners

i.e., ARB. To do this, I ran an ISM responding to the ARB questions using the answers supplied by the Commissioners in [Figure 8.1]. In fact, the program followed a similar pattern of questions, as is shown in the matrix [in Figure 8.4]. However, it asks some questions not originally put to the Commissioners (indicated with a . . . dot o). Luckily, I was able to infer the answers which would have been given directly from the digraph in [Figure 8.3]. Thus the questions 1 R 3, 3 R 1, 3 R 14, 5 R 15, 7 R 16, were not put to the Commissioners but are explicitly shown in the digraph [in Figure 8.3]. However, when I came to elements 17 and 19, the program asked for answers to questions which were not originally put and which could not be inferred (9 R 17, 13 R 19).

[Figure 8.5] shows the computer printout obtained and [Figure 8.6] the digraph constructed from it. Again the digraph is consistent with

ARB
A → B

A \ B	1	2	3	4	5	6	7	8	9	10	12	13	14	15	16	17	18	19
1		1N	3N	9Y			23Y							68Y	74Y			
2	2Y		5N	7Y	11N	15N	22Y	28N			52Y	57Y		67Y	73Y	81N	Y	
3	4Y	6Y			13Y	18Y		31Y	37N	46Y			64N			83N		
4	10N	8N					24N							70Y	77Y			
5	12N			14Y			25Y							69Y				
6	16Y	19N	17N		20N						53N							
7	21N			26Y											75Y		Y	
8	27Y	29Y	30N		32N	33Y			35N	42N	51Y	56Y	61N					
9	34Y	38Y			39N	40Y		36N		45N						84?		
10	41Y	47Y			48N	49Y		43N	44N									
12	50Y	54N										58N						
13		59N									55Y							?
14			63Y					62Y	65Y		60Y							
15				71N							66N				78N		N	
16				76N							72N			79Y			Y	
17	80N			82Y														
18	N													Y	N			
19	N																	

Figure 8.4 Responses to the Questions ARB

all the matix entries as it should always be. However, if one attempted to show a priority structure simply by deleting the relations, a false picture is produced. The discrepancies between this "priority" structure [Figure 8.6] and the matrix [Figure 8.4] are circled... on the matrix. Thus, the Commissioners explicitly said NO to 2 R 5, yet 2 is shown above 5, etc. It is thus not a true priority structure. Also, the so-called priority structures [in Figures 8.3 and 8.6] are different, although produced from the same information. . . .

It was clear that whilst the digraphs contained essentially the same information (excluding elements 17 and 19), the priorities shown are misleading. I thought that I'd better discuss the conclusions with John Warfield in case I had gone wrong somewhere. However, John agreed with what I'd found and has in fact written several papers dealing with this very problem. . . . One thing the papers show is that it would be possible to write a program which asked sufficient questions to generate all the information required to print out true priority structures

PRIORITY LEVEL	ITEMS
LEVEL NO. 1	15
LEVEL NO. 2	18 = 15, 18
LEVEL NO. 3	16 = 18, 16
LEVEL NO. 4	4 = 16, 4
LEVEL NO. 5	7 = 4, 7
LEVEL NO. 6	1 = 7, 1
	5 = 7, 5
LEVEL NO. 7	6 = 1, 6
	12 = 1, 12
LEVEL NO. 8	13 = 12, 13
LEVEL NO. 9	2 = 13, 2
LEVEL NO. 10	8 = 6, 2, 8
	9 = 6, 2, 9
	10 = 6, 2, 10
LEVEL NO. 11	3 = 5, 8, 10, 3
LEVEL NO. 12	14 = 9, 3, 14

Figure 8.5 Second ISM Computer Print-Out

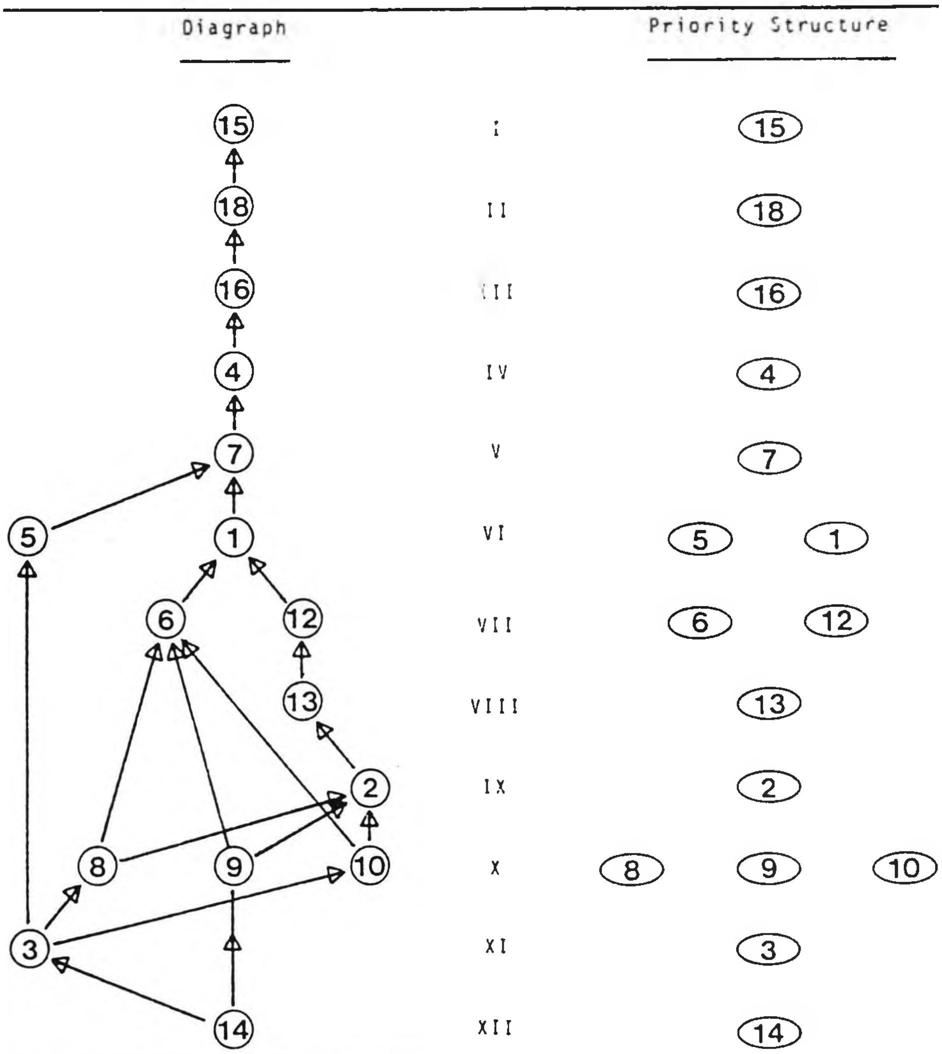


Figure 8.6 Revised Priority Structure

directly. However, John does not think that this software has been written by anyone.

John confirmed that it is vital to ask either the question:

IT IS A HIGHER OR EQUAL PRIORITY TO
[itemA]
THAN TO
[item B]

or

IT IS A LOWER OR EQUAL PRIORITY TO
[item A]
THAN TO
[item B]

The phrase "or equal priority" in the question is all important as it will produce cycles and equate elements at the different levels. In the event of an element's position in the priority structure not being clear, this can be discussed and decided with the participants after the digraph has been produced. However, the inclusion of the "or equal priority" phrase will eliminate or at least substantially reduce the necessity for this to be done.

There are thus a number of important conclusions:

• You cannot just read a priority structure from the sort of digraphs produced [in Figures 8.3 and 8.6].

•• It is essential to include the phrase "or equal priority" if you want to develop a priority structure.

••• Inverting the questions put by the computer from ARB to BRA produces a different sequence of questions and different matrix. In this case the difference happened to be fairly small, but it would seem a risky game to play when doing an ISM in a professional capacity.

SUPPORTING PAPER S

Hammer, K. and Janes, F.R. (1990). Interactive management. <u>OR Insight</u> <u>3</u>(1), 11-13.

Interactive management

Structured mapping integrates ideas and improves group decision-making

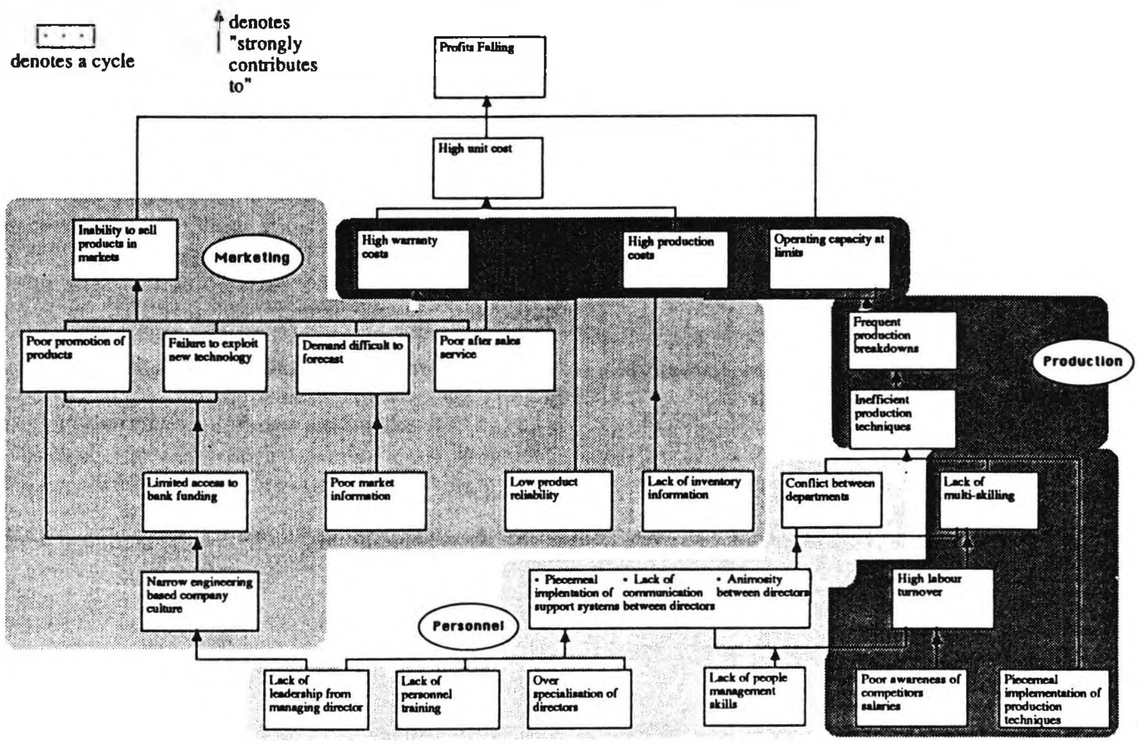
Ken Hammer and Ross Janes

Many complex issues require a team of decision-makers to interact in a cohesive fashion. However, conventional committee meetings, lacking a structured approach to decision-making, are not best suited to making decisions about highly complex, multiobjective problems. Executive managers find that over 60% of their time is consumed by routine meetings arranged to co-ordinate the activities of subordinates or other interested parties. Many say they find this to be an expensive use of their time when they compare the time consumed against the results achieved. Interactive management (IM) brings a new efficiency to this problem. It both reduces the need for repetitive meetings to handle the same issue and increases the effectiveness of those meetings that still have to be held.

Interactive Management (Warfield, 1984) is a process which emphasises the co-operative and integrative gains that can be obtained by moving out of the normal framework of memos, meetings and minutes. It applies an unobtrusive discipline for organizing the work of a group by focusing minds, guiding work and organizing the group's output. There is still the need to gather together an involved group, with each member able to make useful contributions to the discussion, but IM offers, through structured routines, opportunities for each group member to make their maximum contribution in a minimum amount of time.

IM employs an integrated set of techniques to generate ideas and insights and to analyse and structure them, while at the same time increasing and clarifying the group's knowledge of the problem and its immediate environment. IM directly addresses the issues of economy of time, keeping thought focused on the central issue, and managing contributions from both reticent and overbearing group members. It maintains a written record of the process which, together with a structured framework or map of the problem situation and its implications, constitutes an orderly picture of the situation constructed from the knowledge contributed by all the participants. The printed forms of this picture, which we refer to as the structured map of the generated ideas, embody the group's new consensus understanding of the problem. This forms a basis for immediate decisions and future reviews. Managers can be well briefed for making crucial decisions, and their subordinates can be well briefed for implementing the resulting directives

Figure 1: An Illustration — Problem Interactions in a manufacturing company

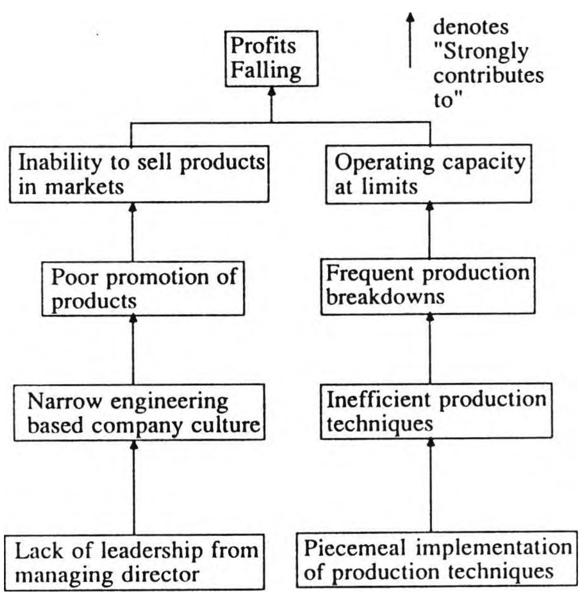


An Illustration

The case study of an anonymous ailing manufacturing company is useful to illustrate the application of IM. A senior management study group, representing six aspects of management were assembled, each having previously received copies of the briefing papers. By the use of NGT, an efficient idea-generation technique (Moore, 1987), the participants created a set of 29 key observations on the state of the company. These were then structured into a diagram or map by the use of interpretive structural modelling (ISM) (Janes, 1988; Warfield, 1976). The relationship chosen as the basis of the structure was "strongly contributes to", which is shown as an upwards flow in Figure 1. The three clusters of issues labelled here as "Marketing", "Personnel" and "Production" were identified by the group while examining the pattern of elements in the completed structure: they did not stem from the existing allocations of managerial responsibilities; they derived from the group work.

The power of this map lies in its being a joint view of the company's position, agreed by all the participants. It expresses the full integration of their individual interests in the problem. It is powerful in being comprehensive, clear and concise, and in being a suitable vehicle for any participant or informed close associate subsequently to articulate clearly what they see as their position, objectives and needs. This can be illustrated by the following use of the diagram by two of the participants. The object of their examination was to establish the crucial follow-on effects of the leadership role of the Managing Director and of the engineering role of the Production Manager. The partial structure in Figure 2, extracted from the main structure, enabled them to articulate their perceived areas of greatest shortcomings and to agree remedial management tasks and objectives. The main structure remained available to illustrate the related issues which each had to incorporate in their own plans if a fully-integrated overall recovery plan was to be developed.

Figure 2: Examples of problem paths



Interactive management can be used in many situations. Because it is a process for integrating the knowledge and judgements of a group of people, it can beneficially be applied to any group whose members are involved with the same issue but are normally more or less autonomous. More specific situations that will respond to and benefit from the use of the IM method will include the following examples:

- executive management preparing a rapid response to a serious external threat;
- managers planning to deal with an unsatisfactory internal situation;
- defining the present situation preparatory to employing business consultants;
- situation analysis preparatory to planning a new project;
- group strategic decision-making and work prioritizing;
- supporting any interacting group needing to define their joint situation, objectives and needs.

The principles of interactive management have their basis in the work of Dr John Warfield and his colleagues at George Mason University, Fairfax, Virginia USA. The Department of Systems Science at City University has been teaching the techniques of interactive management on both undergraduate and postgraduate degrees since 1984. The students have undergone quite deep immersion in IM and some graduate students have returned to employ the Department's IM unit to assist their organizations with complex problems. In a more general mode of support, the teaching group are now working to build a broader management awareness of IM by spreading knowledge of its principles and capabilities.

Areas of application

The IM Unit has been particularly active in providing this type of service to the public sector. The following examples illustrate the types of strategic and tactical problems covered:

- a county council's road-work priorities;
- a university department's new three-year strategy;
- a speech therapy unit's objectives and constraints;
- a military reserve division's recruitment opportunities;
- the engineering industry's training needs;
- products and services for an industrial training board.

The effectiveness of the IM approach has been demonstrated in business and government settings, at high, middle and lower levels of management where assistance in decision-making or problem clarification has been required. Although decision-making may appear the more important activity, the need for problem clarification is normally of equal importance as an essential preliminary activity. IM is an effective method for achieving either or both goals. Experience has confirmed that additional benefits accrue at all levels of management; the learning and information exchange that result from the group processes engender a wider perspective of, and commitment to, the issue under study that extend beyond the limits of individual responsibility. All participants gain an increased ability to articulate their individual position and their group's position on the question considered, in which the layout and permanence of the printed records play a useful part.

For the interested reader

Janes, F.R. (1988): "Interpretive structural modelling: A methodology for structuring complex issues", Trans. Inst. MC Vol. 10, No.3.

Moore, C.M. (1987): Group Techniques for Idea Building, Sage Publications, London.

Warfield, J.N. (1976): Societal Systems: Planning, Policy and Complexity, John Wiley and Sons, New York, USA.

Warfield, J.N. (1984): "Principles of interactive management", Proc. Int. Conf. on Cybern. and Soc, IEEE, New York, USA.

ROSS JANES is Director of the Interactive Management Unit, Department of Systems Science, City University, London and Senior Lecturer in Systems Management. He studied and worked with John Warfield in Virginia and has six years' experience in practical application of IM in Britain.

KEN HAMMER, who also works in the Interactive Management Unit, is a retired airline Operations Manager now researching IM applications at the Department of Systems Science.