A STUDY

OF

INPUTS

AND

THEIR INFLUENCE

ON

TECHNOLOGICAL INNOVATIVE ACTIVITY

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for the Degree of Doctor of Philosophy
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'A study of inputs and their influence on technological innovative activity'.

John Robert Bessant
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Summary

Technological innovation has been widely studied: however surprisingly little is known about the experience of managing the process. Most reports tend to be generalistic and/or prescriptive whereas it is argued that multiple sources of variation in the process limit the value of these.

A description of the innovation process is given together with a presentation of what is known from existing studies. Gaps identified in this area suggest that a variety of organisational influences are important and an attempt is made to identify some of these at individual, group and organisational level. A simple system model of the innovation management process is developed.

Further investigation of the influence of these factors was made possible through an extended on-site case study. Methodology for this based upon participant observation coupled with a wide and flexible range of techniques is described.

Evidence is presented about many aspects of the innovation process from a number of different levels and perspectives: the attempt is to demonstrate the extent to which variation due to contingent influences takes place.

It is argued that problems identified all relate to the issue of integration. This theme is also developed from an analytical viewpoint and it is suggested that organisational response to increases in complexity in the external environment will be to match them with internal complexity. Differentiation of this kind will require extensive and flexible integration, especially in those inherently uncertain areas associated with innovation.

Whilst traditionally a function of management, it is argued that integration needs have increased to the point where a new specialism is required. The concept of integration specialist is developed from this analysis and attempts at simple integrative change during the research are described.

Finally a strategy for integration - or rather for building in integrative capability - in the organisation studied is described.

Key words: Innovation
Integration
Participant observation

'We shall not cease from exploration
And the end of all our exploring
Will be to arrive where we started
And know the place for the first time'.

'Little Gidding'

T.S. Eliot

.....for the hyacinth girl.....

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CHAPTER 1 - Introduction

' "A slow sort of country!" said the Queen. "Now here, you see, it takes all the running you can do to keep in the same place. If you want to get somewhere else, you must run at least twice as fast as that!" '.

('Through the Looking-Glass' Lewis Carroll)

This impressive rate of change, which so surprised Alice, should not be unfamiliar to us. Our experience of technological innovation is associated with rapid development of new ideas, yet this process often seems to outrun our capacity to control it. Phrases like 'future shock' and 'doomwatch' testify in everyday conversation to a belief that technology is running away with the world. On the positive side, the hoped-for improvement in the quality of life expected from technological innovation is not always forthcoming. In a more specific context, industry is very concerned with enhancing the development of new ideas and opportunities, yet it seems that efforts to do so have only met with limited success.

It is suggested that these are all symptoms of a fundamental problem. Despite the enormous amount of study devoted to various aspects of the process, we still appear to lack sufficient understanding for the successful management of technological innovation.

There appear to be two problems associated with this. In the first place, studies of technological innovation have tended to attempt general descriptions of phenomena leading to theories of the process and prescriptive solutions derived from these. Closer study reveals that contingencies vary enormously so that any general approach may be very limited in its applicability to specific situations. Secondly, where guidelines of some specific value are available (as from the Project SAPPHO findings, for example) there is a lack of background knowledge about how to use them.

Arguably innovation in a changing world will require extensive new skills, not just in the sphere of technology. An article in the 'Financial Times' recently made a similar point:

'Britain's chronic underinvestment in skills and technology has left it in a far weaker position than its industrialised competitors to exploit the potential for new products - and therefore new employment. Yet competitive success in manufacturing will depend increasingly on innovation, in specialised design and marketing skills as well as technological strength.....' (April 28th, 1978).

What are the required new skills? What are the problem issues for which they are required? What is the nature of the resistance to their development or acquisition? Is it possible to specify improvement via a programme of planned organisational change using various inputs?

Questions of this kind are the motivation behind the research reported here. The project grew out of interest in this field by many agencies, notably the C.E.I. Committee on Creativity and Innovation. Some time elapsed before an organisation was found prepared to submit to a detailed but open-ended case study of the kind envisaged. Eventually such a firm was found and two years of intensive research into aspects associated with its technological innovative activity were carried out.

In particular emphasis was placed upon non-technological factors since this was felt to be a significant area which had received relatively little detailed study. The 'behavioural dynamics' of the process, whether related to people or systems were the central research target in trying to gain a clearer insight into industrial innovation.

The results presented in this thesis provide a basis for developing some hypotheses and recommendations aimed at improving management of the innovation process.

Organisation of the research

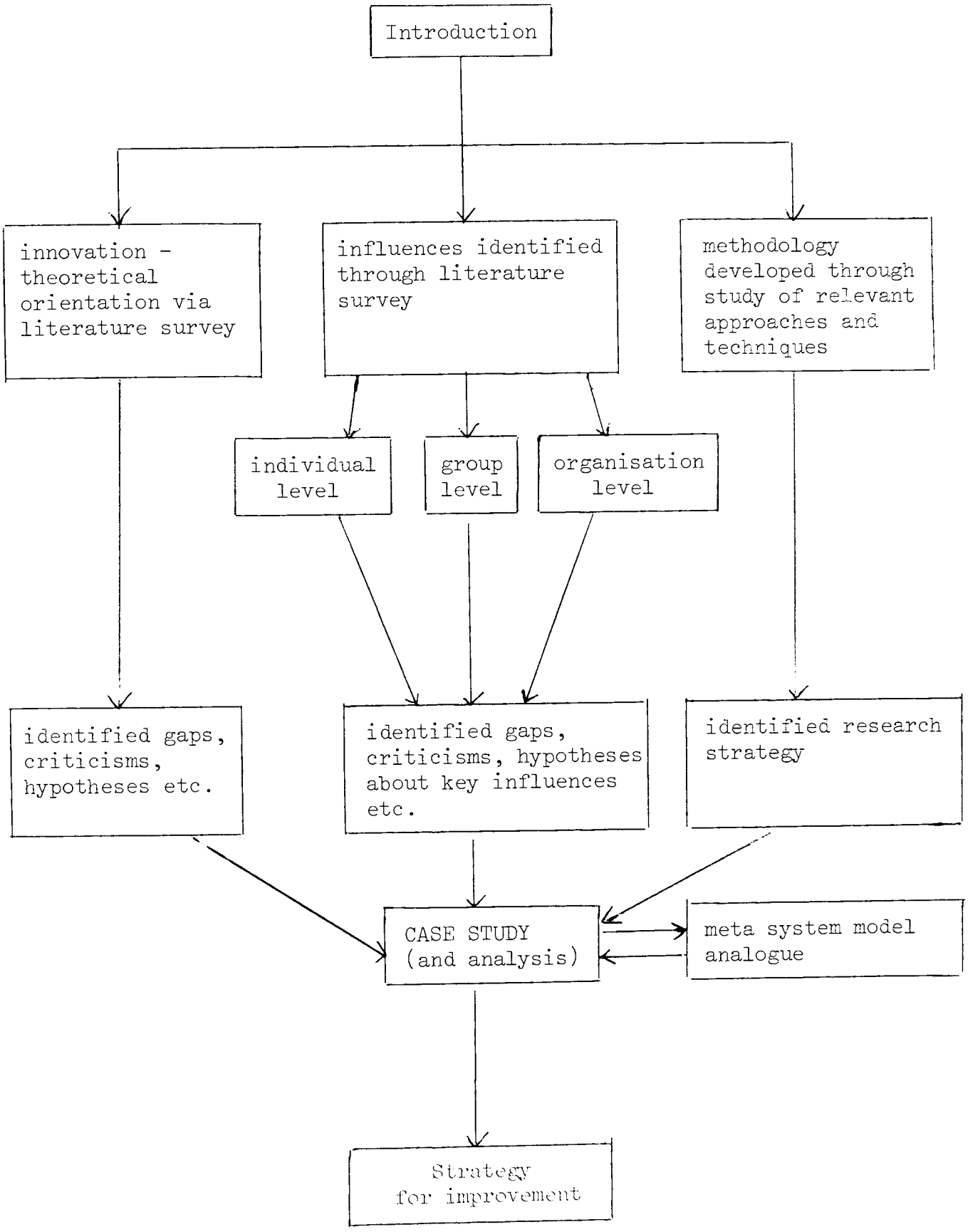
This thesis represents an attempt to weave theory and experience into a workable framework - at least as far as understanding the organisation studied is concerned. When the research opportunity presented itself, it was decided to make use of an 'action research' approach - i.e. to accept that the presence of a researcher would affect the organisation and thus maximise the positive contribution he could make. This took the general form of catalytic change agent; for both researcher and organisation, the study was a valuable learning process.

For this reason the research supporting this thesis was obtained in highly pragmatic fashion. Where opportunities presented themselves they were used to collect what data seemed relevant at the time. Experience in the field and improving awareness of the literature meant that this process became more refined as it proceeded. Over the two years the research improved considerably in definition as the objectives became clearer and the important issues easier to identify. Nevertheless, this approach differs significantly from the more 'normal' scientific method where hypotheses are developed a priori and then subjected to designed experimental testing.

In general the strategy was to identify 'gaps' in the literature and try and cover these areas when a research opportunity existed. Over time this led to simple model building and hypothesis testing in what has been called a 'grounded theory' approach.

Exhibit 1 illustrates the structure of the thesis in a diagrammatic form.

EXHIBIT 1 : Organisation of the thesis



Chapter two deals with a brief description of the innovation process - what it is, how it has been studied, what lessons we can learn about it. It offers a basic criticism of the literature and the current state of research based upon the view that what we know about innovation is too general and prescriptive to be of any great value in managing the process in a real situation. Not enough is known about the enormous range of influences on the process. Emphasis, where we do know something about the process, is on prescriptive solutions whereas it is suggested that what is needed may well be adaptive approaches which will vary solutions to match contingencies.

Chapter three attempts a very simple view of the range of influences which might affect the process. Although emphasis is on technological innovation, it is argued that the survey might represent a first step towards formulating a more general 'theory of action'. Once again the complexity associated with possible influences and their relationship to the process indicates the limitations of prescriptive 'general' theories about the management of innovation.

Chapter four attempts to build a simple system model. The role of the innovation process as an adaptive response means that its management has a high priority. This management is carried out by a 'meta-system', and it is with the improvement of performance in this area that this research is largely concerned.

Chapter five discusses the 'how' of the research. The 'action research' approach and the fact that at the outset it wasn't known what factors would be relevant, or whether it would be possible to study them meant that a highly flexible technique had to be adopted. Participant observation - a multiple approach - seemed to offer the right advantages. Use of this technique involved further learning and led to the development of a whole range of instruments and approaches designed to collect as much relevant data as possible.

Chapter six moves the focus away from the theoretical to the practical by describing the organisation in which the study took place.

Chapter seven presents a wide range of information about the innovation process in this organisation. A number of different viewpoints, represented by various types of data, supply a broad overview of the major problems and a large number of specific examples of particular issues of concern. The purpose of this chapter is essentially to illustrate the enormous complexity surrounding the innovation process; faced with such a variety of influential elements, management is not often able to use prescriptive or general approaches. At times the process appears to be one of pragmatic 'muddling through'.

This theme is taken up strongly in chapter eight. It is argued that complexity is on the increase in the world outside and that organisational responses will tend to be towards increasing internal complexity. Thus there will be a growing need for anticipating strategies, particularly at the non-programmed end of organisational activities. Instead we see responses which are pragmatic or based on reinforcing control systems (rules and procedures) which may be no longer applicable.

In the case of the organisation studied, this reflects in the fact that integration (or its absence) appears to be a major factor in innovation performance. It is argued that management may no longer be able to cope with what is rapidly becoming a full-time specialist field. Instead the notion of integration specialist is put forward, and a description of this character's role and task is developed. The research study is interpreted in this light to add to the concept.

Finally a schematic improvement strategy based upon integration activities is put forward for the organisation. This uses several models developed elsewhere in the thesis and builds on both short-term (practical) and long-term (desirable) options.

Chapter nine summarises the conclusions of the research.

Contributions to Knowledge

The claims advanced as to original contributions to knowledge are:-

- development of a suitable methodology for the study of organisational processes from an internal viewpoint. Very few studies of this kind in the field of innovation research have been reported. The approach was also conceived as involving interaction with the organisation under study in a joint learning process which attempted to improve performance in innovation. It appears that change agent based research of this kind has not been reported in the field of innovation research; the pioneering nature of this work is thus stressed. Co-operative ventures with extensive management involvement at all levels represent a new research direction.

- development of a three-level approach to a study of influences on organisational activity. Although this was only a first attempt and was principally concerned with the sub-activity of technological innovation, it is argued that this might provide a basic framework for a general 'theory of action' in organisations.

- development of a system model which accounts for the innovation process as a key adaptive mechanism in organisations. Within this model the notion of a self-regulating operational system and a controlling meta-system is advanced. Using this approach it is possible to identify where inputs can productively be made.

- development of a framework for analysing problems in innovation by use of a force-field analogy. The success of innovation depends on the balance between driving forces (push or pull) and resisting forces. Inputs aimed at improvement may thus be classified into 'promoters' (enhancing the former) or 'lubricants' (reducing the latter).

- presentation of detailed case study material of various kinds from a participant perspective. Studies of literature suggest that there is very little data of this type (long term intensive case study). Examples might include 'blow-by-blow' accounts of major projects or monitoring of a number of incremental innovations.

- development of the concept of integration specialist as a possible solution to problems of increasing complexity in large organisations.

- development of the concept of integration strategies i.e. planned change efforts of a task-related kind implemented via an integration specialist.

- development of an actual integration improvement strategy for the firm studied. Although this relates to one specific company, it is argued that it could be extended to other, similar organisations.

Conclusion

Technological change will inevitably bring with it changes of other kinds - social, psychological, organisational etc. The question to be answered is whether these are to be considered as unavoidable consequences (desirable or otherwise) or as changes to be anticipated and planned for. Selection of the latter option suggests that suitable strategies will allow for greater control over the process.

The argument of this thesis is essentially concerned with management of the technological innovation process. Examples of the limitations of a pragmatic approach and evidence of the need for a more sophisticated one are presented in both the literature and the case study. From this it would appear that continued success in technological innovation requires accompanying planned organisational innovation.

CHAPTER 2 : Technological Innovation - Background

Outline

1. Introduction
2. Process representation and discussion of elements
3. Characteristics of innovators, adopters, innovations
4. Measurement and study of innovation
5. General studies and empirical evidence
6. Models of innovation
7. Critical review

Summary and Implications for Research

From a theoretical viewpoint, the present state of knowledge about technological innovation appears to be open to criticism and some significant gaps have been identified. Practical guidelines for management and policy-makers are also limited and there is a strong need for clearer understanding of aspects of the process: Exhibit 36 indicates some areas of concern.

The research subject of this thesis describes an attempt to carry out studies aimed at filling in some of this detail. Careful attention was paid to the recommendations of the theorists, and the research design has attempted to:-

- examine all innovations (radical and incremental) over a sustained period of time (2 years)

- to observe the process from an internal standpoint (as participant) rather than by external means.

(1) Introduction

The process of technological change is of central importance in society: Marx aptly labelled it the yardstick of civilisation. "Assume a particular state of development in the productive faculties of man and you will get a corresponding form of commerce and consumption. Assume particular degrees of development of production, commerce and consumption and you will have a corresponding form of social constitution, a corresponding organisation of the family, of orders or of classes, in a word, a corresponding civil society".

Innovation can be defined in a variety of ways and exhibit (1) lists some examples: from these it can be seen that the word implies a span of activities rather than any single one. With a process of such range and importance, it is inevitable that a large number of groups have expressed interest in studying technological innovation: exhibit (2) gives some examples. Expanding the theme of innovation as a major societal process, exhibit (3) lists some arguments for advantages and disadvantages of technological change.

EXHIBIT 1 : Innovation Definitions

"The successful introduction into an applied situation of means or ends that are new to that situation".

(Mohr 1969)

"An innovation is the adoption of a change which is new to an organisation and to the relevant environment".

(Knight 1967)

"'in' plus 'novare' - to make something new,
to change into something new,
to alter

(Oxford Dictionary 1969)

"The process by which science and technology are diffused throughout human activity".

(Brooks 1967)

"The process by which an idea, practice or object is applied for the first time by an individual or institution".

(Rogers & Shoemaker 1971)

"Innovation is change in human activities and the process of carrying out change: the sum total of all innovation would constitute evolution".

(Locke 1976)

"When an enterprise produces a good or service or uses a method or input that is new to it, it makes a technical change. The first enterprise to make a given technical change is an innovator. Its action is innovation".

(Schmookler 1966)

"Innovation is the application of new technique which increases performance at existing or lower cost"

(Doctors 1969)

"By innovation is meant the generation, acceptance and implementation of new ideas, processes, products or services. Innovation therefore implies the capacity to change or adopt".

(Thompson 1965)

"The technical, industrial and commercial steps which lead to the marketing of new manufactued products and to the commercial use of new technical processes and equipment".

(Central Advisory Council on Science and Technology 1968)

"The totality of processes by which new ideas are conceived, nurtured developed and finally introduced into the economy as new products and processes; or into an organisation to change its internal and external relationships; or into a society to provide for its social needs and to adopt itself to the world or the world to itself".

(Technological Innovation; its environment and management 1967)

EXHIBIT 2 : Interested Groups in the Study of Innovation

Discipline	Areas of Interest	Typical Studies
Economics	Innovation as a source of industrial growth and development	Adam Smith
		Marx
	"Schumpeter and Marx are the two great exponents of a type of economics in which changes in the way of doing and making things are fundamentally important".	Schumpeter
	"the way in which innovation provides the dynamic element through the incessant rise and decay of firms".	
	"knowledge as the chief engine of progress in our society".	Marshall
	"Our brief survey of economic expansion during the last 150 years..seems to show that the main force was the progress of technique".	Benham
	"Innovation is an essential condition of technical progress and adaptation and a critical element in the competitive struggle of enterprises and nation states".	Freeman
	investment, productivity, production functions rates of return technical change factors economies of scale	Abramowitz Denison Nelson Solow Minasian Aukraust Walter Charpie Goldsmith

Discipline	Areas of Interest	Typical Studies
	role of government	
	- in fostering innovation	NRDC
	- in improving productivity through innovation	OECD Nelson
	- policy on tax, monopolies patents, trusts, constraining legislation	Pavitt and Walker Schmookler
	technology transfer	Welles, Marts et al
	- within industry	Warner
	- from industry to nation	Urban institute (1971) Furash
	- from developed to underdeveloped nations	Singer Kissinger Murphy
	- historical role	Rosenberg Landes
	sources and timing of innovation	Jewkes et al Enos Mackinnon Maclaurin
	company and market factors	Galbraith
	- large/small	
	- competition	
	- market structure	
	- resource allocation	Rettig
	rates and extent of diffusion	Mansfield Griliches et al Globerman Ray Maddala and Knight Nabseth and Ray Hufbauer

Psychologists	creativity and the process of inventive problem-solving	Mackinnon Prince Osborn
	Stein and Heinze Taylor Haefle	Steiner Parnes and Hardy Rickards Newell, Shaw, Simon Wertheimer
	structure of the intellect, set theory	Bruner Guilford
	resistance to change, theories of dissonance, persuasion etc.	Festinger Rokeach Abercrombie Hovland et al
	motivation to innovate, needs for achievement, self-actualisation etc.	Maslow Herzberg McClelland
	interpersonal psychology under pressures of uncertainty and change	Argyris
	group processes, styles, norms, leadership etc.	Lewin Cartwright and Zander Fiedler
	environments for creative and innovative activity	Pelz and Andrews Jones and Arnold Kaplan Smith

Sociologists and anthropologists	technological change and its impact on the social structures and behaviour of society	Carter and Williams Ogburn Salter
	effects of industrialisation - political implications	Burns Lupton
	'the bourgeoisie cannot exist without constantly revolutionising the means of production'	Marx
	diffusion and adoption patterns, communication of innovations	Rogers and Shoemaker Menzel Mohr
	information flows	Becker
	consequences, anticipated and unanticipated of technology growth	Club of Rome Toffler Schumacher
	- in nations and societies - in organisations	Merton Gouldner Roethlisberger and Dickson
	resistances to change	Selznick
	positive approaches to facilitate change	Dewey Durkheim

Organisation Theorists

role of structure technology bureaucracy and other factors	Pugh and Aston group Woodward Child Crozier Blau
organising for innovation differentiation, integration coping with environmental uncertainty	Burns and Stalker Lawrence and Lorsch Knight
politics of innovation	Mumford and Pettigrew Gouldner
strategy and planning	Ansoff Beer
theory of the firm	Cyert and March March and Simon
decision theory	Simon and the Carnegie group
environmental qualities and effects	Duncan Emery and Trist

'The Professions'

Chemistry Physics Biology Mathematics and other 'sciences'	development of fundamental concepts and their application 'exploring what is'
Engineering	'a battery of problem-solving devices available for the satisfaction of human needs' 'to create what has never been'
Medical	use of new techniques and knowledge to save lives
Management	improvement of productivity " " quality of life " " safety " " social responsibility
Education	how to train creativity and innovativeness relationship between IQ, degree level, education background etc. and innovative ability.

EXHIBIT 3 : Technological Innovation - Pros and Cons

THE NATION:

For:

1. Provides the most important means of improving productive performance of a mature economy and helping its growth.

2. Adds competitive power in overseas markets, particularly in poor world trade conditions, without debilitating devaluation.

3. Deals with hitherto unsatisfied needs.

4. Develops new overseas markets.

5. Improves power of response to attacks or threats from outside whether economic or military in nature.

6. Leads occasionally to the 'triggering' of massive useful change.

7. Offers the only lasting way to adapt to internal and external change.

8. Provides a basis for redevelopment of regions of high unemployment.

Against:

1. Other means, such as rationalisation, improved management, and better labour relations are quicker and cost less

2. Technological innovation is costly, usually misdirected, subject to political manipulation, and distorts the economy.

3. Destroys the value of large social investments.

4. Develops high unemployment in areas of previous prosperity or in established trades.

5. Provokes social disturbance.

6. Introduces pollution and other hazards.

7. Growth is something we should forgo; we should set an example to the world of how to live without change.

THE COMPANY:

1. Enhances profitability and growth and their continuance - through new products or services replacing out-of-date or loss-making items; through entry into new markets; through cost reduction.

2. Builds up competitive power - through new or better products; through better-value-for-money products.

3. Helps obtain access to new technology of others.

1. Other means, such as mergers, provide better and quicker paths to profitability and growth.

2. Innovation is costly, risky, disturbing, and time consuming.

3. Innovation is management intensive.

4. Why do we have to compete?

THE INDIVIDUAL:

As Consumer:

1. Provides better quality, cheaper, more effective products or services in a wider range.

2. Leisure opportunities and possibilities.

3. Improves prospects for one's children.

1. Innovation means lower quality or get-rich quick trash which we are pressured into accepting.

2. Innovation means dangerous products.

3. The old ways are best; the old products are the best.

4. Lays up trouble for our children.

As Worker:

1. Assures the prospect of interesting, better rewarded future jobs.

2. Gives opportunities for self-development and involvement.

1. Puts people out of jobs.

2. Develops boring 'watching' or assembly jobs.

3. Creates trouble for everyone on the shop floor.

(2) Process Representation and Discussion of Elements

As the list of definitions of technological innovation showed, the term is somewhat loosely used and understood. It is, in fact, a span of activities associated with change, with bringing into being and use of new things and ways of doing things. Consideration of innovation as a process has been a common approach amongst researchers and exhibit (4) indicates some examples.

All of these have in common discrete stages for invention, development and adoption/diffusion: it will be useful to consider briefly the essential characteristics of these stages.

(a) Invention

In its simplest form, this can be considered as a stimulus/response pattern through which some new idea is synthesised. Sources of stimuli vary enormously both in scope and perceived intensity: exhibit (5) lists some examples. The actual process of idea generating has been the subject of extensive study both on an individual and also on a group organisational level. Exhibit (6) summarises some of the important influences on this activity. In general, the conditions most favourable for inventive activity are different in character from those required in the later stages of the innovation process: this explains the persistence of the 'lone-wolf' inventor as a major contributor to innovation, and also the tendency for organisations to keep Research and Development operations apart from the remainder of their activities.

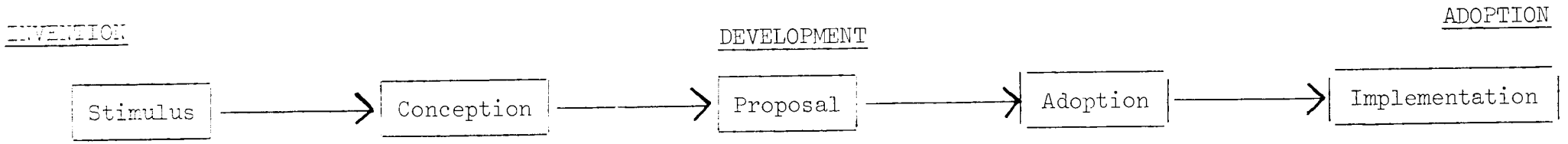
(a) Invention cont'd.

One important characteristic of invention as a problem-solving activity is that it deals with open-ended problems i.e. those with no logically correct answer. Hence the need for some degree of creative thinking in generating solutions. Exhibit (7) gives some examples of the characteristics of open and closed problems.

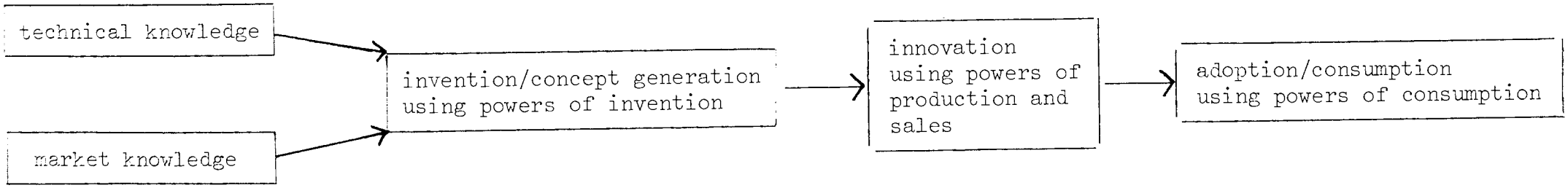
'Creativity' has been the subject of much work in the context of innovation: in particular, this interest has led to the development of a number of approaches to training and developing this facility in individuals and groups: exhibit (8) gives some examples.

Exhibit (9) offers a diagrammatic representation of the invention stage.

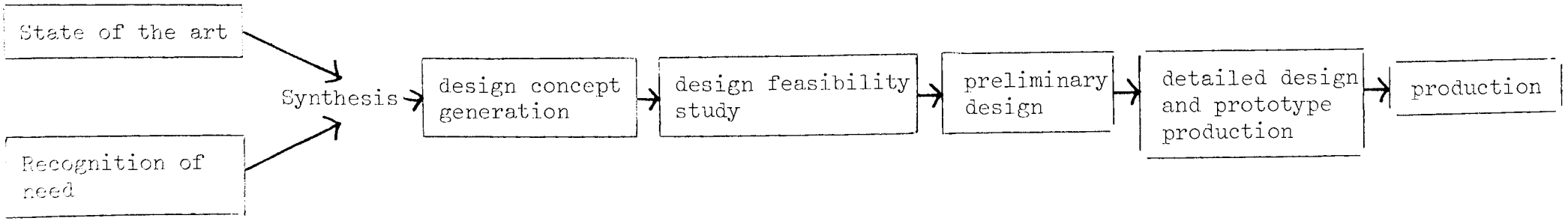
EXHIBIT 2 : Process representations of innovation.



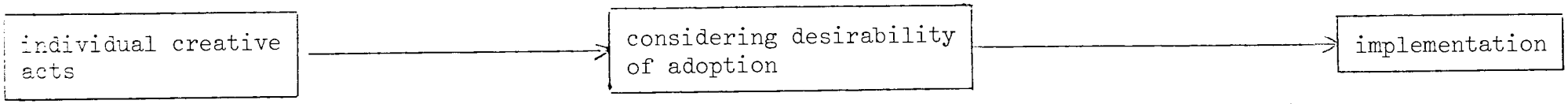
(Becker and Whisler 1967)



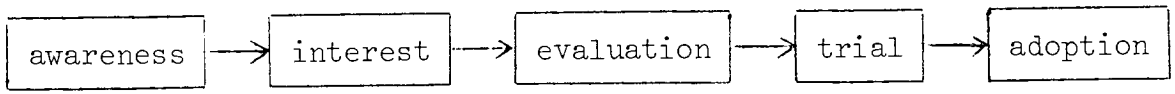
(Gregory 1974)



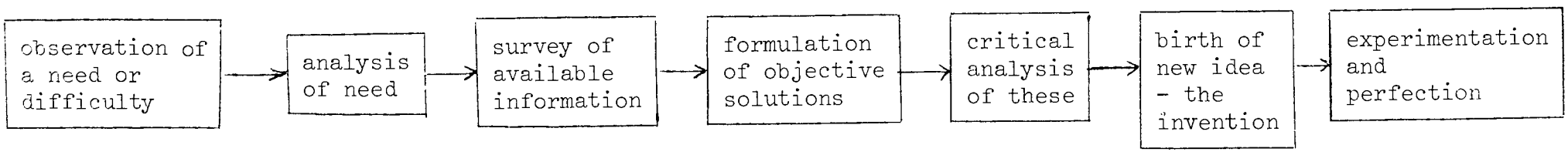
(McCrory 1966)



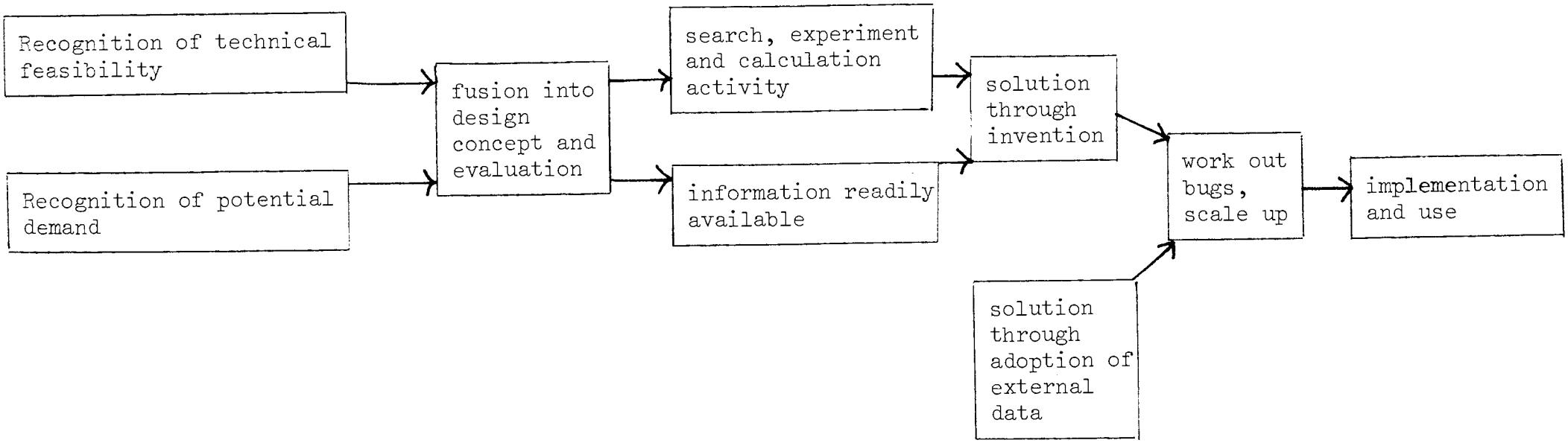
(Baker and Freeland 1972)



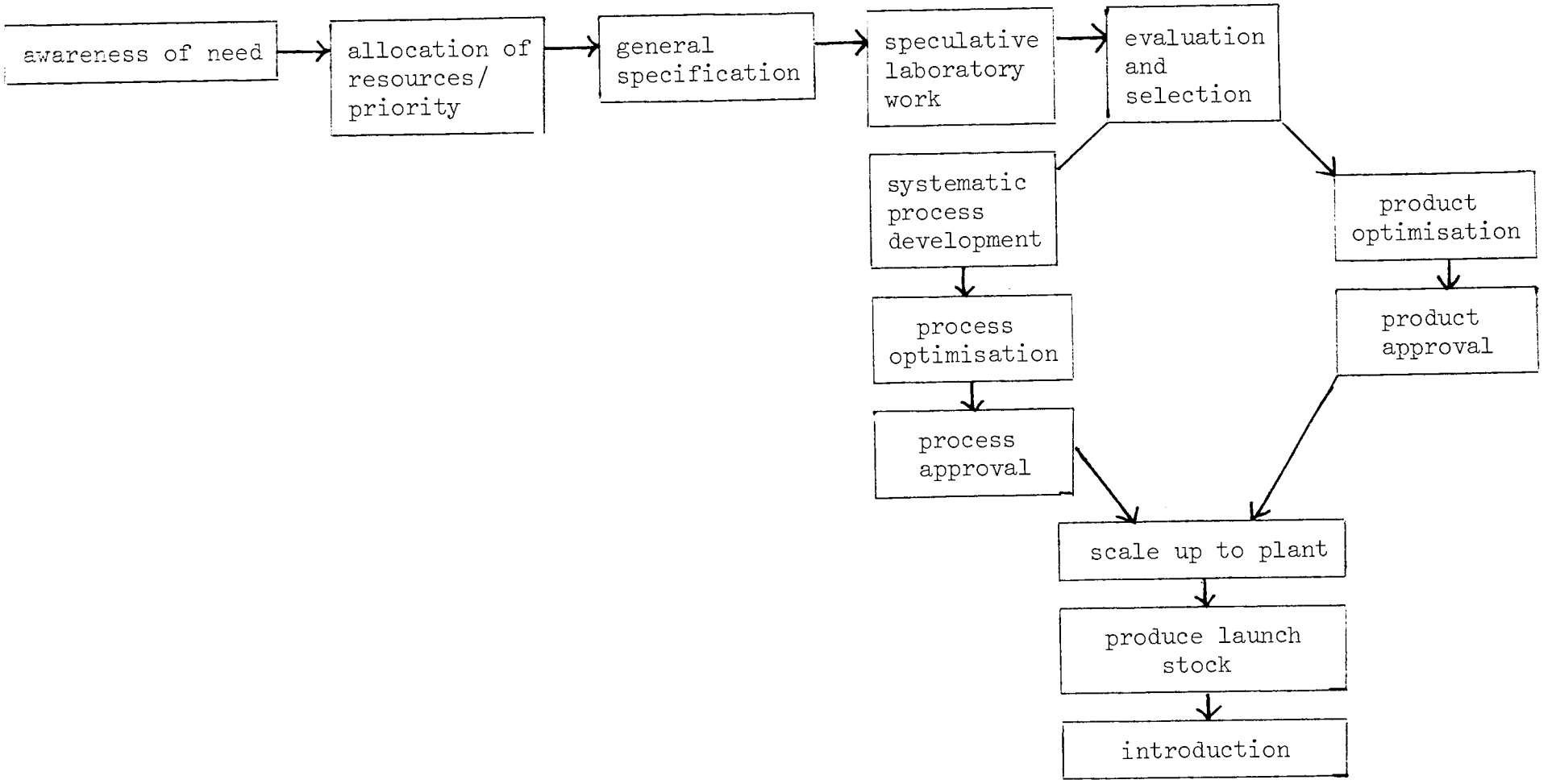
(Myers 1966)
(Rogers and Shoemaker 1971)



(Rossman 1964)



(Marquis 1968)


awareness of need
allocation of resources/ priority
general specification
speculative laboratory work
evaluation and selection
systematic process development
process optimisation
process approval
product optimisation
product approval
scale up to plant
produce launch stock
introduction

(Miller 1978)

EXHIBIT 5 : Some Sources of Stimuli for Innovation

- market needs something new.
- new technology suggests something new.
- outdated technology.
- competition requires innovative step to restore market share.
- corporate strategy requires growth/diversification/rationalisation.
- legislative pressure - e.g. tighter control on pollution.
- safety considerations.
- 'bad experiences' of others e.g. Seveso, Flixborough.
- pressure groups - e.g. public opinion, consumer action, trades unions
- individual/corporate needs for achievement.
- national/local incentives - cash/resources/markets.
- interest rates - falling, stimulate interest in innovation
  - rising depress interest in innovation.
- organised incentives e.g. government finance, NRDC, available risk-capital sources.
- secondary but.....an educational agent leading to applied research. The crucial role of basic research in industrial innovation lies in continual reinforcement and understanding of the implications of applied work. (Utterback 1975)
- product/process life cycles - replacement/displacement trends.

EXHIBIT 6 : Some Identified Influences on Idea Generation

- individuals using deferred judgement at the initial stage of idea production are more productive than the same number of people working in a group using deferred judgement.
(Taylor 1958)

- the use of deferred judgement at the initial stage gives better results, whether employed by individuals or groups, than the conventional approach used by individuals.
(Parnes and Meadows 1959)

- group leadership style and atmosphere can greatly affect idea output.
(Parnes and Meadows 1959)

- detailed introduction of a test such as 'how many uses for?' can help subsequent performance.
(Hudson 1968)

- the results from such tests can be strongly influenced by the behaviour of the test setter .
(Hudson 1968)

- matched groups, trained by General Motors, after training performed better as such and better than controls.
(Harris 1960)

- tests at General Electric indicate that a 'constructive set' to ideas ('what is good about this?' approach) produces better solutions than a critical set.
(Hyman 1961)

- desirable sets and attitudes can be developed through various types of training, by carefully prepared examinations.
(Heywood 197)
and by periodic support devices (McClelland 1969)

- preconceived ideas may be dislodged (Abercrombie 1960)
(Rokeach 1960)

- 'there appears to be a good deal of agreement now on some of the factors that most enhance inventiveness or creativity in organisations, including the availability of individuals capable of producing new ideas
(Steiner 1965)
and the development of an organisational pattern than maximises flexibility and opens lines of communication.
(Guetzkow 1961)
(Mohr 1969)

- effective scientists:- were self directed by their own ideas and valued freedom

  - did not limit their activities either to the world of 'application' or to the world of 'pure science' but maintained an interest in both: their work was diversified.

  - were not fully in agreement with their organisation in terms of their interests: what they personally enjoyed did not necessarily help them advance in the structure.

  - tended to be motivated by similar things to their colleagues but differed in the styles and strategies with which they approached their work.

  - in effective older groups, the members interacted vigorously and preferred each other as collaborators, yet they held each other at an emotional distance and felt free to disagree on technical strategies.
(Pelz and Andrews 1966)

EXHIBIT 7 : Characteristics of Open and Closed Problems
(Rickards 1974)

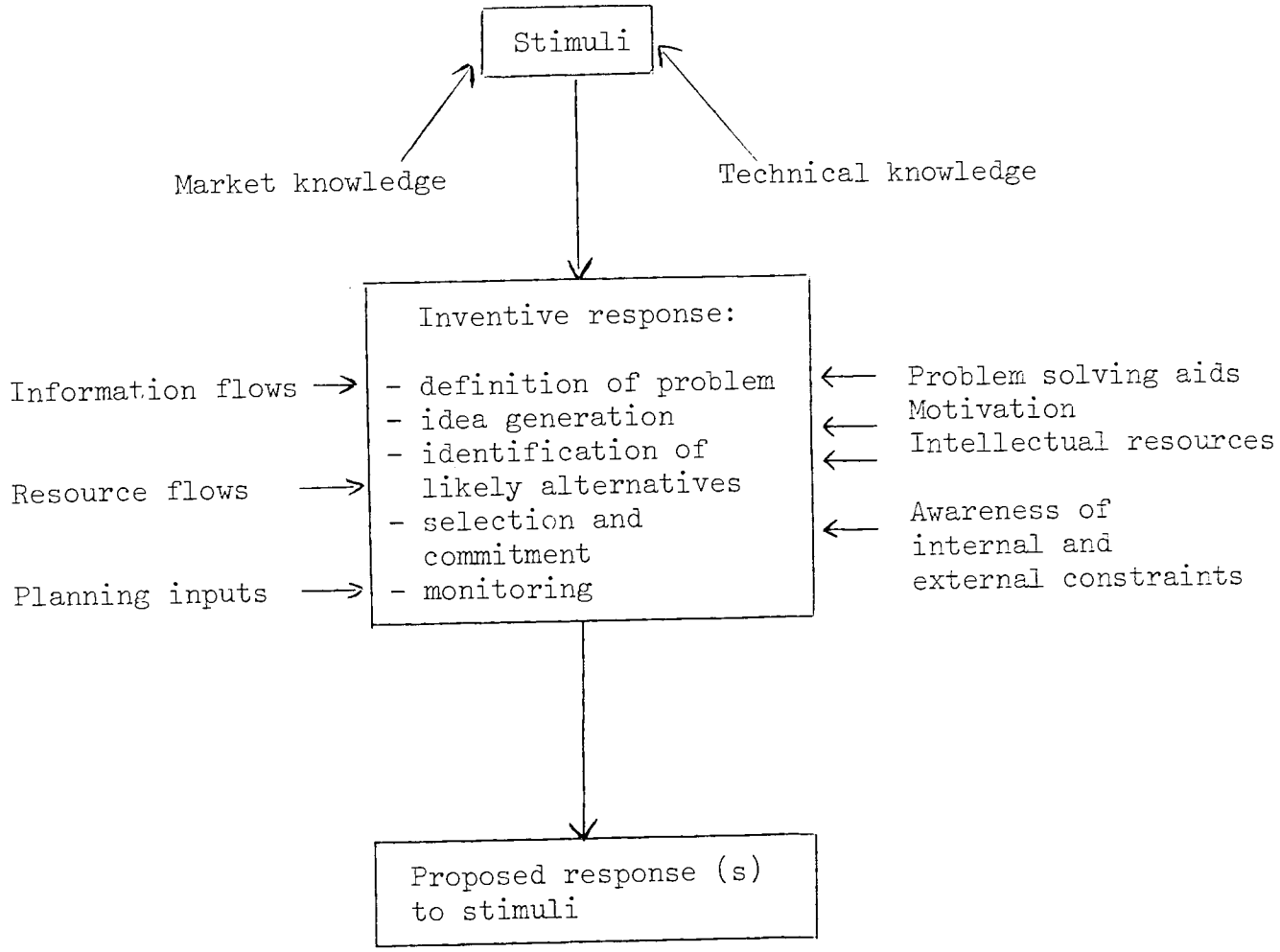
Open Problems	Closed Problems
Boundaries may change during problem-solving.	Boundaries are fixed during problem solving.
Process involves the introduction of novel ideas.	Process marked by predictability of final solution
No one correct solution.	Solutions may be demonstrated to be logically correct.
	Procedures are generally known.
Examples of open problems:	Examples of closed problems:
- inventing new products	- solving a jigsaw puzzle.
- resolving communication problems.	- IQ tests.
- resolving economic problems.	- mathematical problems.
- resolving conflict.	

EXHIBIT 8 : Some examples of approaches and techniques to aid creative problem solving.

(Rickards 1974)

Individual	Group
(a) restructuring techniques	(a) brainstorming
- morphological analysis - relevance systems - attribute lists - research planning diagrams	- Osborn's methods - trigger sessions - recorded round-robin - wildest idea - reverse brainstorming - individual brainstorming
(b) decision aids	(b) Synectics
- weighting procedures - checklists	- active listening/ constructive group behaviour - goal orientation - itemization - changed meeting roles - excursion procedures - individual synectics
(c) redefinitional aids	
- goal orientation - successive abstractions - analogy procedures - wishful thinking - non logical stimuli - boundary examinations - reversals	

EXHIBIT 9 : Diagrammatic Representation of Invention Stage



(b) Development

Having arrived at an inventive proposal for a response to the stimulus, it is necessary to develop this idea into a physical reality. Inevitably this activity will require a higher proportion of resources and may well involve a recycling activity if the original invention turns out to be impractical for some reason.

Innovation is essentially a two-sided coupling activity bringing together technical knowledge and market information via a development sequence of design, trial production, scale up etc. Some indication of the range of activities which make up this phase is given in Exhibit 10.

Costs and time factors play an increasingly important role here: invention rarely accounts for more than 15-20% of total innovation costs, the rest being largely taken up by development charges. Time lags between new ideas and their commercial realisation can be extensive: Kingston (1977) cites the case of enzyme-based detergents as an example of this. In general, high technology industries have the shortest lags, then pharmaceuticals, chemicals and finally mechanicals.

Development is basically a problem-solving stage: Exhibit (11) illustrates a paradigm of this process. Several workers have attempted to classify problems: Saward (1976) gives a useful review of some of these proposed taxonomies. Exhibit (12) indicates one such classification, due to McKenney (1973) . Type 4 problems define the extreme case of highly radical innovation moving into totally new areas whilst Type 1 problems are little more than modifications and small increments. Other classifications discuss factors the degree of motivation/commitment required, specific constraints e.g. time, the required degree of group cooperation etc. The distinction between open and closed problems discussed earlier is also relevant here.

EXHIBIT 10 : Diagrammatic representation of development stage

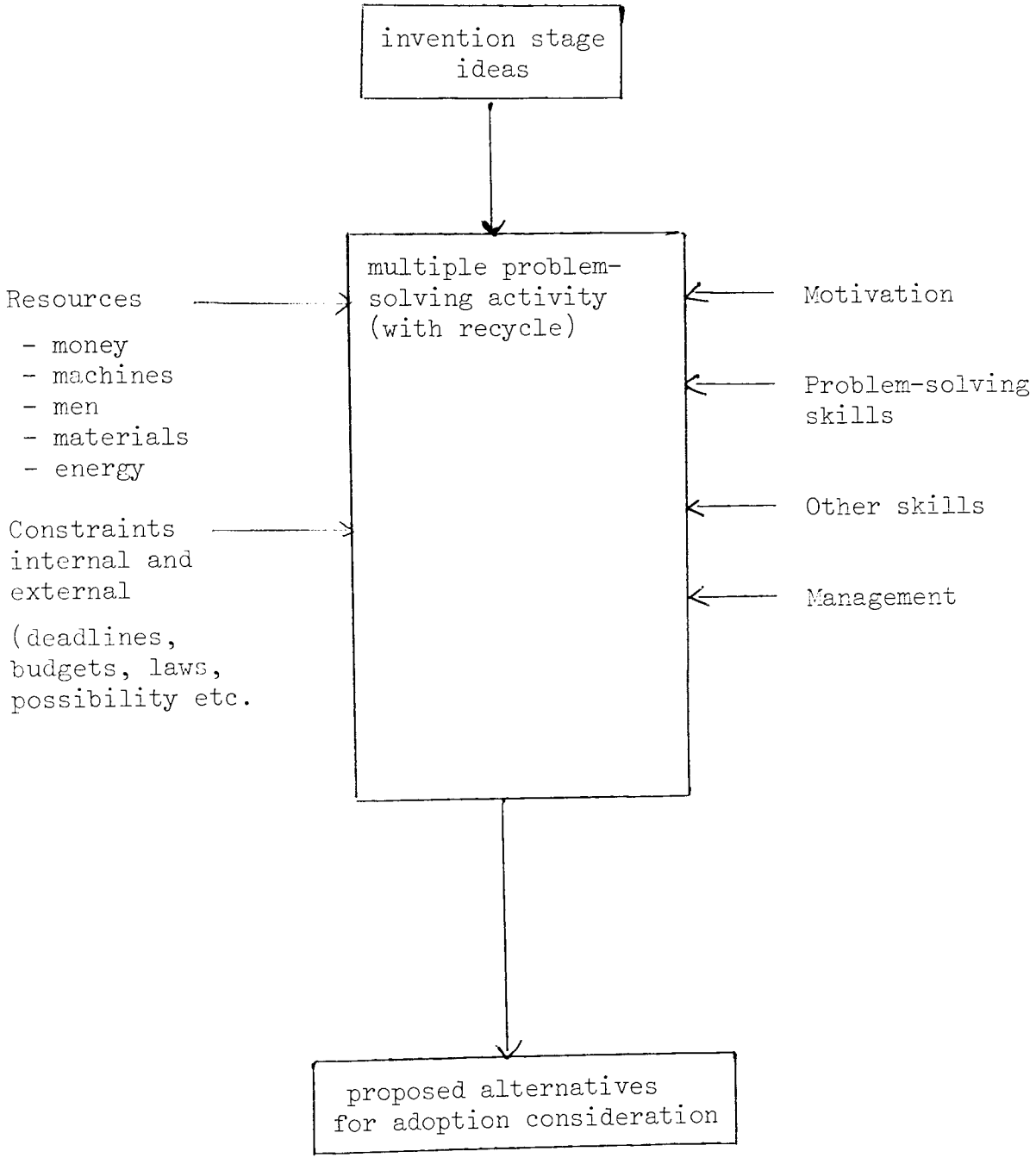


EXHIBIT 11 : A paradigm of the problem-solving process
(source Purdon 1971)

Aston University

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Aston University

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EXHIBIT 12 : Categories of problems (McKenney 1973)

Type 1	The problem involves planning. The problem solver knows that data are relevant and what mental operations and analysis are required to deal with the data. He merely has to arrange the data into a form which may be used as inputs to a defined sequence of evaluation.
Type 2	The required operations and methods are known, but not the data.
Type 3	The problem-solver understands the data, but does not know how to manipulate them to achieve a desired end.
Type 4	Both the information and the operations are unknown. The problem solver must search for cues, generate explanatory concepts and develop a method for manipulating the data once they are organised.

(c) Adoption/diffusion

'Boss' Kettering of General Motors is reputed to have said 'the hardest substance in the world is the human skull, to judge by the force needed to drive a new idea through it!': his observations reflect the major problem implicit in the adoption phase of innovation. Sayles (1974) describes this as the longest and most critical stage in the whole process: in essence it is characterised by the decision to adopt or reject the new thing.

Much work has been carried out on the patterns of adoption, the characteristics of innovator and adopter, the perceived attributes of the innovation, etc. In practical terms, most innovations involve a whole series of adoption decisions since the decision-making elements in the structure must be constantly assessing the advantage of continuing against that of calling a halt to the process. The final adoption/consumption decision is rarely a single event but a process affected by a series of variables and taking place over time.

Rogers and Shoemaker (1971) suggest that this decision process can be described by the paradigm in Exhibit (13): this indicates the range of both rational and emotional influences which bear on adoption behaviour. They argue that the decision will be a function of innovation, innovator and adopter characteristics: these factors are discussed in more detail later.

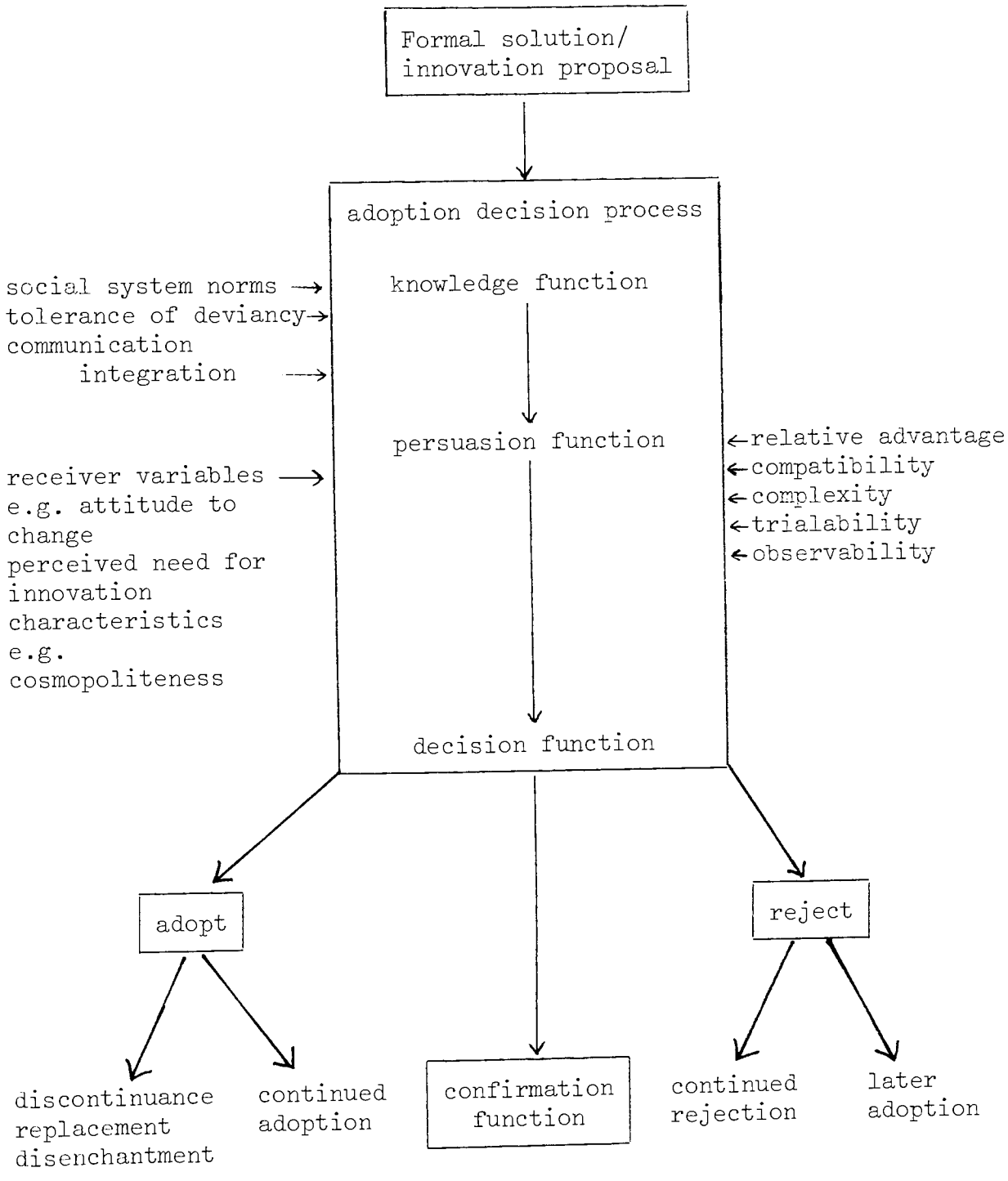
In essence their model assumes that innovations are communicated from a source to a receiver via certain channels - the SMCRE model due to Berlo (1960) . On receiving the innovation, the adoption process involves a five-stage response on behalf of the adopter: awareness, interest, evaluation, trial and implementation (Myers 1966) . The determinants of this process will involve four major functions:

- knowledge about the need for change and the innovation
- persuasion and evaluation of the innovation by an evaluating unit
- decision concerning acceptance of rejection of the innovation by the decision-making unit
- confirmation and communication of this decision to all those affected by it - and feedback of their response

Rogers and Shoemaker point out the similarity of this model to that proposed by Howlands (1956) to account for attitude change in individuals.

EXHIBIT 13 : Diagrammatic representation of the adoption process

(after Rogers and Shoemaker 1971)



Most writers agree that there are different ways of approaching the adoption decision, in particular:

(i) individual decisions

(ii) authority decisions - these are the most prevalent within industry and represent unilateral decision by authority figures. The essential characteristic of this 'decree' approach (described by Taylor, 1911, Gouldner 1954)) is that it involves minimum participation of the adoption unit in the decision process.

(iii) 'marketing' decisions - this is an attempt to modify authority decisions by consciously 'selling' the decision to the adoption unit: it is still taken unilaterally and without participation.

(iv) participative decisions - this process involves a two-way interaction between those involved in accepting it. The adoption unit is widely involved in identifying, evaluating and deciding activities.

There are advantages and disadvantages associated with each of these approaches - for example, individual decisions are simple and fast, authority decisions are most effective for organisations in terms of speed and formal acceptance. However, there is growing interest in the innate resistances to change which can be generated, and in terms of successful decisions which mobilise support and commitment, the participative approach is generally agreed to be most effective. Mumford summarises the responses engendered by these decision approaches (Exhibit 14).

It is also possible to categorise adoption decisions in terms of whether they represent:-

- addition of something new
- replacement of something old or
- displacement of the existing by a better alternative

Gold, Pierce and Rosegger (1969) suggest that the outcome and determinants of the process will vary, depending upon which type of decision is involved.

EXHIBIT 14 : Alternative Approaches to New Technology Adoption

(Mumford)

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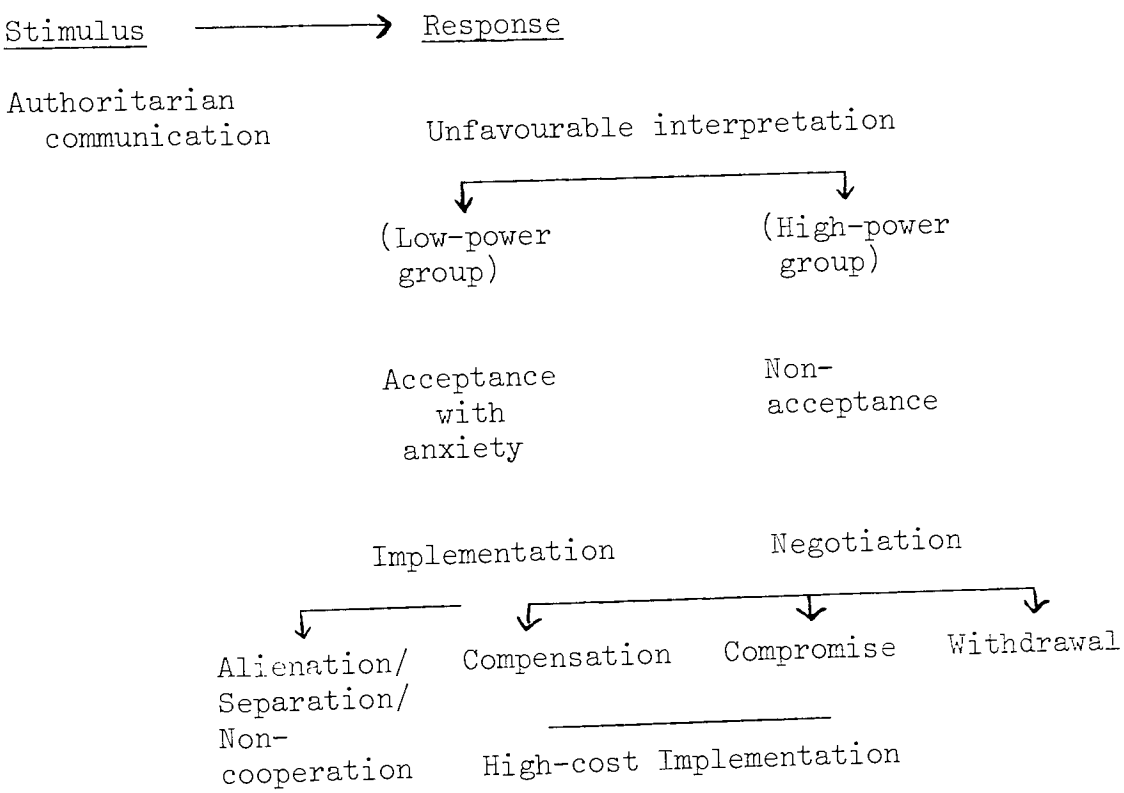
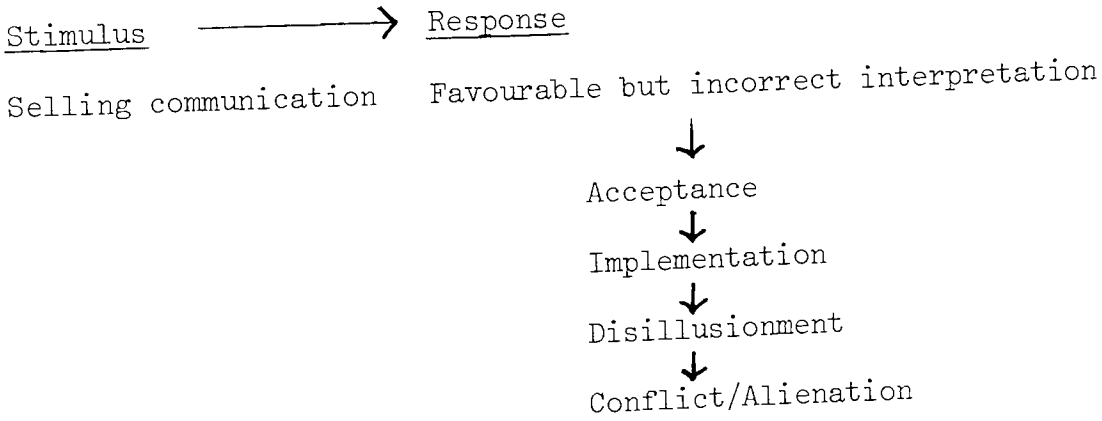
1. Command approach:



2. Marketing approach:



3. Participative approach:

Stimulus

Democratic communication/
Request for ideas and
assistance

Response

Correct interpretation

→ Participation

↓ Acceptance

↓ Implementation of jointly conceived system

↓ Cooperation/
Involvement/
Motivation

Before examining the general findings of research on technological innovation, it will be useful to consider some of the essential characteristics of innovations and some of the suggested models of the proces.

(3) Characteristics of innovation

(a) radical vs incremental:- it follows from our definition of innovation that the degree of newness will be an important factor in the process, particularly at the adoption stage. Obviously this will be a relative quantity depending upon the organisation involved: what may be a radical departure for one may be little more than a logical progression for another.

Radical innovation can best be considered as one extreme of a continuum where the degree of newness is very large and will involve a revolution in thinking or action; incremental innovation then occupies the opposite end of this line where the changes involved are minimal. Exhibit 15 illustrates this. The demands placed on individuals and organisations in terms of resources, risk etc. are naturally more extensive in radical innovation than in incremental but at the same time, successful innovation of a radical nature is likely to bring with it substantially greater rewards.

EXHIBIT 15 : Radical/incremental continuum for innovation.

	PRODUCT INNOVATION	PROCESS INNOVATION
RADICAL	Major transformation in technology - radical shift into new product concept area e.g. VTOL aircraft transistors radar Emiscanner pharmaceuticals e.g. Librium, Valium, Intal Mini car	Major transformation in technology - radical shift in the way of doing things e.g. basic oxygen process box girder bridge design microprocessors floatglass
	fully automatic transmission systems for cars (synthesis of well-known ideas to provide new answer to well known problems) semi-synthetic penicillins - systematic investigation of different reaction lines	shuttleless looms for weaving - improvement on an old idea using new materials, experience and market demand. Chorleywood bread process - based on old ideas using new treatments
INCREMENTAL	Minor changes, almost developmental e.g. style, colour, simple increments of change	BICC's continuously transposed cables. Catalyst development in the petrochemical industry - use of different machinery, raw materials etc. but relying on similar principles. Minor alterations in process technology e.g. new equipment

Since we are talking about a continuum, it is impossible to delineate a point at which an innovation becomes radical: Miller's spectrum model (Exhibit 16) aptly illustrates the overlap in different aspects of industrial research. However, most writers on innovation have tended to study discrete major innovations rather than the sum of minor modifications over a period of time: this is principally due to the difficulty of handling increments as units of analysis. A notable exception to this trend is Hollander's study of incremental innovation within du Pont (1965) in which he clearly illustrates the significant contribution which a series of minor modifications can make.

Knight suggests that it may be necessary to consider this dimension in terms of performance and structural factors. Here 'performance radicalness' describes a measure of the increase (or decrease) in the ability to perform a required task. It is defined as 'the amount of change in output that results from one innovation when compared with a second one' and a large change in output, positive or negative, that results from the introduction of a new idea will be indicative of high radicalness. By contrast, 'structural radicalness' defines a measure of the extent to which the structural arrangment differs from existing ones. This is a similar concept to that suggested by Normann in which new product development involves either 'sequential' or 'substantial' relationships between activities, the former corresponding to the simple increment model and the latter to a substantial reordering of structure involved in a radical one.

EXHIBIT 16 : Innovation as a 'spectrum' in industrial Research and Development

(Miller 1978)

Incremental Service type operations	Problem-solving		Invention
- making better use of existing equipment	-new equipment which reduces costs	- process modification which reduces costs	- new process which reduces costs
- modified product with improved properties	- new equipment which produces special product	- new process which produces special product	- new chemical structure with special properties
- low risk			- high risk
- low cost			- high cost
- low time scale (weeks)			- high time scale (years)
- individually low impact on profit			- large potential impact on profit
- objectives are clear, knowledge required is usually acquired by long experience			- arises from awareness of need and an idea requires new scientific knowledge
- work closely integrated with day-to-day business			
- introduction is straightforward			- introduction to production involves major change in plant and skills

Broadly speaking, most industries practice both kinds of innovation but there will be a bias in favour of one kind over the other depending on such factors as the overall economic environment and the basic strategy of the industry. Utterback , for example, indicates some of the preferred emphases for typical industries. (Exhibit 17).

EXHIBIT 17 : Typical industrial innovation strategies

(Utterback 1974)

automotive industry	- sales maximisation
transportation, communications	- cost minimisation
aerospace chemicals	- performance maximisation
mining petroleum	- control of resources

(b) product or process: Knight offers the following definitions of innovation categories.

(i) Product or service innovations - these are the introduction of new products or services which the organisation produces, sells or gives away.

(ii) Process innovations - these are the introduction of new elements in the organisations task, decision and information system or its physical production or service operations, the advances in the technology of the company.

(iii) organisation structure innovation - this includes the introduction of altered work assignments, authority relations, communication systems, reward systems, formal interaction etc. into the organisation.

(iv) people innovation - these are actions which produce direct changes in the people within the organisation.

a great deal will depend on the kind of industry involved as to the relative type of innovation practised. Product innovation inevitably involves selling in the market place and will thus be affected considerably by consumer uncertainty, market trends etc.; process innovation is concerned with the way in which things are done and will be involved in factors like cost, safety and efficiency.

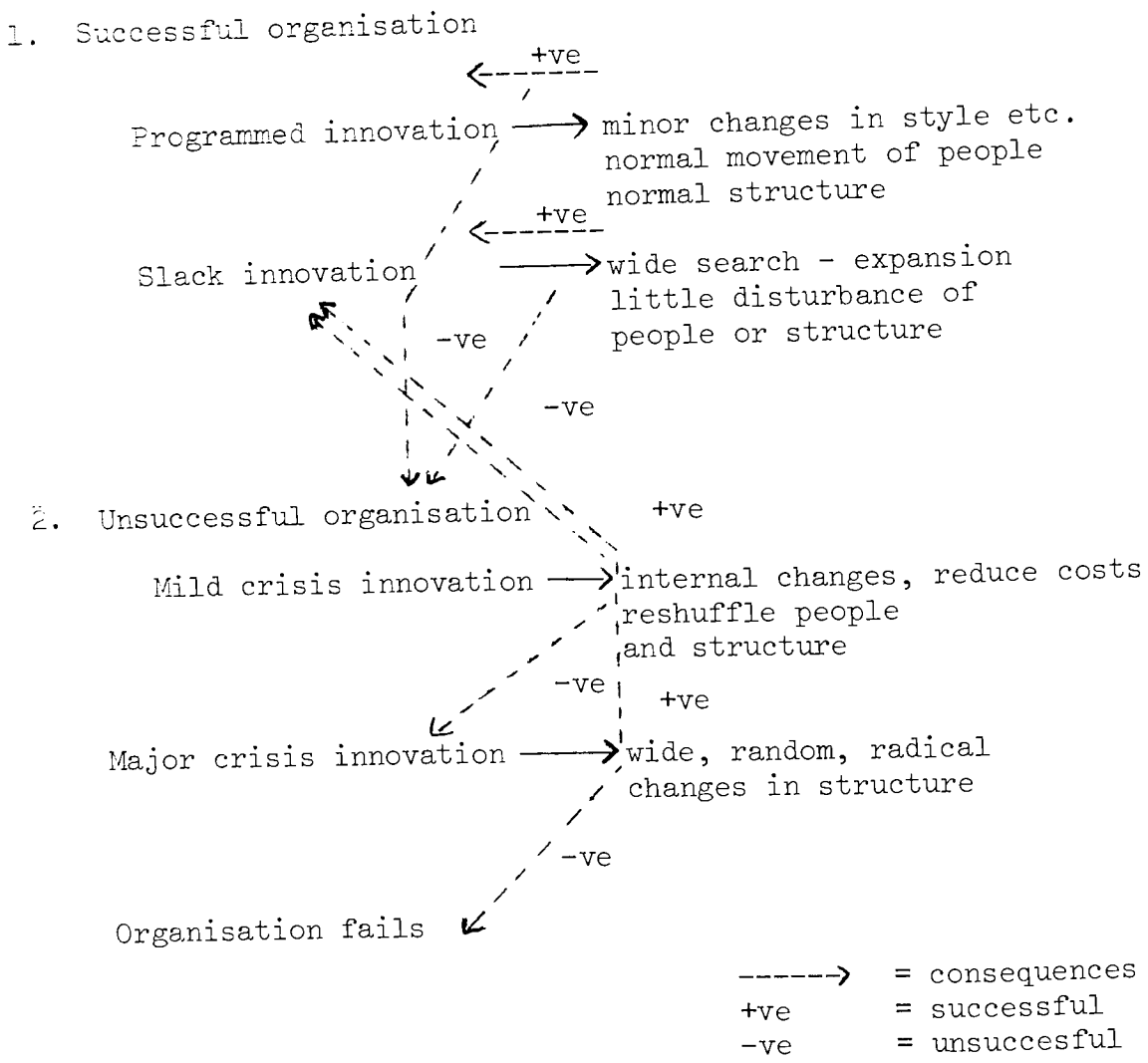
(c) routine vs non-routine: industrial organisations exist as dynamic systems and will thus pass through phases in which they can afford to take extensive risks and those in which their whole survival will depend on adapting. The notion of routine or programmed innovation covers those cases of innovation which are largely planned: there may be creative problem solving in the creation of the idea but once it occurs, there are well-defined routines and procedures for evaluating and implementing the idea. Style changes, minor product modifications and minor extensions of the production line are all examples of this type of innovation and are usually characterised by their regularity e.g. to keep abreast of the market, most consumer industries change styles, colours and other minor options on a regular basis.

By contrast, there are innovations which are dependent upon the success or failure of the organisation(Cyert and March 1963) suggest that success produces excess resources which the firm can decide to use in a variety of ways - a condition they term 'slack'. Under these conditions, the organisation tends to spend heavily on Research and Development activities, often adding new groups or resources, in an attempt to keep on top of new knowledge: the hope is that by doing so an advantage over competitors will be gained which will help to keep the organisation successful.

Unsuccessful firms, are more likely to attempt small-scale innovation with emphasis on cost reduction because they do not have the resources to devote to high risk, high cost innovation like new product or process introduction. The greater the crisis, the more desperate the firm becomes and it will begin to seize radical proposals in a random fashion because it sees the necessity for a significant performance improvement in order to survive.

Knight has a model of innovation as an organisational search activity related to the crisis or slack position of the firm: this is reproduced in Exhibit (18).

EXHIBIT 18 : Model of innovation as organisational search.



	Innovation type	Radicalness
1. Successful organisation		
Programmed innovation	Products and services Organisation structure People	Low
Slack innovation	Products and services Process Organisation structure People	Moderate/high " Low Low
2. Unsuccessful organisation		
Mild crisis innovation	Products and services Process Organisation structure People	Low Low Moderate Moderate
Major crisis innovation	Products and services Process Organisation structure People	Variable (random) Moderate High High
Organisation fails		

(d) risk and uncertainty: since it involves bringing the new into being, innovation must, by definition, carry with it an element of uncertainty. This is not merely a matter of technical 'working' or 'not working' (although this factor will be decisive for success). The uncertainty lies in the extent to which the innovation will satisfy a variety of technical criteria without increased cost of development, production or operation, and the extent to which the final product is acceptable to the market.

Most economists make a distinction between 'measurable' and 'unmeasureable' uncertainty, and innovation falls into this second class: the distinction is essentially one of degree. The notion of 'calculated risk' is common to businesses such as insurance where theories of statistical probability can be used, but these involve repetitive, low levels of uncertainty. Innovation, however, tends to involve higher levels of uncertainty and makes risk-estimation difficult: for this reason, risk capital for innovation is often difficult to obtain from conventional banking sources. Exhibit (19) indicates the range of uncertainty which can be associated with various types of innovation.

EXHIBIT 19 : Degree of uncertainty associated with various types of innovation

true uncertainty	fundamental research fundamental invention
very high uncertainty	radical product innovations radical process innovations outside firm
high uncertainty	major product innovation radical process innovation within own system
moderate uncertainty	new 'generation' of established products
little undertainty	licensed innovation imitations of product innovation modifications of products and processes early adoption of established process
very little uncertainty	new 'model' product differentiation agency of established product innovation late adoption of established process innovation in own system minor technical improvements

(Freeman 1974)

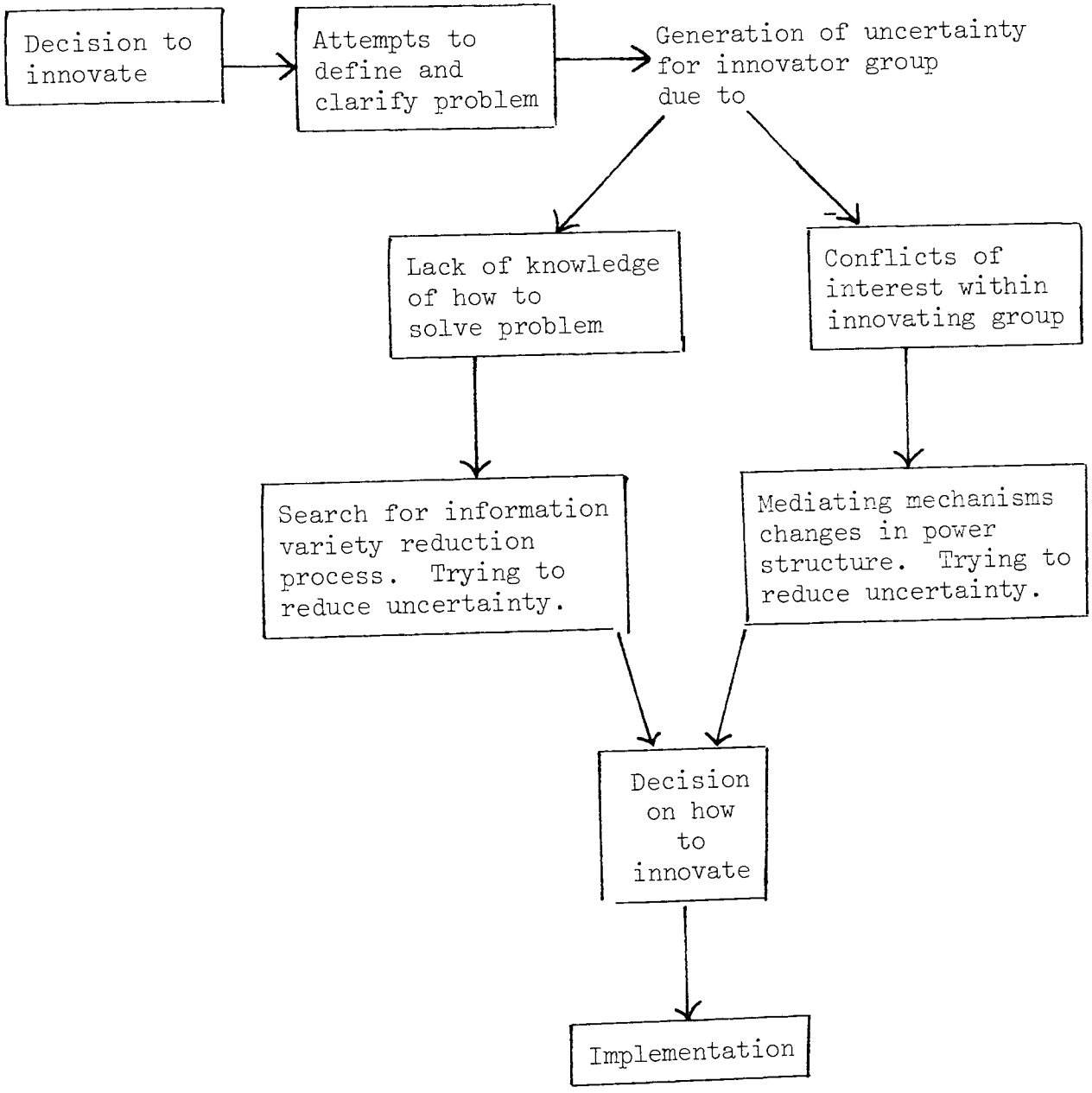
As a general principle, most firms would prefer process innovation within their own works since this only involves technical uncertainty - as compared with radical product innovation which would involve high levels of technical and market uncertainty. This will reflect in a tendency towards committing Research and Development resources towards defensive, imitative, product differentiation and process innovation and away from radical, open-market operations.

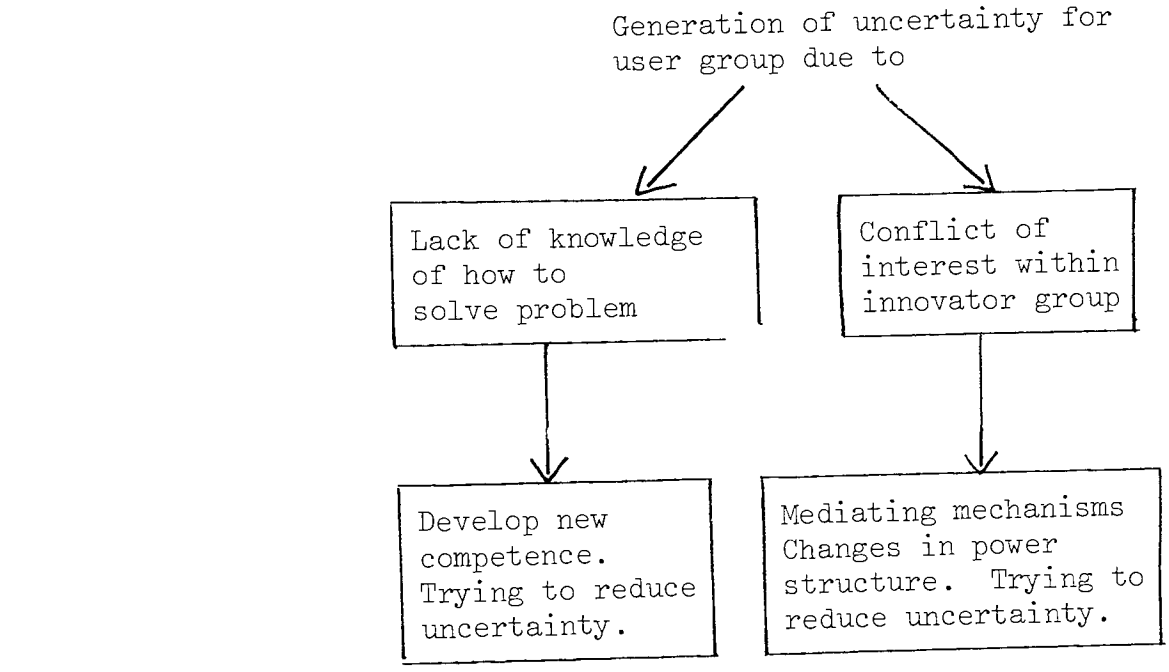
Mumford and Pettigrew (1975) suggest a model which illustrates the generation of uncertainty, including its effect on the social system involved. (Exhibit 20). Gold (1969 challenges some common beliefs about innovation which ignore uncertainty generation and Schon (1966) suggests that much of the innovative work in an organisation should be aimed at converting uncertainty to risk.

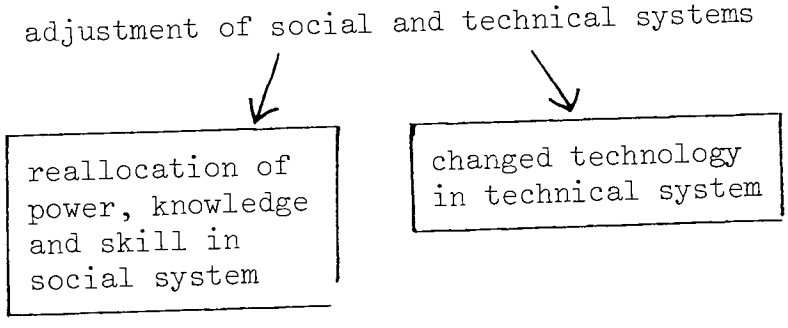
EXHIBIT 20 : Model of innovation and the generation of uncertainty

(Mumford and Pettigrew 1975)

External stimulus




Generation of uncertainty for user group due to
Lack of knowledge of how to solve problem
Conflict of interest within innovator group
Develop new competence. Trying to reduce uncertainty.
Mediating mechanisms Changes in power structure. Trying to reduce uncertainty.


adjustment of social and technical systems
reallocation of power, knowledge and skill in social system
changed technology in technical system

Thomson (1967) has a similar view of uncertainty as:

- the general lack of understanding of the relationship between causes and effects in the culture as a whole and

- the fact that the outcomes of organisational action are in part determined by factors operating in the external environment.

(e) relative advantage: in discussing the adoption decision, Rogers and Shoemaker identify several characteristics of innovations which influence that decision. First among these is the relative advantage, which defines the subjective perception of the innovation as being in some way better than the existing thing which it proposes to replace.

(f) compatibility: this is the perception (both objective and subjective) of the innovation as being consistent with the values, experience, needs, technology etc. of the receivers.

(g) complexity: this is the perception (again objective and subjective) of the difficulty in understanding and use of the innovation.

(h) trialability: this is the degree to which experimentation is possible with the innovation, the chance for practical proving of what it is and what its implications might be.

(i) observability: the degree to which the results of the innovation are visible - this is particularly important in the adoption decision and its later confirmation.

Characteristics of innovators, adopters and environments:

(a) environmental texture: inevitably, since innovation does not take place in a vacuum, it will be affected by the quality of the environment in which it occurs, Factors such as market competition, economic climate, legislation, political stability etc. will undoubtedly play a significant part. Many theorists view innovation as an adaptive response on behalf of organisations and have attempted to categorise the various possible environments involved. Exhibit 21 illustrates two of those suggested, due to Emery and Trist (1965) and Duncan (1972)

both indicate that adaptive responses, such as innovation become extremely difficult to make as environmental texture increases in complexity. Lawrence and Lorsch (1967) provide some excellent examples and analyses of companies coping more and less successfully with product innovations in highly complex environments.

They view uncertainty in relation to the environment as being made up of

- the lack of clarity of information
- the long time-span of definitive feedback
- the general uncertainty of causal relationships.

EXHIBIT 21 : Characteristics of environments.

(a) Emery and Trist (1965)

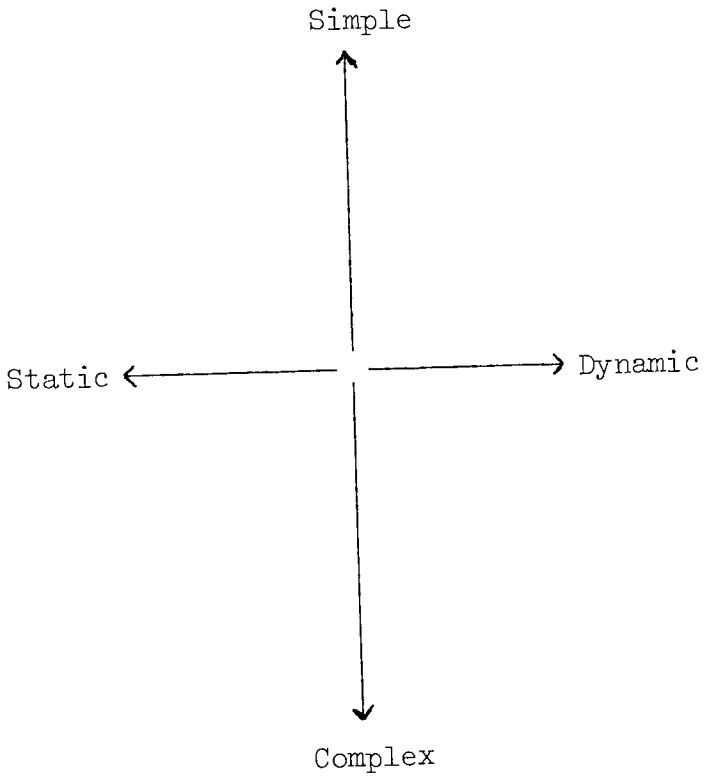
(i) simple, placid, randomised: in this type, goals and noxiants are relatively unchanging in themselves and randomly distributed. A critical property from the organisation's viewpoint is that there is no difference between tactics and strategy and organisations can exist adaptively as single, and indeed quite small, units.

(ii) placid, clustered: in this type, also static, goals and noxiants are not randomly distributed: they hang together in certain ways. The need arises for strategy as distinct from tactics. Under these conditions organisations grow in size becoming multiple and tending towards centralised control and coordination.

(iii) disturbed, reactive: this type is dynamic and consists of a clustered environment in which there is more than one system of the same kind, i.e. the objects of one organisation are the same as, or relevant to, others like it. Such competitors seek to improve their own chances by hindering each other, each knowing the others are playing the same game. Between strategy and tactics there emerges an intermediate type of organisational response - what military theorists refer to as operations. Control becomes more decentralised to allow these to be conducted. On the other hand, stability may require a certain coming-to-terms between competitors.

(iv) turbulent fields: this type is dynamic in several respects arising not simply from the interaction of identifiable component systems but from the field itself. The turbulence results from the complexity and multiple character of the causal interconnections. Individual organisations, however large, cannot adapt successfully simply through their direct interactions.

(b) Duncan (1973)



(b) adopter characteristics: Rogers and Shoemaker, in their study of communication and diffusion of innovations lay great emphasis on adopter characteristics as being central determinants of the innovation process. In particular, the influence of reference groups, opinion leaders and other social structures appears to have a significant part to play.

In their research summary, Rogers and Shoemaker identify five classes of adopters:

innovators

early adopters

early majority

late majority

laggards

and Exhibit 22 indicates the distribution of these over time.

The determinants of adoption, according to their model, depend heavily on communication - related factors, and the important characteristics of adopters are thus held to be those which expose a degree of similarity or dissimilarity between adopter and innovator.

Three concepts appear important here: homophily and heterophily between individuals, traditional and modern systems orientation of social structures and 'cosmopoliteness' vs 'localness' which refers to the individual's orientation and values. Innovativeness is a measure of an individual's likelihood to adopt an innovation and is related to these factors. Exhibit 23 discusses these concepts.

Rogers and Shoemaker identify a number of propositions about adoption which are associated with three groups of factors: socioeconomic variables, personality variables and communication variables. These are discussed in later sections.

EXHIBIT 22 : Distribution of adopter categories

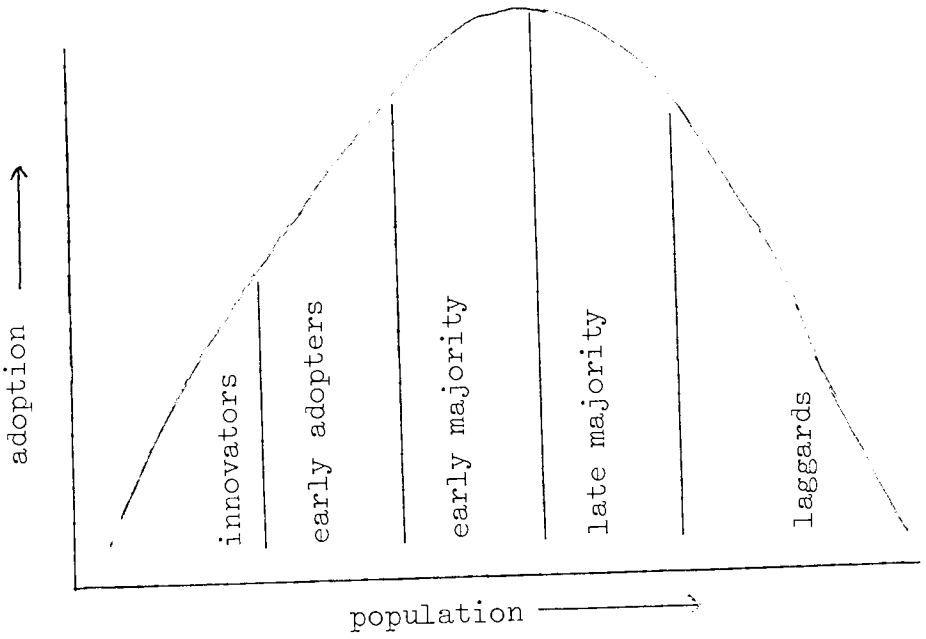
The basic distribution of adoption of innovation across a population is normal: both curves shown below support this and are based on extensive empirical evidence. This is to be expected: if we look at learning theory, we find that learning (i.e. response to new ideas) is proportional to the amount already known and the amount still to be learned.

Within the distribution across population, Rogers and Shoemaker (1971) identify five characteristic types. These are:

(i) innovators
(ii) early adopters
(iii) early majority
(iv) late adopters
(v) laggards

and are discussed in greater detail elsewhere.

(a) adoption distribution over population



(b) adoption distribution over time

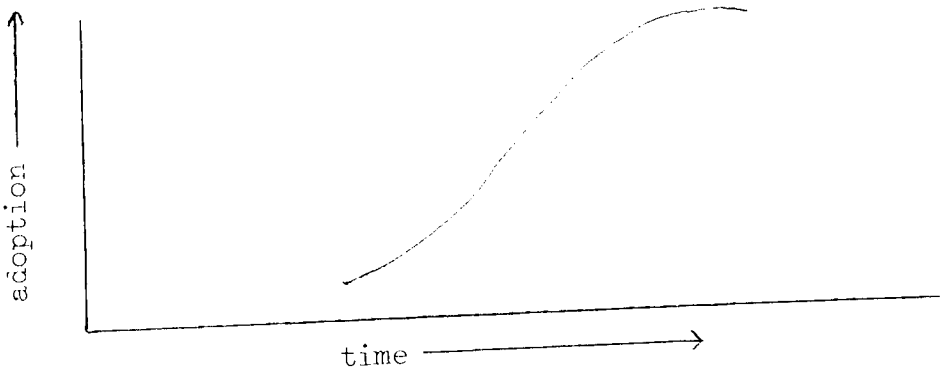


EXHIBIT 23 :

(i) homophily/hererophily: in viewing innovation as a communication process involving the transfer of a message between a source and a receiver, Rogers and Shoemaker point out the importance of the similarity or otherwise in the viewpoints of these two agents. They use a concept outlined by Lazarsfield and Merton (1964) of hetero- and homophily where these labels define two poles of a continuum describing the degree of similarity.

For communication of innovation, there must be some degree of both hetero- and homophily: in the ideal case homophily should be evident in all respects except the innovation itself. The 'heterophilic gap' (degree of dissimilarity) increases with the cultural changes between groups - this partially explains the lack of effective communication and transfer of innovation from highly developed to underdeveloped countries.

(ii) traditional/modern: closely associated with innovation adoption are the system norms, values and general cultural orientation in which the change is being introduced. The two terms, characterised by the elements listed below, define poles of a continuum which describes the 'degree of societal open-mindedness' - i.e. the likely receptivity to new ideas.

Traditional Systems	Modern Systems
lack of favourable orientation to change	positive attitudes to change
'simple' technology	developed technology and labour organisation
low levels of literacy, education etc.	high value and levels of education, literacy etc.
social enforcement of the value system as status quo	rational social relationships
little communication across system boundary - isolation	cosmopolitan characteristics and interactions
lack of ability to empathise	empathy

(iii) cosmopolitans/locals: the Rogers and Shoemaker research summary indicates that there are certain qualities associated with early adopters and innovators: following Gouldner they define two extreme types, cosmopolitans and locals.

Once again these represent poles on a continuum describing individual open-mindedness and breadth of experience; they relate to receptivity to new ideas. Elements characterising these two extremes are listed below.

Cosmopolitans and locals - essential characteristics

(Gouldner 1970)

- cosmopolitans have a relatively complex set of skills derived from long formal training. They tend to be more committed to their job than to any organisation: their training offers them greater job mobility amongst many organisations. They are 'itinerant' rather than committed members of any company. Values, particularly with respect to professional skills are refined and developed by reference to a professional peer group rather than by members of his employing organisation.

- locals by contrast are 'company' men, loyal and committed to the organisation. Their reference group is internal and they tend to lack specialist professional skills. Their commitment is often to the organisation rather than to the task, and career patterns are important for them.

(Arguably this difference in roles and orientation might emerge between Research and Development specialists and production personnel in the innovation process).

- cosmopolitans are less influential within organisations than locals.

- cosmopolitans participate less in organisation activities than locals.

- cosmopolitans have a higher propensity to reject organisational rules than locals.

- cosmopolitans are less informally 'linked in' than locals in the organisation.

(4) Measurement of innovation

Before we pass on to the general findings and conclusions of research on innovation, it will be useful to consider how it can be measured. Most attempts employ some kind of black-box input/output model but this has the disadvantage of revealing very little about the determinants of the process itself.

Simple output measures might include:

- idea production rate in Research and Development
- number of ideas produced in Research and Development
- number of proposals put forward to meet a stimulus
- number of adopted innovations
- number of innovations produced
- number of successful innovations now/after time
- number of unsuccessful innovations now/after time etc.

These modify easily to input/output ratios which are slightly more meaningful, e.g.

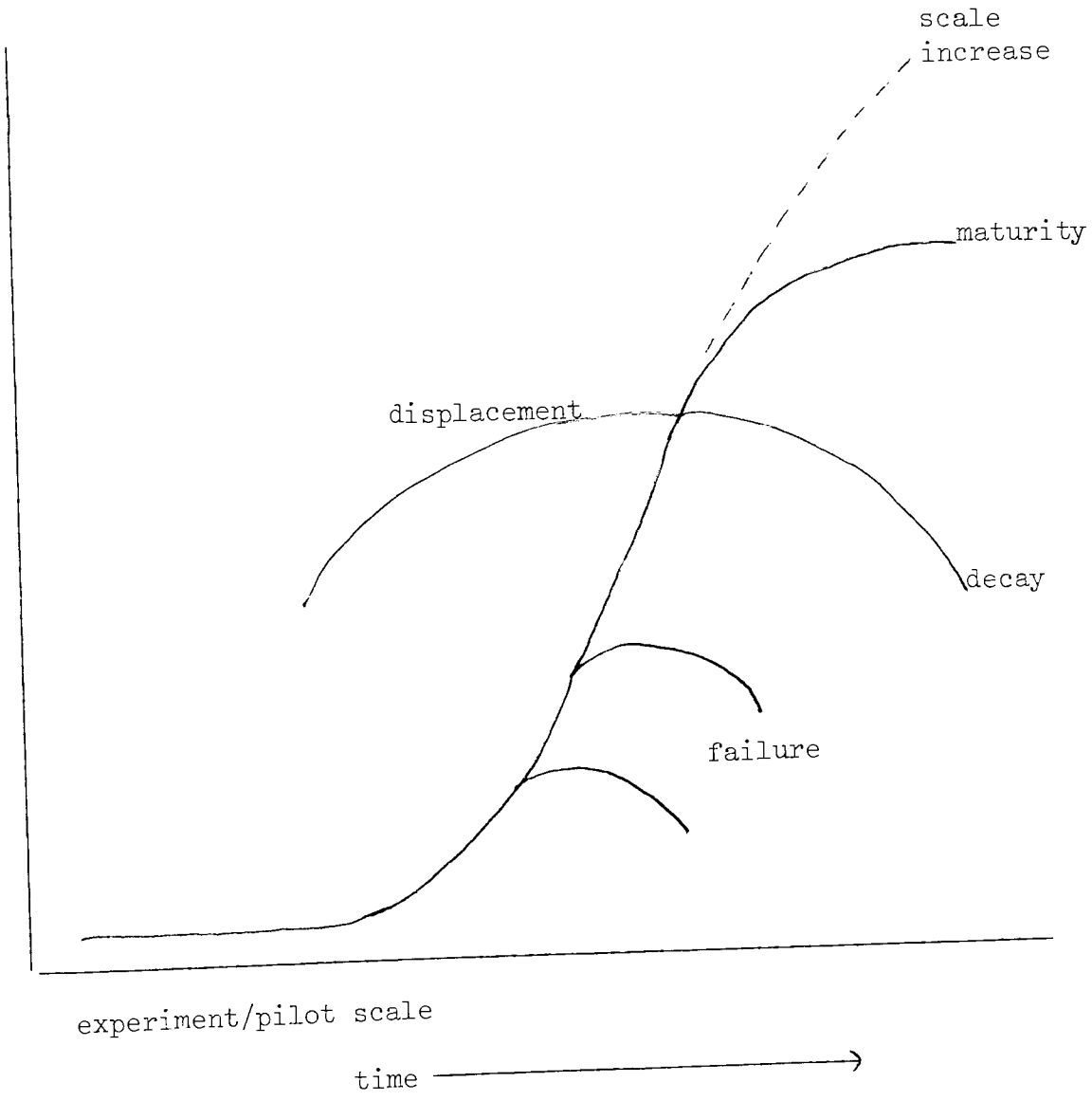
- effort in/innovation output
- resources in/innovation output
- research efforts and resources/idea rate and quantity
- marketing efforst and resources/adopted innovations

A whole series of ratios could be built up in this fashion and, to some extent, provide a useful guide to the effectiveness of innovation. Most capital investment decisions, for example, are made on the basis of some kind of comparison between an expected rate of return from the investment in innovation, and a similar investment earning interest.

There are two motives for measuring innovation: control and research. In the former case, the measures need to be practical since they are part of the operational mechanism in industrial innovation - for example in project selection, monitoring, evaluation, planning etc. Control measures are also needed as guidelines in national and commercial strategy and policy-making: again these are often economic in basis and deal with the efficiency and effectiveness of innovation under different sets of circumstances. With the increase in inflation rates and world recession, major Research and Development especially when backed by governmental aid, has come in for sharp criticism and it is evident in the case of a project like Concorde that much of this is directed at inadequate means of measuring the real progress of the project.

Another comparative set of measures for project control is based upon product/process/plant life cycles: in general these follow the pattern indicated in Exhibit 24. Deviations, either positive or negative, show up clearly on such a visual representation.

EXHIBIT 24 : Project Life Cycle Diagram



Measures designed to facilitate study and research on the subject of innovation can afford to be more complex and developed because of the absence of time constraints. However, when attempts are made to move beyond historical input/output type assessments, problems of individual perception of factors like degree of radicalness, complexity, relative advantage etc. makes generalisation very difficult. (These criticisms are discussed atlength at the end of this chapter).

Consequently, most of the general studies carried out have been along the lines given in Exhibit 25. In general there appear to be five dominant classes of studies on innovation.

(i) statistics: by far the largest group, these involve working at high levels of generality and allow for little discrimination between characteristic elements in the innovation process under differing circumstances.

(ii) specific industry studies: using the same approaches as (i) but focussing attention on one specific industry or sector of industry. Still provides information of limited value in being so general: examples might include Enos's studies of the development and diffusion of petroleum refining processes within the petrochemical sector of the chemical industry.

(iii) 'critical incident' studies: by contrast, highly specific studies based upon individual recollection of innovation and the factors which affected the process. Suffers from bias due to subject and to distortion over time as well as referring to those large elements in the process which stick in the memory.

(iv) contextual studies: attempts to take into account a number of factors hitherto ignored in statistical studies e.g. size, age, wealth of firm, type of market, type of technology etc. Notable amongst this class of studies would be Project Sappho, with its attempt to account for contextual variables by 'pairing' companies.

(v) case studies: most recent of the recommended approaches this class attempts to generate information of a highly specific nature based on extended, in-depth studies of individual organisations. They have the advantage of including all potential variables and influences in their field of study, but may be limited in that this information is only valid for one organisation. However, there is (as will be discussed later) a growing body of opinion suggesting that it may not be possible to derive a general theory of innovation and that our best hope lies in developing a contingency/probabilistic model of some kind based on a number of case studies. As the OECD report (Pavitt 1971) suggests, "this source is likely in the long term to lead to a more fundamental understanding of the processes of technological innovation".

EXHIBIT 25 : Some overall performance measures of innovation.

- relative improvement in yearly indices and figures such as GNP, trade balance etc. -- this is an indirect measure since it only indicates the contribution from the manufacturing sector, and is based on the assumption that some of the improvement results from the contribution of innovation and technological change.

- analyses like that above, but given in terms of specific sectors of industry so that relative rates of development emerge.

- investment/output ratios for industry - this measure is based on the assumption that a significant proportion of investment goes into innovation and thus a crude input/output ratio can be constructed. Lave (1966) summarises the detailed investigations made by a number of economists and suggests that their conclusions can be justifiably accepted where the figures are for long periods of time and show considerable differences between any two sectors. He cites, for example, the period 1909-49 where technological change in the USA was twice as rapid in agriculture as in manufacturing. Mansfield, (1968) after an exhaustive and definitive study of the economics of innovation, has reservations about the precise measurement of technological change, especially by these means.

- patent statistics. Schmookler (1966) has made extensive study of this area in the USA and has developed models etc. based on analysis of innovations revealed through patents. Unfortunately, as Kingston (1977) argues, many firms no longer believe in patents as an effective protection for new ideas and prefer to gamble on holding a market advantage by being ahead of competition for a significant period of time.

- success/failure pairs. Project SAPPHO developed this technique in an attempt to identify the contribution or absence of key factors in the innovation process. 'Success' is defined in commercial terms.

(5) General Findings

A large number of studies have been carried out on aspects of the innovation process in an attempt to arrive at some general conclusions. The majority of these have looked retrospectively at a range of innovation within a variety of industries and attempted to determine emergent patterns. Despite some recent theoretical reservations (Downs and Mohr 1976, , discussed later) and some reflections on the practical design (Utterback 1975 , Rothwell 1977), these remain the principal source of knowledge about what innovation is or how it takes place.

Exhibit 26 summarises the conclusions of several recent studies of this kind and provides a suitable indication of the range of factors which appear to contribute to 'successul' innovation (usually judged on commercial criteria): Exhbit 27 lists some common factors in failure. This work is largely in agreement with previous studies (Exhibit 28) and suggests that these factors will be reasonably consistent in technological innovation: unfortunately prescriptive use of this information is difficult because of the general and non-specific nature of the conclusions.

Research on implementation and diffusion of innovations has also been extensive and is summarised in Exhibit 29.

The principal reservation about general research at present is the lack of information of the specific case study variety; where case studies have taken place, they have often been retrospective recollections or critical incident orientated. If we accept Utterback et al's view of innovation (1976) as 'a function of the firm's environment including technical, market, economic, governmental and other components, communication between the firm and it's environment, the firm's resources and its organisation and allocation of resources, technology and information', then it is clear that studies based on long-term observation of firm's overall operations will be of value in elucidating some of the detail of these compelx relationships.

Many of these studies have been carried out for motives other than pure research interest: since technological innovation is such an important element in national economy, there has been a great deal of effort directed towards obtaining a set of guidelines which have practical value for improving innovation effectiveness. Exhibit 30 indicates the contribution Project Sappho makes, for example, in updating conventional thinking in some areas of innovation.

Inevitably, there are contradictions and areas of vagueness in these findings and it is significant to note that many commentators are critical of the present state of knowledge about innovation and suggest directions in which future research should be concentrated.

EXHIBIT 26 : Factors associated with innovation success (based on Rothwell, 1977).

(a) Good internal and external communication

- 'use of outside technology and scientific advice'
- survey of potential ideas
- better contacts with the scientific community in the specific area associated with the innovation
- a willingness to share knowledge (not secretive)
- the information system which is at the disposal of the enterprise is associated with success - both good internal and external information are associated with high profitability
- communication outside the firm played an important role in the projects studied. Outside consultants more often used by successes
- good internal and external communication important to success. External communication particularly important for firms attempting radical innovations
- high quality of incoming information. Better contacts with outside establishments

(b) Collaboration with outside agencies

- successful innovators collaborate with potential customers during the development
- an element of success was the ability of a research unit to improve scientific and technological cooperation with extra-mural scientific and technological organisations
- readiness to cooperate with outside agencies
- collaboration with customers and suppliers
- successful innovators collaborated with external agencies from an early stage in the innovation process. Collaboration occurred most frequently with customers and other private industry
- frequent contact was maintained with customer
- external information is not obtained form symposia. A great deal of information results from personal contacts within and outside the company and from captive know-how and experience
- personal contacts and personal experience are best information sources for successful innovations.

(c) Good integration and cooperation

- successes, on average, out perform failures in all the areas of competence encompassed by the innovation
- harmonious cooperation between research, development, production and financial organisations contributed to success
- good internal coordination and cooperation
- innovation management is a corporate task, not Research and Development in isolation. Cannot be left to one functional department.
- good intra-firm cooperation
- the balance of functions of production, marketing and Research and Development is an element in the success of an enterprise over the long term. It is a question not only of quantitative balance but also of a balance in quality. The firms which have the highest economic successes are those which attain a high quality simultaneously in these three major functions
- successful firms took steps to coordinate the effects of various functional departments. More progressive firms formulated a corporate strategy. Innovation is a corporate-wide task and success cannot be explained in terms of one or two factors only. On average successful firms out performed failures right across the board.

(d) Effective development work

- successful innovators perform development work more efficiently and eliminate technical defects before commercial launch. In successful innovations there were fewer unexpected adjustments to production
- success was greatly facilitated by the adequate preparation of works for solving emergencies in the course of pilot production. Success was furthered considerably if the enterprise succeeded in overcoming the different operational problems.
- good consciousness in research
- successful firms performed their development work more efficiently than failures. Successful firms eliminated technical bugs before commercial sales.

(e) Good financial control

- the drawing up of a preliminary budget
- quantified investment decisions
- budget for market and development available
- most innovations were formally budgeted for at the start. This was particularly the case with incremental innovations.

(f) Use of management and planning policy/strategy

- successful innovators undertook a deliberate search for the innovation. Successful innovators took a more serious approach to planning. In successful firms the Research and Development programme was systematically and periodically considered.
- good use of management techniques
- innovative capacity is associated with an active policy in finding and developing new products
- planning was more highly structured and sophisticated in the successful cases
- the majority of successful innovators claimed to have an explicity formulated policy towards innovation and change to formulate in writing the objectives and plans of their development efforts. This was particularly true for radical innovators. Growing use of technico/economic analysis of new innovations in the more progressive firms.

(g) Scientists and managerial positions

- did not discriminate. The successful Chief Executive was often a graduate scientist or engineer
- scientists and technologists on the board
- senior staff are mostly engineers but other graduates are also included.
- in the case of radical innovators, 70% of Chief Executives possess a technical qualification, 35% were graduates. In the case of incremental innovators, 60% possessed a technical qualification, 26% were graduates.

(h) Marketing contact and orientation

- marketing was the most important SAPPHO discriminator. Successful innovators understood user needs better. Successful firms pay more attention to marketing publicity and sales. Successful innovations arise in response to a market need.
- an effective selling policy
- recognition of demand is a more frequent factor in successful innovation than the recotnition of a technical potential
- clean identification of a need. Realisation of potential usefulness of a discovery
- the product policy aims essentially at orientating the resources of the enterprise towards the most profitable opportunities.
- need recognised among users. Need recognised before technical solution. Project intended for specific user or end-product.
- an active attitude towards the market. Anticipation of a future market demand. Recognition of an existing demand.
- knowledge of consumer demand is an important factor in success. Where no deliberate marketing was practised in the interests of successful development, this circumstance had a decisive role in failure. If the innovation formed an integral part of the marketing policy of the enterprise, the chances of success improved significantly.

- the great majority of successful innovations arise in order to meet a customer need. This is particularly true for incremental innovations. Successful innovators interact strongly with customers during development. Successful firms have a 'market' rather than a 'technical' orientation. Most progressive firms possess a formal marketing policy.

(i) Good technical service

- the avoidance of technical after-sales problems by good development work is important to success. Successful firms pay more attention to user education.
- successful operations were furthered by the adequate preparation of consumers.
- good technical service to customers
- successful firms had no initial difficulty in marketing the product
- successful firms provide an efficient and reliable after-sales maintenance service. Successful firms mount comprehesive operator training courses. These factors are particularly critical in the case of radical innovations.

(j) Forecasting

- in successful innovations systematic sales forecasting was undertaken. Successful firms rated the prospects of technical success lower.
- prior to introducing the new product, predictions were made regarding the new product.
- a readiness to look ahead
- in the majority of successful radical innovations systematic sales forecasting was involved in the decision to add the innovation to the firm's product lines.

(k) Technical and power promotors

- the executive in charge of success has more responsibility, higher status, higher authority, more enthusiasm, more involvement. Associated with success there is a clearly identifiable technical innovator. In successful firms there is a product champion
- an element of success is if the head of the Research and Development department had considerable experience and his sphere of interest in Research and Development management has been increased. The same is true for the project manager. In successful projects, the project manager had more commitment.
- outstanding person in a position of authority who makes special contribution to the innovation. Other person, e.g. a 'mechanical genius' or someone who possesses a unique form of knowledge that would otherwise not have been at the disposal of the firm - he is particularly important in innovations embodying large technological change.
- project was initiated by firms top management

- success is promoted by enthusiastic top management. Enthusiasm, technical innovators and product champions have played decisive roles in fostering success. These individuals are particularly effective when the management structure is horizontal and decentralised and when management style is open and consultative. The clear will of management to innovate is important.

EXHIBIT 27 : Some factors contributing to failure and delay in innovation.

(a) Market related factors

- made no enquiries of users
- made too few or wrong kind of enquiries, picked a typical users
- made enquiries but ignored answers
- misinterpreted or misunderstood answers
- committed to a preconceived design
- made user enquiries but no on-the-spot investigations
- market research neglected or ignored
- neglect of publicity or underinvestment in marketing effort
- failure to educate users
- unforeseen changes in the market (e.g. demand falls, price falls, low cost substitutes etc)
- competitors developed new products much faster
- inadequate information about competitors
- defective marketing activity
- too expensive to be competitive
- potential market too small
- insufficient marketing and servicing resources available

(b) Technical factors

- poor or incomplete development work
- over-dependence on outside technology, lack of in-house capability
- insufficient resources for development work
- unexpected superior competitive technology
- belated supply of materials and parts
- lack of contact with research and production
- impractical design, technically 'nice' but lacks commercial performance
- incorporation of unnecessarily complex features
- competitors patents too strong
- problems with new production techniques

(c) Management factors

- project not taken seriously by top management or not integrated into company strategy
- inadequate project evaluation or control
- failure to communicate with critically important outside interests
- business innovator too junior, weak, inexperienced or not present

- powerful committed but mistaken product champion
- few development personnel with experience in determining economic factors
- potential not recognised by management
- remote, uninvolved business innovators
- secretive inventor/hostile business innovator
- general lack of experience in new area
- poor internal/external communication
- overattachment to old, traditional designs on behalf of management

Factors (a) to (k) are those in which all the studies considered show significant agreement: in addition a number of other factors emerged which are felt to be of interest. Rothwell summarises the general characteristics of all the factors as follows:-

(a) good communication and effective collaboration: Successful innovators, while enjoying good intra-firm communication, establish efficient communication links with outside scientific and technical establishments and make deliberate efforts to survey potentially useful externally generated ideas..... the studies emphasise the role played by individuals ('informal' as opposed to 'formal') communication channels in the retrieval and dissemination of useful information.....it appears to be important.....for the innovator to collaborate with potential users from an early stage in the innovation process, thus ensuring that he gains a full understanding of user needs - and an appreciation of the conditions in which the innovation will be required to operate.

(b) innovation as a corporate wide task:- innovation is not, as many managers appear to believe, simply a matter of Research and Development, but should involve inputs from the production and marketing departments throughout the course of the project.

(c) efficient development work:- this factor.....highlights the need for efficient Research and Development procedures and underlines the prime importance of eliminating technical bugs before the innovation is launched onto the market.

(d) planning and management techniques:- careful project cost control procedures, careful production planning and control, and a readiness to look ahead and attempt to make meaningful sales forecasts, all appear to make some contribution to success.

(e) quality of management, personnel policy and management style: top management should be open-minded and progressive..... this factor reflects the importance of possessing management of high quality and ability, of having the capacity to attract talented people and of formulating an effective training policy.....successful innovation tends to be associated with an open-horizontal management style.....it is within such a framework that imaginative middle-management can function most effectively in stimulating and championing innovations and in which in-house entrepeneurial activity can take place.

(f) marketing and user needs: the majority of successful innovation (on average 75%) arise in response to the recognition of a need of one sort or another (need-pull) as opposed to the recognition of a new technical potential (technology-push). In those cases where a new technical potential does become available first, then successful innovators determine that a need exists before they proceed with the project and take great paints to determine precise user needs and to interpret them in the design of the new product or equipment. Failure is associated with the 'we know best' attitude.....success is furthered by an active marketing and sales policy, while failure is associated with the 'take it or leave it' approach to the marketplace.

(g) after sales service and user education: it is essential to provide a good technical service to customers.....it is also essential to train users in the right use and limitations of the innovation. Adequate preparation of customers can circumvent many reputation-damaging after-sales problems which are the result of user ignorance rather than any malfunction on the part of the innovation.

(h) key individuals: there is no doubt that success is associated in particular in the presence of the firm of one or two 'key individuals' (product champion, business innovator, technical innovator) who are committed to and who enthusiastically support the innovation.....to be fully effective, moreover, the business innovator must have sufficient power and authority to positively affect the course of the innovation, which means that he should hold a place high in the firm's hierarchy.

(i) other factors: success is also correlated in some studies with:

- willingness to look outside the firm
- the firm's attitude towards the need to establish strong contacts with outside scientists and technologists
- good forward planning
- adequate resource allocation
- combining radical and incremental projects in the innovation portfolio
- Governmental and other outside agencies 'lending a hand' e.g. making risk capital available.
- size of firm - large firms benefit by being able to generate and exploit more radical innovation: small firms are more flexible and can respond to needs more quickly.

Rothwell summarises the findings of these studies by stressing the essentially pluralistic nature of explanations of the innovation process. "Technological innovation is a complex technico/socio/economic process which involves an extremely intricate web of interaction, both intra-firm and between the firm and its economic, technical, competitive and social environment". (cf Utterback et al definition, quoted earlier).

Surveys covered in Exhibits 26, 27

Project SAPPHO - comparitive analysis of 'paired' successful and unsuccessful innovations in chemicals and instrument industries. 43 pairs (22 chemical, 21 instruments) on an international basis. Decisive success/failure criteria were commercial.(Rothwell 1973)

Hungarian SAPPHO - extension of above technique to 12 'pairs' in Hungarian electronics industry. (Szakasits 1974)

Carter and Williams - study of 200 technically progressive firms in UK. (Carter and Williams 1974)

Myers and Marquis - characteristics of 567 successful technological innovations in 5 USA industries - railroad supplies, housing supplies, computer manufacturers and suppliers. (Myers and Marquis 1974)

'Wealth from Knowledge' - comparative analysis of the factors in success and delay in 84 cases which won the UK Queen's Award for Innovation, 1966-69. (Langrish et al 1972)

Belgian study - study of innovation strategy and product policy in 12 Belgiam firms over 10 - 15 years. (Hayvaert 1973)

Dutch study - study of 45 firms in Dutch metal working sector between 1966 and 71, based on relative innovative capacity. (Schock 1974)

MIT study - study of success and failure factors in innovation over a sample of 164 innovations from UK, France, West Germany, Netherlands and Japan. (Utterback et al 1975)

Textile study - study of success and failure factors in textile machinery industry, 20 firms, international. Covered incremental and radical - 20 radical, 15 incremental in success, radical, 10 incremental in failure. (Rothwell 1976)

Some other general studies of innovation

Author	Industries studied	Sample Size
Arthur D. Little, Inc.	Textiles	12
	Machine tools	6
	Construction	8
	Semiconductors	12
Carter and Williams	116 British firms	204
Enos	Petroleum refining (processes only)	11
	Other industries	35
Goldhar	Winners of Industrial Research Award	108
Hamberg	Major innovations 1946 - 1955	27
Jewkes et al	Major innovations 1900 - 1945	61
Langrish	British innovations given Queen's Aard in 1966 and 1967	51
Mansfield	Iron and Steel	49
	Petroleum refining	66
	Bituminous coal	28
	Railroads	10
Miller	Steel products and processes	12
Mueller	DuPont's major innovations 1920-1949	25
Myers and Marquis	9 railroads	79
	14 railroad equipment suppliers	125
	53 housing suppliers	196
	12 computer manufacturers	90
	23 computer equipment suppliers	77
NSF-11T	Magnetic ferrites Video type recorder Oral contraceptive pill Electron microscope Matrix isolation	5
Peck	Aluminium	194
Robertson et al	Chemicals	34
	Scientific instruments	24
Sherwin and Isenson	Weapons systems	20
Tannenbaum et al	Major materials developments	10
Utterback	Instruments	32

EXHIBIT 28 : Other general findings

Maclaurin (1950) - found that the quality of entrepreneurial leadership is related to successful innovation.

Hamberg (1963) - found that the size of industrial Research and Development laboratories was significant, the larger ones are likely to be minor sources of major innovations and major sources of minor ones.

Williams (1967) - found that the more successful innovating firms had a higher proportion of scientists and engineers in the top echelons.

Scherer (1965)
Hamberg (1966) - found that gigantic scale is far from and essential condition for vigorous industrial Research and Development activity and that bigness may be a stifling factor.

Williamson (1965 - found that research intensity and innovative effort appear to decline where industrial concentration is high and firms are few and very large.

Mansfield (1963) - found that, given a constant size of firm, the number of significant inventions developed was related to the level of Research and Development expenditure. The productivity of Research and Development departments is lower in larger firms than in smaller.

Meadows and Marquis (1969) - found that firms spend 60% of their Research and Development resources on innovations which fail, because unsuccessful projects have greater excess costs on average than successful ones.

Schwartz and Goldhar (1975) - studies of prizewinners in innovation - found that there were six environmental characteristics conducive to innovation - easy access to information, free flow of information in and out of the organisation, rewards for sharing, seeking and utilising 'new' (externally developed) information, rewards for risk-taking, rewards for accepting and adapting to change and encouragement fo mobility and interpersonal contacts.

Pelz (1964) - studies of research environments - found that although scientists said they desired freedom, autonomous scientists were not necessarily superior in performance. The most productive researchers were those who had substantial influence on decision-makers, but who allowed their choice of technical goals to be influenced by several other persons and groups.

Gordon and Marquis (1963) - found that innovation tended to occur in those areas of the organisation where conflict was tolerated, i.e. where management influenced the goals of the researcher but where there was a low ratio of specified procedures.

Gordon, Marquis, Anderson (1962) - found that maximal freedom alone did not lead to high rates of innovation. Motivation to innovate was dependent upon the observability of the consequences of the innovative activity.

Ben-David (1960) - studies of medical innovations - found that major innovations tended to be developed by scientists who were marginal to medicine, and academic institutions of medicine tended to depress innovation by their insistence upon specific approaches to science which allow few tangential pursuits.

Allen (1965) - studies of matched cases of problem-solving groups - found that ideas and solutions which are considered to have a high probability of success initially tend to persist over a longer period of time than those ideas which are assigned lower success probabilities, even when there are indications that the idea will not be successfu. When an idea is dominant, inertia develops which tends to limit the search for alternative ideas.

Allen and Marquis (1963) - studies of biasing sets - found that sets develop based on previous solutions to problems which are then transferred inappropriately to new problems and have a negative effect on problem-solving.

McLaughlin, Rosenbloom and Wolek (1965) - studies of information acquisition patterns - found that technical communication was primarily oral and face-to-face and that most of the information acquired by the researchers was through in-house sources.

Witte (1977) - studies of 233 computer introductions in Germany, particular interest in the champion/promoter concept - found five types of influence structure.

- 87 adopted through technical know-how/power agents working in tandem
- 37 adopted through unilateral power agents influence
- 43 adopted through unilateral know-how agents influence
- 16 adopted through individual combining both skills
- 50 no promoters involved in adoption

Battelle Laboratories (1973) - ranked the 21 most important factors in innovation success or failure - found that most important were recognition of technological opportunity or need and the management venture decision. Least important were formal market analysis and macro-political and social factors.

Rubenstein et al (1976) - report on the Program on management of research and development (POMRAD) at Northwestern University - found the following factors were significant in innovation success:

- effectiveness of communication, especially technical-marketing, and technical customer links
- scientific and technical competence
- presence of a champion
- recognition of market opportunities
- recognition of technical opportunities
- degree of top management interest
- competitive factors
- timing

EXHIBIT 29 : General findings in adoption, diffusion and technology transfer areas.

In essence there have been four perspectives on diffusion research. The first involves the 'avalanche', 'snowball' and 'chain reaction' models proposed in numerous studies - and the more recent S-curve generalisation due to Warner (1974).

In the second area, this sigmoidal relationship is assumed and studies focus on comparison of curves for firms and nations: attempts are made to isolate key determining variables like profitability and relative advantage. Other economic and sociological factors influencing adoption and diffusion are also included in this area of study - e.g. the role of capital availability or management attitudes.

The third perspective refers to the 'technological gap' theory of international trade. This approach focuses on the temporal differences among nations in inventing, producing and imitating technology: obviously the idea of leads and lags is intimately related to many other contextual factors and most studies bear out this view.

Finally there is a significant area of study of environmental factors and their influence on adoption and diffusion. Here interest centres on issues such as government policy, resource allocation, educational levels, absorptive capacity for change etc.

EXHIBIT 29 cont'd. : General studies in the field of adoption, diffusion, and technology transfer.

Griliches (1957) - study of hybrid corn diffusion - concludes that the socio-economic standard of living and the relative importance of the crop, and the total capital per farm were not significant in explaining adoption patterns.

Nabseth and Ray (1974) - studies of major innovations including the basic oxygen process for steelmaking, special presses and shuttleless looms for weaving - found support for the 'accelerator' theory of investment (i.e. increase in demand draws investment in new productive capacity) as opposed to the 'vintage' model (i.e. with given demand, new processes will be introduced more rapidly in firms with old rather than new capital equipment, because replacement of equipment is more urgent for the former). Capital availability is an important factor in adoption. The presence of international contacts had some importance in explaining the diffusion of shuttleless looms and special presses: firm size was important in the diffusion of the presses but not the looms. Attempts to categories 'management aggressiveness' as opposed to 'passivity' did not show a differentiating relationship with diffusion: other attempts at measuring and relating management and organisational attitudes were also unrevealing.

Hufbauer (1966) - studies of export shares for plastics and synthetic rubbers and man-made fibres - found that the initial technological and marketing advantages of being an early producer yield, in time, to stable scale economy advantages....."although many developing nations have lowered their lags relative to the advanced countries, their export shares have failed to grow because North America and Europe have exploited the advantages attending size".

Tilton (1971) - studies of the imitative lags in the semiconductor industry of Britain, France, W. Germany and Japan relative to the U.S. (via regression analysis) - found these lags were considerably greater than zero and that only Japan has managed to reduce the lag during the ten years 1960-70.

Sean (1973) - study of synthetic rubber diffusion amongst a varied group of nations - found that the date of technology acceptance is explained by an awareness of foreign competitive threats and by the domestic market size. National rates of diffusion are significantly explained by the date of technology acceptance, the rate of growth of the domestic industry and the threat of imports.

Schott and Miller (1975) - studies of export shares to explain competitive positions in the LDPE cindustry (which is characterised by major process improvements) - found that imitative lag models (with varialbes accounting for process change decisions included) fitted the facts well.

Bar-Zakay (1974) - studies of technology transfer from the defence to the civilian sector in Israel, paying special attention to organisational factors - found that for successful transfer, organisations should prepare technology specifications and accept recipient personnel for work, as well as allow 'donor' workers to work at recipient organisations.

Spencer and Woroniak (1967) - studies in Japanese industry of the mechanism by which adopters became aware of technological innovation - found that the growth of output of manufactured goods connected with advanced technology is closely related to the nation's own planned predetermined allocation of resources and the import of technically advanced raw materials and machinery. Japan's absorbptive capacity' appeared to depend upon national educational and technical levels, science and research efforts, foreign contacts and government policies.

Woroniak (1970) - studies in W. Germany of the same factors - found the absorbtive capacity depended upon international liquidity, foreign contacts, school expenditures and engineering imports (used as a measure of the technological level of the economy).

Barquin (1973) - studies of Latin American countries and their potential for developing a computer industry - attempts to predict potential using economic, educational and technological statistics which he argues are the determinants of this potential.

Bernhardt (1970) - study of catalytic techniques in medium size petroleum-refining firms.

and Sutten (1975) - study of third generation computers - found that uncertainty regarding an innovation is a major determinant in the transfer process.

Bundgaard-Nielson and Fiehn (1974) - study of catalytic reforming processes in the U.S. petroleum industry - found that the firm's technological background, strategic pressure and size are related to diffusion.

Lakhani (1975) - study of petroleum refining - found that the greater the percapita expenditure on water pollution in a state, the faster the diffusion of hydrocracking technology in private firms within the state.

Globerman (1975) - study of the carpet-making industry - found that differences in demand elasticity between the U.S.A. and Canada partially explained the lag in Canadian adoption of the tufting process.

Ettlie (1973) - studies of successful utilisation of numerically controlled machinery in Chicago firms - found that the shop floor location of the machines, the degree of commitment to NC machinery, the sophistication of programming, the selection of machines based on tasks rather than vice-versa, employee training, a history of exposure to NC machinery, and internal communications were all associated with successful utilisation.

Radnor, Rubenstein and Tansik (1970) - found that the urgency of the problem to which the technology is related will have a significant effect on the firm's willingness to adopt that technology (cf also Knight 1967). The availability of financial and personnel resources is dependent upon top management support for the project and organisational and external environmental conditions, and is related to the degree of implementation.

Denver Research Institute (1970) - studies of NASA 'Tech. Briefs' (descriptions of NASA technologies that might be adopted for commercial and other use) - found that the more mature the technology, the more likely new technology will find acceptance.

Clarke (1968) - studies of liquid propellant rocket engines

Knight (1963) - studies of digital computers

- found that the history of innovation in these technologies consisted of a number of small, discrete innovations, that many of the improvements in performance occurred as the sum of numerous routine production and engineering innovations and that more minor innovations occurred than radical ones: this again relates adoption success to technological maturity.

Nelson, Peck and Kalacheck (1967) - found that the state of the scientific base was related to the capacityto achieve technological advancements and thus to the potential for adoption success.

Stewart (1969) - found that transfer of technology is affected by the scale of investment: management tends to be more conservative about incorporating new technology from the laboratory or from external sources when the investment is large. Top management can work to overcome resistance to innovation through its control of departmental funding and the organisation's reward mechanisms.

Rogers (1962) - found that the quality of information received from the source about the innovation will affect the degree of success of adoption. The financial position of the potential user affects the adoption decision: wealth and innovativeness are related.

Holloman (1966)
Kimball (1967) - found that one of the primary limitations on an organisation's ability to innovate is the absence of people with adequate technical knowledge and a broad enough technical viewpoint to ensure the success of the innovation.

March and Simon (1958) - found that the extent of top management involvement affects the innovation process in several ways. It influences the institutionalisation of innovation, the mechanisms of communication and coordination and the time pressure for completion of an innovation.

Guetzkow (1967) - found that the existence of organisational 'slack' provides an increased capability to absorb error and a noticeable ethos for risk-taking.

Carter and Williams (1959) - found that 'technical progressiveness' is related to the general quality of the firm, and attention to other aspects of this quality - e.g. management efficiency, salesmanship, market research - helps to create the conditions for technical progress.

Barnes (1960) found that organisations differ, particularly along the dimension of open/closed systems, in providing adequate environmental arrangements to facilitate achievement of 'organised efforts' to adopt new technology.

Burns and Stalker (1961) - studies of the electronics industry in UK - found a dimension of organic/mechanistic organisation which characterises the flexibility within the system. In general 'organistic' systems are effective for uncertain tasks and environments whereas 'mechanistic' systems are effective for stable and programmed activities and environments.

Lawrence and Lorsch (1967) - studies of product innovation in plastics and other industries - found support for Burns and Stalker's work and that the mechanisms for conflict resolution are important in determining the relative success or failure of comparable firms to innovate. In particular, confrontation was used to a significantly greater degree and 'smoothing' to a lesser degree in high performing organisations than low performing ones.

Barth (1970) - studies of communication among task-interdependent Research and Development groups - found that modes of conflict resolution affected the communication process and indirectly the adoption process.

Ozanne and Churchill (1968) - studies over five years of the industrial adoption process - found that a decision-making group is the most likely unit of adoption in the diffusion of industrial innovations.

Wright (1969) (118) - found that the adoption of process innovations was more heavily influenced by technical than business factors.

Chakrabarti and Rubenstein (1976) - studies of NASA innovations and their diffusion - found that top management interest was important in the produce cases only and that the success of process innovations was dependent upon the quality of information and the specificity of relationship between the technology and some recognised existing problem.

Hayward, Allen, Masterson (1976) - studies of flour-milling industry in UK - found that the perceived characteristics of innovations (trialability, cost, advantage etc.) may be correlated to the time taken for them to diffuse throughout an industry.

Globerman (1976) - studies of diffusion in the Canadian tool and dye industry - found that in spite of close industrial ties with the USA, over a reasonably similar period, the rate of diffusion in the US industry was four times that of the Canadian one.

Hayes (1974) - studies of competitive pressure in the computer industry in Europe and USA - found that the European industry was under strong pressure to merge across national boundaries in order to create one or several large firms, to drastically reduce costs and standardise product lines and to compete more vigorously on the basis of services aimed at specific customer requirements.

EXHIBIT 30 : SAPPHO Project - Factors in Success vs Conventional Wisdom (based on Science Policy Research Unit report)

Conventional Wisdom	SAPPHO Finding
1. Managers are well aware of user needs and take great care to ascertain them before committing funds or launching new products.	1. Managers frequently ignore user needs, do little or no market research or disregard its findings. Commonest contribution to loss.
2. Large-corporation management is almost always able to plan new-product launch and through marketing power, etc. ensure a satisfactory degree of adoption.	2. In the capital goods industries no firm is normally able to impose its plans on the market. A smaller firm which has grasped customer requirements better will beat a larger firm. Without competition there are failures by large corporations.
3. The small firm will usually be more efficient at invention and innovation than the large because of easy communications, single-minded effort, and whole-hearted commitment of the entrepreneur.	3. Size of firm does not appear to affect the outcome of competitive innovation. Size of project team is associated with success, whether committed by larger or smaller firm.
4. Successful innovation depends on good Research and Development project evaluation and control, with appropriate incentives for project engineers and scientists.	4. Innovation success bears little or no relationship to the method of project evaluation and control, and none at all to formal incentives. Success is closely related to the power, responsibility and experience of the business innovator.

Conventional Wisdom	SAPPHO Finding
5. Successful innovation depends on younger, more enthusiastic product champions, more ready to reject established ideas and structures and take bigger risks.	5. In the chemical industry the successful business innovator is usually more senior, has more experience and has been longer with the innovating firm than the unsuccessful. He is usually older. There is no clear association between change in the management system and innovation success. In the instrument industry, although success is also associated with power and experience, including experience abroad, successful innovators were often younger and had been a shorter time with the firm.

(6) Models of the innovation process

Arising from the large number of general studies discussed here, and those carried out in allied disciplines, a number of theorists have proposed models to account for aspects of the innovation process. These can be conveniently divided into macro- and micro-level ideas, the former attempting to generalise about the whole process and the latter about some detailed element within the process.

(a) Macro-level models

Economists tend to be interested in the way innovation relates to overall development and a large number of models have been proposed. Schumpeter introduced a two-phase model derived from Ravenshear (1908) in which a distinction is drawn between technological change, which 'sets the direction which development will take' and technical change which 'establishes the rate at which it will proceed'. In Schumpeter's terms, α-phase innovation is of the 'quantum jump' variety, a leap or discontinuity which establishes a new production function changes the course of development irrevocably, needs high levels of creativity and is ultimately understandable only with hindsight. β-Phase innovation is multiple and small, each change arising from its predecessor and determining its successor. It moves along a theoretical production function to make it a reality, determines the rate rather than the direction of change, requires less creativity and is ultimately as economically important because it optimises scarce resources.

Schmookler's more recent studies of patent statistics led him to generalise about the economic role of innovation: Exhibit 31 gives a simplified version of his model. Langrish et al (1972) indicate a series of models (such as need-pull, technology-push etc.) which had been proposed as descriptive of the innovation process: their study did not give strong support to any of these except the market-pull model.

Exhibit 32 indicates a different approach due to Cadwallader : this is illustrative of the abstract models developed by systems theorists and based on cybernetics. Innovation here is viewed as an adaptive device: Mumford and Pettigrew modify this model to indicate that innovation as adaptation applies equally well to the social systems involved.

EXHIBIT 31 : Updated Version of Schmookler's Project Model

(arrow indicates 'determines')

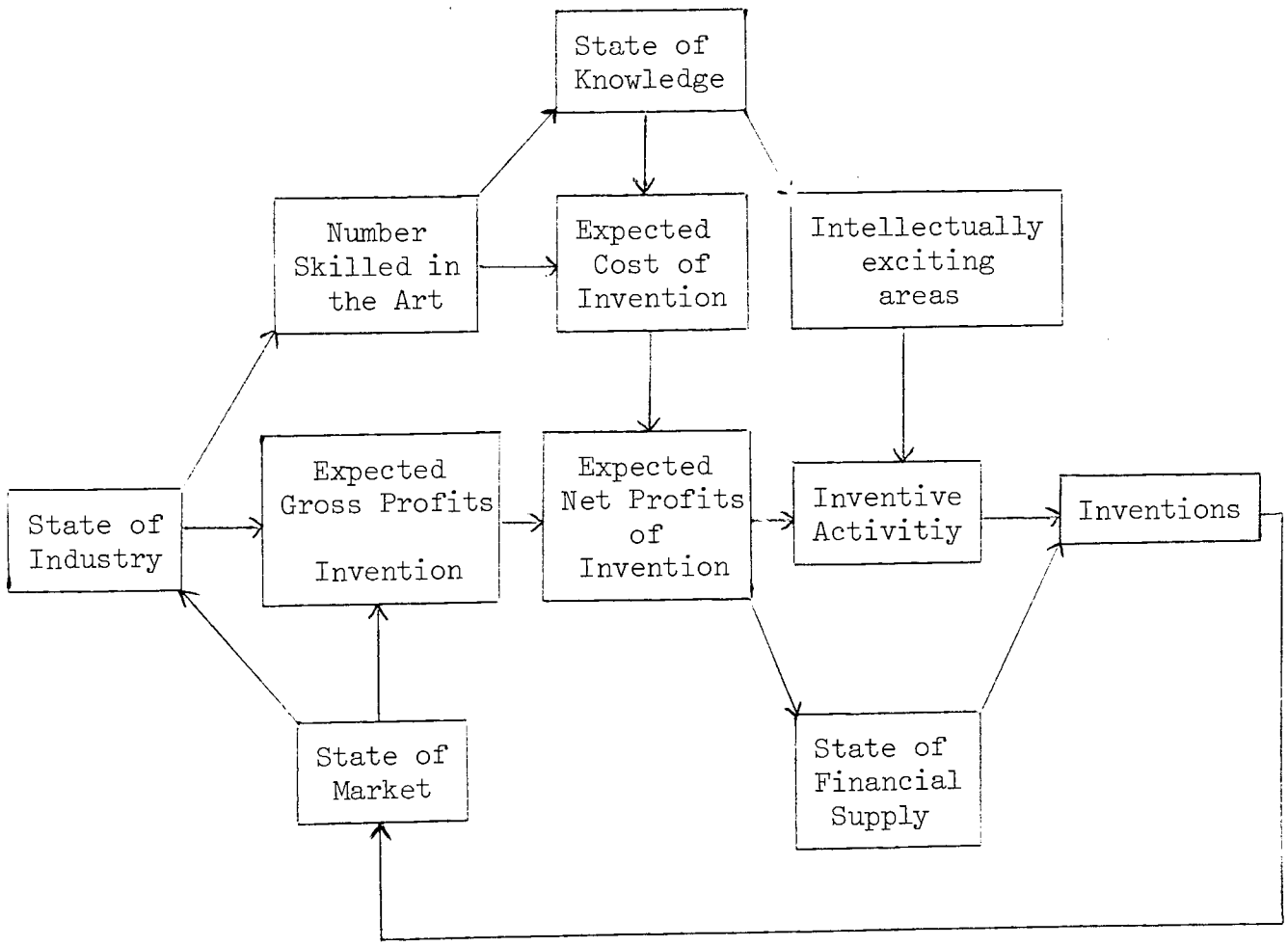


EXHIBIT 32 : Cadwallader (1969) Cybernetic model of organisations and innovations.

- the rate of innovation is a function of the rules organising the output of the system.

- the capacity for innovation cannot exceed the capacity for variety or available variety of information.

- the rate of innovation is a function of the variety and quantity of information.

- a facility mechanism for forgetting or disrupting organisation patterns of a high probability must be present.

- the rate of change for the system will increase with the rate of change for the environment.

Mumford and Pettigrew (1975) Sociological interpretation of this

- the rate of innovation is a function of the ability of the people concerned with it to accept and to adjust to it.

- the capacity for innovation cannot exceed the knowledge and learning ability of the people concerned.

- the rate of innovation is a function of the variety and quantity of information and of the willingness of people to search out and use this information.

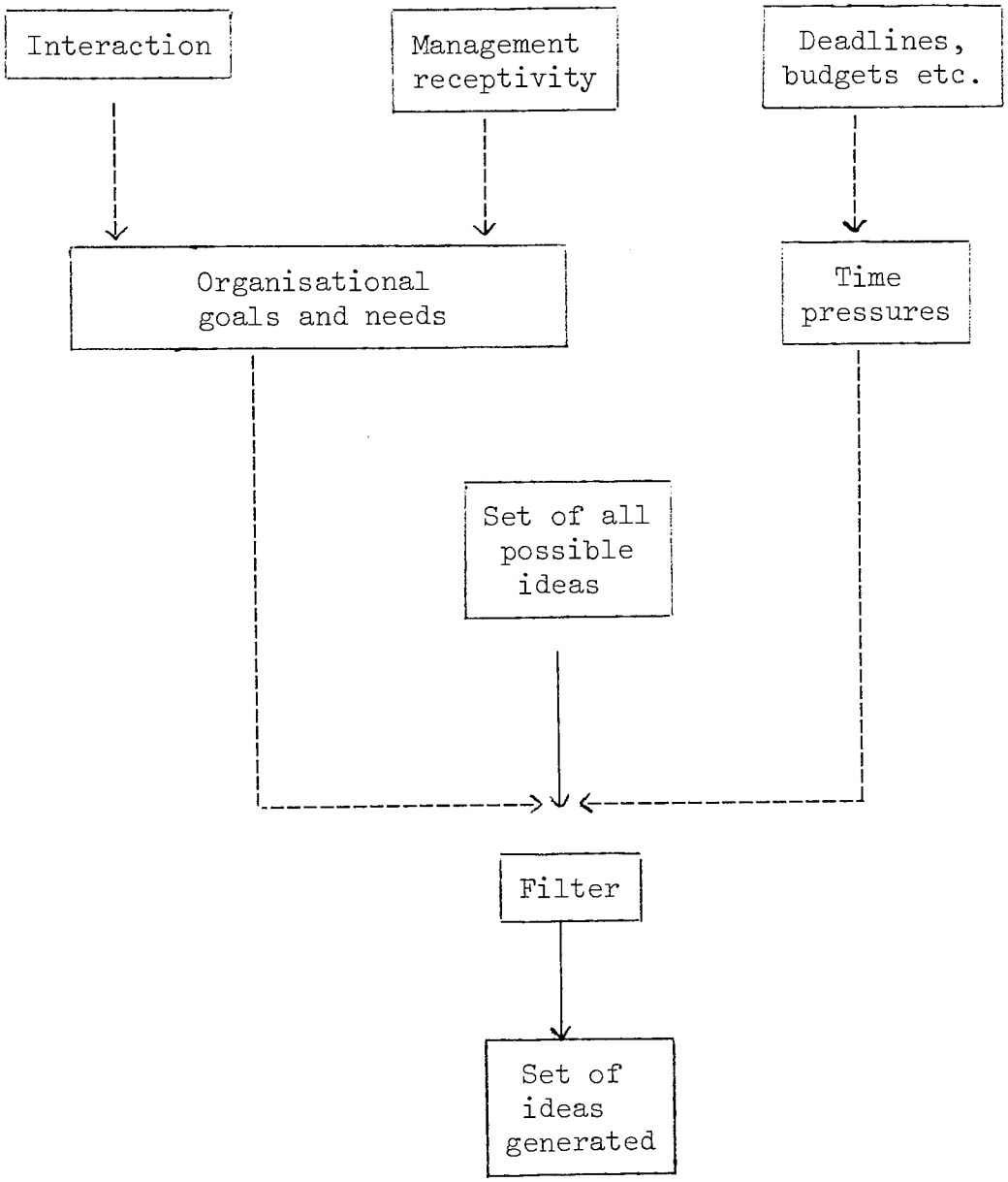
- people must be willing and able to change old ways of doing things.

- the rate of change for the system will increase with the rate of change for the environment, providing the people in the system are prepared to recognise and respond to the environment.

(b) Micro-level models

Many theorists are interested in the way in which innovation synthesises needs and means by a search mechanism: Knight's model has already been described. Rubenstein et al, as a result of their extensive research programme at Northwestern University have developed an idea flow model which relates to perceived needs and means (Exhibit 33). Allen and his associates at MIT have carried out extensive work on communication patterns and information flows during the preparation of innovation proposals in Research and Development: the major contribution of this work has been to identify the role of the informal structure in communication and, in particular, the role of certain key personnel who act as filters. He calls them 'technological gatekeepers' and relates this phenomenon to the two-step flow model involving opinion leaders which was first postulated by Katz and Lazarsfield.

EXHIBIT 33 : General idea-generation flow model linking perceived needs and means (Rubenstein et al 1967).



Adoption models abound in the literature: Exhibit 34 indicates some specific types identified and described by Ross (1974) Katz, Levin and Hamilton (1963) . identify seven key elements which must occur in any model of the adoption and diffusion process. These are the acceptance over time of some specific innovation by individuals, groups or other adopting units linked to specific channels of communications to a social structure and to a given system of values or culture. The similarity of this model to the Rogers and Shoemaker (1971) one is apparent.

At the individual level, Barnett (1953) . developed a model incorporating six sequential stages: configuration of idea, recombination, identification of relevant new ideas, substitution of old ideas, discrimination between different ideas and final evaluation of losses and gains associated with the different ideas. The main feature of interest here is the influence of emotional, and consequently irrational, elements of the individual's psychological process in innovative behaviour. Acceptance of an idea is based on its perceived superiority to other available ideas, and is related to individual needs.

Foster (1962) follows a similar theme, arguing that 'people often are unwilling to change their ways because of cultural and social and psychological factors'. He views economic gains and competitive pressures as the main motivating devices for innovation.

Such an approach assumes a strong element of rationality and relates well to the decision-making approach used by many writers and described by Rogers and Shoemaker's (1971) paradigm (discussed earlier). Decision theory runs developed from Taylor's (1965) 'economic man' acting under conditions of certainty to the Carnegie school's approach (Simon et al 1957) which attempts a more realistic approach, based on the concept of 'bounded rationality'. 'The capacity of human mind for formulating and solving complex problems is very small compared with the size of the problems whose solution is required for objectively rational behaviour in the real world'.

Support is thus strong for the Rogers and Shoemaker model which incorporates innovator and adopter cha·acteristics and is essentially subjective in nature. Witte (1976) has carried out extensive research on the 'promoter' phenomenon (also reported by Geshka et al (1976) : this is an extension of the product champion/top management influence idea. His two-centre model suggests that there are five possible 'promoter structures' and these are related to the adoption success: these are

- no promoter
- knowledge (fach-promoter) only
- power (machpromoter) only
- key individual combining both functions
- tandem teams of mach and fach promoters.

At the organisational level, Gruber and Marquis (1969) suggest a model based on sequential probabilities of success in stages such as research, development, production, marketing etc.: Schon (1967) has a similar approach based on studies of product design processes.

The key element here is the need to dismiss as myth the 'rational' view of innovation as 'an orderly, goal directed, risk-reducing process': there is a constant interaction between 'need' and 'technique' which varies in character and with the necessary component uncertainty. Myers and Marquis (1969) attempt to develop a problem-solving approach to their model, in which the decision process for adoption involves consideration of

(i) the estimated probability of technical success
(ii) the estimated cost of development
(iii) the estimated time for development
(iv) the estimated probability of commercial success
(v) the estimated return to the firm if successful

Chakrabarti (1973) argues that there are six factors which are important to understanding and modelling the adoption process in organisations: these are:-

- organisations are viewed as open systems in their behaviour.

- innovation in organisation involves the environment as well as the members of various subsystems within it.

- decision for innovation (i.e. adoption of a new technology, either new product or new process) should be viewed as an investment decision.

- the characteristic of an innovation decision vis a vis an ordinary routine investment decision would be in the difference in handling the uncertainty associated with the innovation. (A distinction should be made between risk and uncertainty. Risk means the case where one knows the probability distribution of the outcomes of the action, whereas uncertainty denotes the condition where one does not have a probability distribution for the outcomes).

- organisations vary in their capability for handling uncertainty either by institutional arrangement and/or by their member characteristics.

- economic, social and psychological factors influence innovative behaviour in organisations.

Mohr (1969) also suggests a model based on overcoming resistances: he suggests that 'innovation is directly related to the motivation to innovate, inversely related to the strength of the obstacles to innovation and directly related to the availability of resources for overcoming such obstacles'. The model is essentially multiplicative, and sees innovation as a function of motivation and the balance between obstacles and resources.

Atkinson (1957) has a model of risk-taking behaviour in terms of individual psychology, whilst Dickson (1977) attempts to interpret this process statistically: this is in keeping with many decision theorists, e.g. Slovic and Lichtenstein (1968) . The central issue here is one of expectancy as the key factor in the adoption decision. Child (1973) examines this notion in terms of political rewards and costs.

EXHIBIT 34 : Some models of innovation adoption (Ross 1974)

(a) 'strong leadership' model - adopt innovations under the direction and insistence if necessary, of the administrative or functional head of the target organisation.

(b) rational change/management by objectives model - adopt innovations by

(1) having the target organisation sense problems or needs,
(2) develop alternative solutions
(3) evaluate alternatives using specified criteria
(4) select and adopt one alternative
(5) follow up to observe achieved results.

(c) response to need/squeaking wheel' model - adopt innovations only after a need or problem located either in the market or in the organisation itself, is clearly recognised: then tailor the innovation to the need.

(d) internal change agent/organisation development model - adopt innovations as a consequence of the active influence of one or several people working in the target organisation who facilitate communication and group attention to group objectives, acting in self-conscious and socially recognised ways, to produce continuing attention to adoption of a particular innovation or of innovations in general.

(e) adopting competitive practice/'lighthouse' model - adopt innovations by observing a demonstration in a similar organisation, then modify or copy it for use in the target organisation: cause target organisations to adopt innovations by demonstrating the innovation in actual operational use.

(f) 'outside agent' model - adopt innovations by creating an agency outside the target organisation whose special role is to introduce innovations, usually through consultative practices or through the requirements of law or other regulation.

(g) incentives for change model - adopt innovations by offering financial support of a temporary or continuing kind on the condition that the target organisation adopts a specified innovation.

Following Rogers and Shoemaker's model of communication of innovations, Exhibit 35 indicates how some of the characteristics might affect the positive or negative outcome of the innovation.

(a) Model of communication of innovations

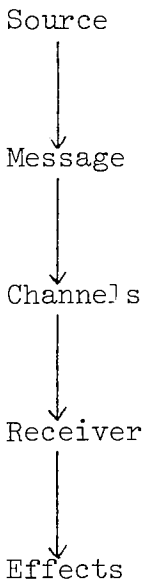


EXHIBIT 35 : Negative and positive characteristics in innovation communication.

Sender:	
company objectives unclear	company objectives clear
no clear role obligation	clear role obligation
primary receiver poorly defined	primary receiver clearly defined
negative self-image	positive self-image
lack of receiver support	definite receiver support
'distance'	'closeness'
without warning	prior intimation
technical uncertainty	technical assurance
low situation relevance	high situation relevance
inadequate preparation	careful preparation
inadequate grasp of potential	clear perception of potential
prior failure	prior success
low peer support	high peer support
technical incompatibility of scheme	technical compatibility of scheme
fear of exposure, convention-breaking, ridicule	self-confident
low motivation	high motivation
Transmission:	
inadequate channel, poor usage	adequate channel, good usage
wrong mode, style	correct mode, style
misfit between verbal and non-verbal elements	match between verbal and non-verbal
high physical noise	low physical noise
lack of shared concepts, language	shared concepts, language
poor feedback high message uncertainty	good feedback, low message uncertainty
unsuitable timing	suitable timing

Primary Receiver:

apparent irrelevance, lack of situation fit
complexity
lack of appeal in general
pressure of current work, overload
low technical interest
apparent unworkability, incompleteness of data
apparently irrational, strange, lacking credibility
from 'wrong' person, lacking personal support
prior failure through listening
desire for quiet life
fear of failure, exposure, ridicule
lacking curiosity
tired, under stress
highly specialised
narrow information intake normally
many and variable predispositions

apparent relevance, situation fit
simplicity
'eye-catching'
relates to current work interests
high technical interest
apparent workability, good data
clearly logical, familiar credible
from 'right' person

prior success through listening
willingness to try anything
self-confident
high in curiosity
fresh
generalised background
cosmopolite
few and predictable predispositions

Advantage/interest:

inadequate profitability
high demand for resources
company need unlcear, low significance

much time required
technically difficult
involves other commitments
unfashionable
low personal identification, achievement
low apparent fit with company objectives
little search made for alternatives
poor prior evaluation
mismatch between initial proposal and decision-maker

need for forced vote and narrow majority
low trialability
complete package requirement
mismatch with top management demands
unacceptable level of overall uncertainty
inadequate analysis of uncertainty, use of date
incommunicability of uncertainty
unfavourable potential consequences
lack of resources

high profitability
low demand for resources
clear company need, high significance
low time required
technically acceptable
'free-standing'
fashionable
high personal identification success
good fit with company objectives
good search made for alternatives
high quality prior evaluation
match between initial proposer and decision maker as well as intermediary
consensus possibility

high trialability
piecemeal approach possible
match with top management demands
acceptable level of overall uncertainty
uncertainty analysis, with with data use
communicability of uncertainty
lack of unfavourable consequences
resource availability

(7) Reservations and limitations

This chapter has attempted a brief overview and summary of the current state of knowledge about the process of technological innovation. Inevitably there have been many attempts to generalise from this information but recent discussion (Utterback 1975, Downs and Mohr 1976, Rothwell 1977) suggests that any conclusions drawn need to be carefully qualified.

The argument is essentially on a conceptual level: Downs and Mohr identify factors which they consider to be key sources of inherent 'instability' in the body of data on innovation. These are:

(a) variations among primary attributes

(b) interaction

(c) ecological inferences

(d) varying operationalisations of innovation

They suggest that until research designs take these factors into account, it is impossible to arrive at a general theory of innovation. The alternative is to reject the notion of a unitary theory and postulate a series of distinct types of innovation, each characterised by a separate theory. (Rowe and Boise 1974) . These theorists may include different variables or they may contain the same explanatory variables while positing different interrelationships among them and different effects upon the dependent variable.

Taking their four categories individually:-

(a) variations among primary attributes - primary attributes of innovations are held to be those which place an innovation in the same category irrespective of the size, wealth, structure, complexity etc. of the organisations involved. By contrast, secondary attributes are those in which classification requires that organisational factors be taken into account.

The consequence of this for innovation theory is that if the variations observed in the research findings were of primary attributes, then a whole series of theories would be required to account for this. However, nearly all studies reported have tended to be based on secondary attributes and so it is possible to accept the often significant variation between them.

A similar typology can be applied to other units in the process e.g. attributes of innovators or adapters

(b) They suggest that one way of coming to terms with the problem of interaction of secondary attributes is not to think of them as composed wholly of the characteristics of the innovation or the organisation but as characterising the relationship between them. From this perspective, secondary attributes can be viewed as variables that characterise the circumstances surrounding a particular decision to innovate rather than complex interactions.

(c) ecological inferences - many studies have employed the strategy of treating a whole series of innovations as an aggregate in an attempt to increase the reliability and generalisability of the findings. However, the flaw in in this argument is that the inference from the collective or ecological level to the individual may be biased or variable. Such a fallacy will occur when the independent variable in the study is a secondary attribute, i.e. one whose value differs from one innovation to another.

(d) variable operationalisation of innovation - this element of instability arises because measuring innovation has tended to focus on certain aspects only. For example, the adoption process can be seen as involving a first adoption or use (or a rejection) or can be seen as having degree and extent over time: the latter is far more difficult to measure and is consequently rarely used. Yet this operationalisation may in fact be more meaningful in terms of clarifying certain aspects of adoption behaviour. They suggest that, in cases of this kind, it would be wise to conceive of the two operationalisations as two different behaviours to be explored. As they rightly point out, 'if one attempts to ignore the instability and generalise impressionistically about the impact of a specific variable across a number of studies that operationalise innovation differently, the result will be an unenlightening average that would depend on the proportion of studies having employed each operationalisation'.

From their accurate criticism of the present state of innovation research, they have developed a series of guidelines for future work.

(i) use studies of different innovations to expose the impact of primary attribute variations on models of innovation. This will involve observing and reporting the primary attributes of innovations and restricting generalisations from a given study to innovations in the same category of a primary-attribute typology rather than expecting all results to be identical.

(ii) measure the secondary attributes of innovation with respect to each organisation and consider them as characteristics of adopters.

(iii) use interactive models.

(iv) do not conduct multiple innovation studies in which the organisation is assigned on aggregate score for innovation.

(v) recognise that extent of adoption and time of adoption are distinct conceptualisations of innovation. Do not generalise from one dependent variable to the other. Do not use either as a comprehensive measure of innovativeness. There is not a single, unitary theory but rather different theories to explain different aspects of innovation.

(vi) study the adaptability of innovations by using either many innovations in relation to one single organisation or by using the innovation-decision design.

Rothwell (1977) echoes many of these points in his comments on the limitations of past innovations studies. His criticisms are as follows:-

(i) most studies have concerned themselves with project execution varialbes whereas success/failure may also be associated with project selection variables.

(ii) the measures considered in most innovation studies refer almost exclusively to endogenous factors and exogenous factors such as the role of external legislation, competition etc. are rarely examined. This is likely to present a biased view of the innovation process.

(iii) the results of most innovation studies tend to be presented in the form of a series of horizontally linked areas, usually of specialist competence. Whilst vertical links, such as the management role, may be implicit in these explanations, it might be of more value to specify these in an explicit fashion.

(iv) most studies have been of major innovations and, with some exceptions, the field of incremental innovations has been largely unexplored. Evidence indicates that not only does the cumulative effect of these play a major role in innovation impact but that the circumstances surrounding their generation may be different to those for major innovations.

(v) the cross-sectional studies reported indicate a wide variation in success/failure factors for different industries. The implication of this is that future studies should not cast the net too widely and that in-depth sectorial studies would appear to promise to yield the potentially most meaningful results.

(vi) it may be valuable to construct a structural typology in examining the results of studies - e.g. multi-level analysis of within-firm characteristics, firm behaviour variables and manifestations and results of firm behaviour. This distinction is important from the policy viewpoint since the levels are associated with different spans of change.

Utterback (1975) also makes a number of points which are similar in nature, notably:-

- many generalisations are drawn from small, unrepresentative or incomparable samples.

- the retrospective nature of nearly all the sources probably means that the process has been viewed as much more rational and well-ordered than it is in fact.

- definitive answers will require experiments in the field.

- these promise to yield valuable information beyond that available from largely historical sources.

Fischer (1976) comments 'what would appear useful is the consideration of behavioural, social and political variables as well as economic variables in refining diffusion models'.

These authors all lay out some telling criticisms of the way in which the process of technological innovation has been studied in the past. The suggestion is that, despite the vast range and number of studies carried out by many different interest groups, the actual sum of our knowledge about the process is still limited and rather too vague and general to be of any great practical value.

Models and theories of innovation can give rise to prescriptive recommendations, as with Project Sappho, for example. The problem is that specifying factors like 'good internal communication' or 'good integration and development' as being associated with innovation success is of little practical use unless information is also available as to how one achieves or measures these, how it relates to innovation, how it matches up with other potentially conflicting demands in the organisation etc.

For this reason, it is suggested that there is a gap in the literature and state of knowledge about the innovation process. The research reported elsewhere in this thesis represents an attempt to investigate this area using the recommended approach of detailed case study.

Exhibt 36 indicates some typical areas of concern in this research.

EXHIBIT 36 : Some areas of concern and interest in the innovation process.

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inadequacy in respect of market (customer linkage; market/R&D linkage; uncertainty)

motivation

objectives

organisation (communication; cooperation; coupling; group size; information; speed)

potential (recognition of)

psychology

resources (availability in general; finance; people; production; R&D)

style

support (acceptance of responsibility; resource provision)

technology (methods of attack; product back-up; product exploitation; product obsolescence)

understanding of innovation process

Specific complaints:

market:	inadequate understanding of customer/user problems, initial adoption
	insufficient emphasis upon value to customer, back up
	lack of need
	unattractively small market
	uncertainty with monopsonistic buyer
	unattractive level of competition
	lack of marketing capacity/expertise
	lack of market/technology match
motivation:	company practices inimical to motivation
	organisational structure unsuitable
	management style out of tune
	objectives not clear, not understood
	personnel selection incorrect
	professional n Ach low

Communication/cooperation/information:

absence of 'gatekeeper'
availability of information inadequate
fragmentation of work
secrecy
need to cross departmental boundaries, associated company boundaries
lack of source credibility (N.I.H., I.H., standing, etc.)
'coding'/perceptual differences, leading to resistance

Resources:

information on resources inadequate (e.g. finance)
shortage of skilled personnel (marketing, production, R & D.)
lack of capacity (marketing, production, R & D.)
lack of R & D. finance; cost escalation

Technology:

inadequate methods of attack; obsolescence of new products
other technology insufficiently developed
product exploitation technology needed

CHAPTER 3 : Theoretical Orientation

From the discussion in the preceding chapter, it is clear that there is a lack of detailed information about the industrial innovation process. In particular, whilst there are a number of clear recommendations as to the effective management of innovation (e.g. in the SAPPHO and OECD reports), there is little reported on the way in which these conditions can be brought about.

This chapter attempts to look at influences acting on the process, at least as far as they are covered in the literature. A three-level model of individual, group and organisation activity is developed. (The arbitrary nature of this split is acknowledged; considering the environment as well would be too large an undertaking for this chapter. Equally, there will be considerable overlap between levels). Exhibit 1 presents this model.

Analysis is carried out on the basis of structural, environmental and contingent factors. By contingent is meant those factors on which behaviour will depend but which will vary in a number of different ways. Strategies for coping with and improving the situation are then considered.

The chapter is organised according to the following system.

Section (1) Individual-level influences

- structural factors
- environmental factors
- contingent factors
- coping strategies
- improvement strategies

Section (2) Group-level influences

- structural factors
- environmental factors
- contingent factors
- coping strategies
- improvement strategies

Section (3) Organisation-level influences

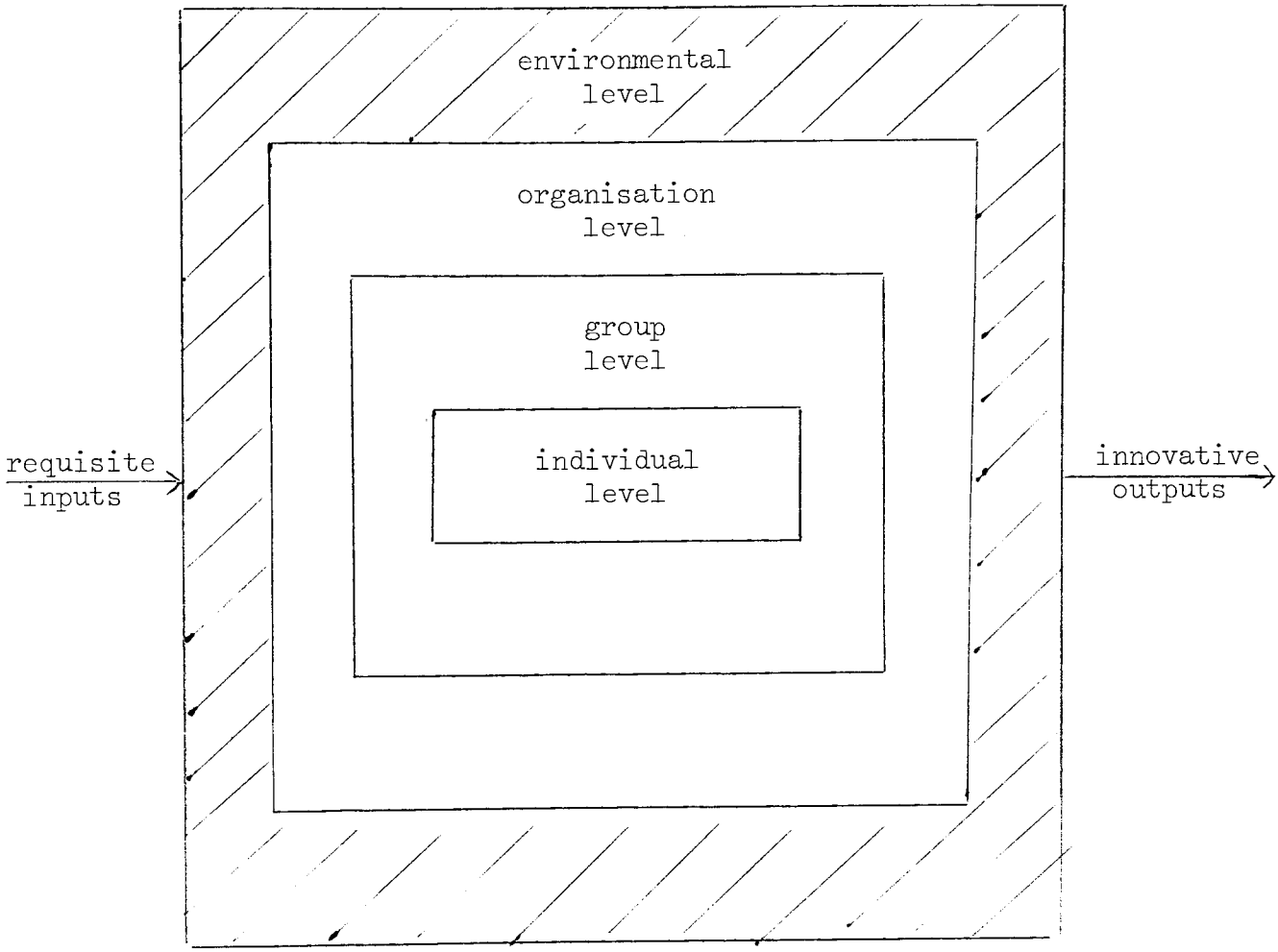
- structural factors
- environmental factors
- contingent factors
- coping strategies
- improvement strategies

Section (4) Management of innovation

Section (5) Critical review

The word 'innovation' poses some semantic difficulties since it is commonly associated with change of various kinds. For the purposes of clarity, it will be taken to mean technological change only; all other forms of change - structural, social, behavioural etc. will be otherwise identified.

EXHIBIT 1 : Possible range of influences on innovative performance



(a) individual level

- structural factors (psychology, personality, strengths and weaknesses etc.)
- environmental factors (formal and informal position, interrelationship with other individuals etc.)
- contingent factors (nature of task, demands, skills and experience, motivation etc.)
- strategies for coping
- strategies for improvement

(b) group level

- structural factors (size, composition, status distribution, state of development, personal characteristics, communication patterns etc.)
- environmental factors (physical setting, functional position, interrelationship with other groups etc.)
- contingent factors (task nature, demands, skills and resources, motivation, leadership etc.)
- strategies for coping
- strategies for improvement

(c) organisation level

- structural factors (specialisation, hierarchy, differentiation, control, integration etc.)
- environmental factors (environment types, diversity, pressures and constraints etc.)
- contingent factors (size, technology, culture intensiveness, maturity, etc.)
- strategies for coping
- strategies for improvement

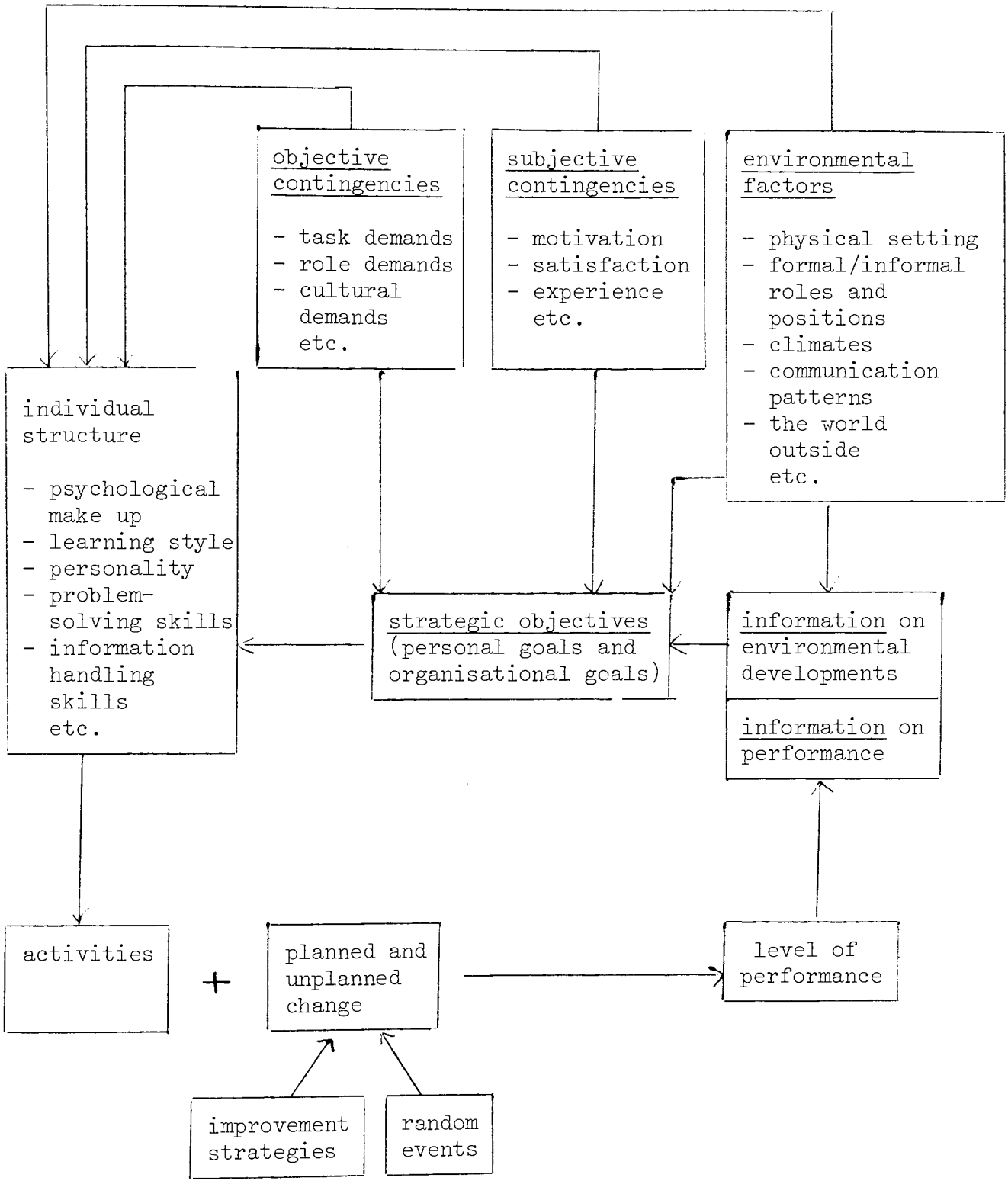
Section 1 - Individual Level Factors

Technological innovative activity within organisations depends upon the contribution of individuals; either in a direct creative capacity or in progressing ideas into practice, taking decisions, providing intelligence as to market needs etc. Consequently an understanding of dominant influences on individuals concerned with innovation will be of value.

Exhibit 2 presents a diagrammatic representation of the approach adopted in this section. The individual's internal elements - his psychological make-up and the way he tackles problem solving, responds to new ideas, etc. are discussed first. Environmental factors, including his formal and informal roles, relationship to the communication structure, to other people, to the physical environment etc. are then considered. Contingent factors are examined in two categories - those related to the individual and those related to his job. In the former case, variables will include his motivation, his responses to the organisation, his propensity to take risks etc. whilst the latter include the special demands and constraints which the task imposes.

Strategies which individuals use to cope with these contingencies and to achieve their goals are then discussed. Finally an indication of the ways in which planned improvement can be attempted is given here.

EXHIBIT 2 : Individual Level Influences Model



(a) Structural Factors

(i) Problem-solving activities: the early stages of the innovation process are concerned with invention and development; these involve different kinds of information-processing and problem-solving behaviour. A brief description of these mechanisms in individuals is offered here.

Extensive psychological research has been carried out in this area; Gregory (1972) lists several theories of mechanisms to account for creative behaviour (Exhibit 3). He suggests a classification into intellectual and motivational categories. Not all of these are amenable to testing, but evidence supports some of the later models, particularly of the information-processing variety. The ideas of Guilford (1959, 1963) based on a multiple-trait approach are of interest since they suggest the existence of convergent and divergent thinking; other factors such as perception sensitivity and analysis are significant. Rickards and Freedman (1978) also mention concepts such as association of elements into new combinations (Mednick 1962), the moment of insight (Wertheimer 1968) and the mediation of preconscious processes (Kubie 1958).

Cybernetics and information science have attempted simple analogues to the human brain; studies in this field are concerned with associative and multiplicative/

/models of creative mechanism. (Newell et al 1972).

The notion of 'sets' or frames of reference is common to many writers, e.g. Bruner (1956). When applied to a theory of problem-solving in organisations, it gives rise to the model unit used by March and Simon (1958) for individual behaviour; 'a choosing, decision-making, problem-solving organism that can do only one or a few things at a time, and that can attend to only a small part of the information recorded in its memory and presented by the environment'.

They consider human information-processing as a key element in their study. The effects of 'nature' and 'nurture' are offered as conditions which account for the behaviour of an organism at any interval in time, and predispose the internal state for the next. The part of memory involved in influencing behaviour at any instant is the evoked set; the pattern of evocation which causes changes in the content of memory is learning. Behaviour can thus be influenced by changes in memory content (learning) or by changes in the active determinants of current behaviour (evocation).

There is a similar division between relevant environment which produces stimuli to influence behaviour, and passive environment which has no effect.

Using this model, they identify two classes of problem-solving activity; 'reproductive' in that mental activity is of a relatively routine search type, and 'productive' in which creative search and solving procedures are used. This is similar to the distinction between invention and development problem-solving activity.

The central feature of the model (e.g. Newell, Shaw, Simon 1972) is that of cognitive limits to rationality. This suggests that when an individual is faced with a complex, unprogrammed situation he will tackle it by breaking it down into a number of sub-problems which he has a repertoire of responses and routines to solve. He will also tend to 'satisfice' rather than 'maximise' the outcomes.

Individuals vary in the approaches they use to problem-solving. Saward (1977) reports on individual style influences, specifically those associated with different roles in group problem-solving. He argues, following Bruner et al (1956) that individuals use past and current information (memory and evoked set) to establish expectancies. An individual's cognitive style may restrict his problem-solving flexibility, limiting him to reproduce existing ideas rather than explore novel ideas. Exhibit 4 presents Johnson's (1972) summary of problem-solving styles in individuals.

In general, problem-solving activity follows the paradigm of awareness and recognition definition, exploration, development of solution and implementation. Gregory (1977) suggests a model which introduces a problem-solving 'activity line' through this process. (Exhibit 5). He also indicates desirable personal features at various stages and possible improvement inputs; these will be returned to later.

EXHIBIT 3 : Theories and Mechanisms of Creative Behaviour
(Gregory 1972)

(a) intellectual

- remembering or copying the eternal 'form' (Plato)
- seeing resemblances maong a multitude of differences (Aristotle)
- inductive logic (Aristotle, Bacon, Mill)
- dreaming (primitive belief, Descartes)
- association (da Vinci, Hobbes, Locke, Hartley etc.)
- unconscious cerebration (Leibniz, Carpenter)
- imitation by transfer into new field (Tarde)
- 'cross fertilisation' by injecting more potentialities
- single intellectual ability (Spearman)
- structural organisation or 'Gestalt' formation (Wertheimer, Duncker)
- 'multiple trait' (Guilford)
- problem-solving of special kind (Newell, Shaw, Simon)
- information and communication theory approaches (Golovin, Brinkley)
- complex information processing (Schroeder,Driver, Streufert)

(b) motivational

- persistence
- intolerance of obstacles
- unconscious will (Boehme)
- neurotic behaviour
- psychoanalytic theories of replacement or compensation (Freud, Adler, Allport)
- 'instinct' of workmanship (Veblen)
- 'life force'
- response to challenge (Toynbee)
- response to stimulus (Watson)
- creative drive (Woodworth)
- need achievement (Maslow)
- need for order or urge for adaptive integration at high level (Barron)
- need and love for preconfigurative realisation and full configurative action (Chiselin)
- tension between the inner and outer environments (Rugg)
- multiple personality factors, with profile (Cattell)

(c) joint intellectual and motivational

- inspiration by god or muse
- the personal 'daemon' (Socrates)
- learning from master ('atelier' method)
- unconscious/conscious interaction (Cudworth)
- volition and chance association (Goethe)
- desire and imaginative association (Ribot)
- interaction between 'unconscious', 'preconscious' and 'conscious' (Platner, Goethe, Freud, Varendonek, Kris, Kubie, Rugg)
- work style (Gough and Woodworth, Sprecher, Taylor)
- leadership style (Owens, Andrews)

(d) chance

- early technological developments (Rossman)
- serendipity
- present-day scientific discoveries (Mach, Taton)

(e) impossibility of theory

- 'the creative act will forever elude the human understanding' (Jung)

EXHIBIT 4 : Problem-solving styles (Johnson 1972)

Style	Principal Findings
flexibility/rigidity (extent to which direction during problem-solving is varied)	1940s and 1950s studies indicate little generality of rigidity trait across problems. Cognitive flexibility is a more substantial factor; open-minded individuals are generally more effective problem-solvers than closed-minded (dogmatic) individuals.
information seeking (extent to which data is sought)	open-minded individuals are likely to seek more information (of a higher quality) than dogmatic individuals, who tend to 'protect information in order to maintain their belief system.
conceptual differentiation (extent to which relations between items are distinguished)	studies involving free-sorting tasks tend to indicate that individuals have generally a stable style of cognitive control, independent of general intelligence and ability to abstract.
reflective style (extent to which the rapidity of attack on a problem is varied)	this style is in part attributed to the control of impulsivity, which allows for inhibition of incorrect solutions and reflection over alternative possibilities Increased control over impulsivity increases generally problem-solving effectiveness.
cognitive complexity (extent to which the structures of a problem are distinguished)	no unitary factor of cognitive complexity has been identified. Rather it comprises several relatively independent conceptual dispositions, and is not the same as conceptual differentiation.
analytical field approach (extent to which individual problem elements are examined)	individuals who use this style tend to achieve a high performance on certain classes of problems.

Style	Principal Findings
abstract approach (extent to which a problem is examined independently of its attributes)	'abstract thinkers' have a more complex differentiated system of concepts for cetegorising data than 'concrete thinkers'. The latter tend to make absolute evaluations and have a greater need for cognitive consistency.

(ii) Adoption Influences

At the other end of the innovation process, there are influences relevant to the adoption process. As we have already seen, adoption depends on the perceived characteristics of the innovation, and the personality characteristics of innovator and adopter.

Innovativeness, (the readiness of an individual to adopt something new) has been shown to follow a relatively standard distribution across a population sample (Rogers and Shoemaker 1971). This relates to learning theories in psychology. Exhibit 6 summarises essential characteristics associated with adopter classifications.

Rogers and Shoemaker identify the following personality characteristics as independent variables in the adoption process.

- early adopters have greater empathy than later adopters
- " " are less dogmatic " " "
- " " have greater ability to deal with abstractions than later adopters
- early adopters have greater rationality than later adopters
- early adopters have greater intelligence than later adopters

EXHIBIT 6 : Adopter Characteristics (Rogers and Shoemaker 1971)

(i)	innovators	venturesome, eager to try new ideas Cosmopoliteness follows since they will want to expand their social experience as well. High risk-taking behaviour and tolerance of failure.
(ii)	early adopters	respectable, more integrated into a particular social system, local orientation. Most opinion leaders occur in this category (innovators being seen as 'too eccentric') since they command social system respect. Moderate risk taking and tolerance of failure.
(iii)	early majority	deliberate, interact frequently with peers but rarely tend to be leaders. Tend to consider carefully before adopting and rarely lead adoption, despite a willingness to accept new ideas. Moderate risk-taking, low tolerance of failure unless an unavoidable, logical consequence of adoption.
(iv)	late majority	sceptical, adopt new ideas only when pressures and constraints force this response. Persuasion of the utility of new idea must be accompanied by acceptance as the social norm before adoption by this group. Low risk-taking and tolerance of failure.
(v)	laggards	traditional, conservative, very local in orientation. Reference points always in the past, 'the way we've always done it'. Suspicious of change and alienated by it. Very low risk taking and tolerance of failure.

- early adopters have a more favourable attitude towards change than later adopters
- early adopters have a more favourable attitude towards risk than later adopters
- early adopters have a more favourable attitude towards education than later adopters
- early adopters have a more favourable attitude towards science than later adopters
- early adopters are less fatalistic than later adopters
- early adopters have higher levels of achievement motivation than later adopters
- early adopters have higher aspirations (education, occupation, etc.) than later adopters

During the adoption decision process, they suggest that the individual passes through phases of awareness, interest, evaluation, trial and adoption/confirmation/ discontinuance. Associated with these are four functions which represent the major influences on the process.

Knowledge - Hassinger (1959) argues that awareness is not a random occurence but takes place as an active, purposive activity. Selective exposure (exposure to ideas which are in accordance with an individual's interests, needs or attitudes) is a well-reported principle which supports this view. (Bruner 1949) Thus there has to be a perceived personal need for an innovation before an individual will become aware of it.

Persuasion - awareness of innovation is insufficient to ensure its adoption; persuasion is that agency which acts on the attitude-forming mechanism. (cf Rokeach 1966). Attitudes towards change are both general and specific, and there are well-documented studies in which individuals professing one general attitude behaved in contradictory fashion in specific instances (e.g. La Piere 1934). Innovation dissonance is a special case of Festinger's (1957) general theory of cognitive dissonance.

Decision - at this stage the individual engages in activities such as trial prior to making an adopt/reject decision. Marketing practice illustrates the value of offering trialability of new products via free samples and trial sizes; a similar example in process innovation might be the pilot plant (cf Gregory 1976).

Confirmation - most empirical evidence indicates that the adoption decision is rarely taken on a once-for-all basis; the individual continues to seek reinforcement for his decision. Once again, cognitive dissonance may provoke a re-examination of earlier actions if they fair to reduce the original dissonance provided by the awareness of a new idea.

In organisations and groups, the characteristics of the adoption-decision process will also be significant. As has already been discussed, commitment and support for a particular decision is most likely to be secured via a participative process.

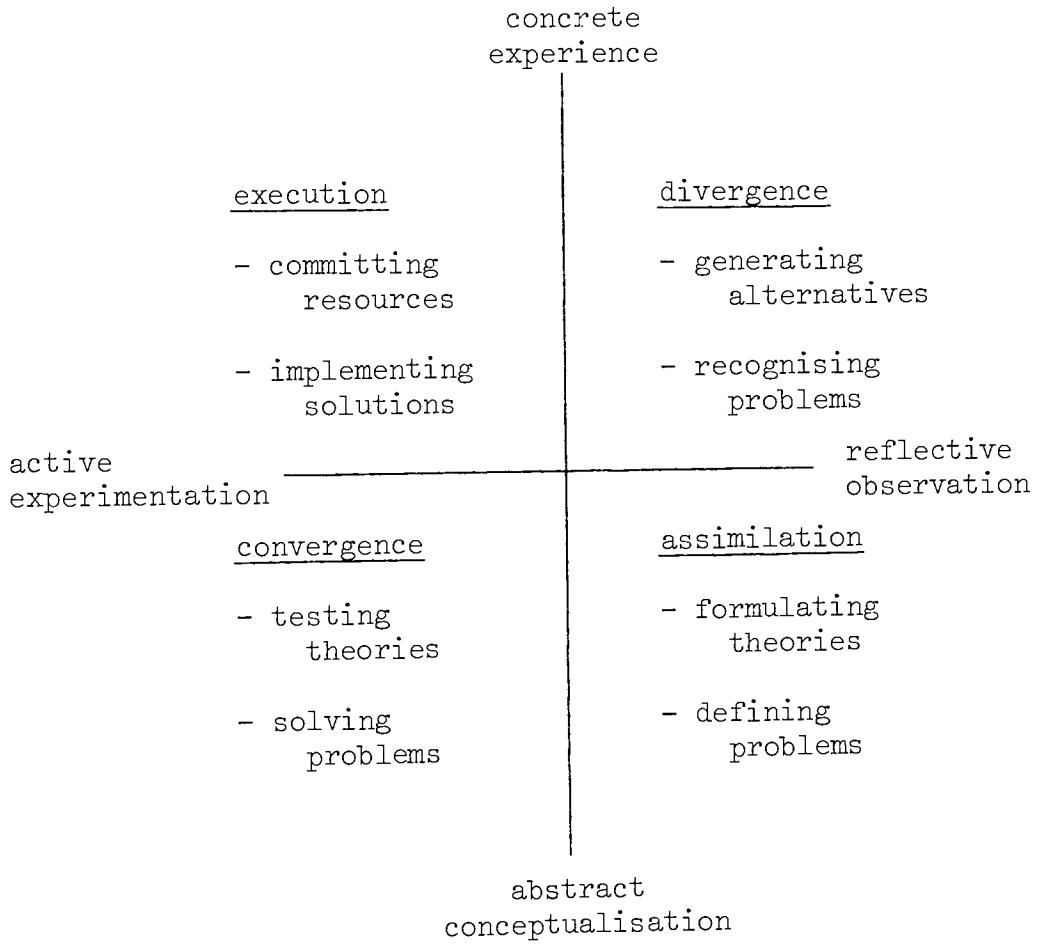
(iii) General personality variables

Cattell (1970), Eysenck (1965) and others have addressed themselves to problems of general personality variables. Bruce (1976) attempts to examine personality traits associated with entrepreneurs, following McClelland (1961) and Collins (1964).

One particular variable which will be strongly associated with both problem-solving and adoption behaviour is learning style. Kolb (1973) proposes a four-step repetitive cycle to account for experimental learning: individuals may well display one style dominantly. Exhibit 7 indicates the model: the cycle can be summarised thus:

'Immediate concrete experience is the basis for observation and reflection. These observations are assimilated into a 'theory' from which new implications for action can be deduced. These implications, or hypotheses, then serve as guides in acting to create new experiences'.

EXHIBIT 7 : Kolb's Model for Individual Learning



Since the innovation process itself involves a similar learning process, it could be argued that individuals dominant in each style will be required to facilitate it. Kolb also talks about 'integrated learners' as describing those individuals able to employ and switch between learning styles very easily. He also argues that 'organisations and professional disciplines often develop values which favour activity in one learning stage over the others'.

On the basis of his model, individuals may be executors, divergers, convergers, assimilators or integrated learners: the mixture and balance of these types will be important in management of individuals. Exhibit 8 indicates strengths and weaknesses in each style type.

Recent research (Spencer, 1978) suggests that there may be peak and plateau periods of learning during an individual's career progression. This may be related to the demands of the task or to personality skills.

EXHIBIT 8 : Strengths and Weaknesses in Learning Styles
(Carlsson et al 1976)

concrete experience

execution		**divergence**	
strength:	accomplishment goal-oriented action	strength:	generation of alternatives creativity
excess:	trivial improvements tremendous accomplishment of the wrong thing	excess:	paralysed by alternatives
deficiency:	work not completed on time not directed to goals	deficiency:	inability to recognise problems/ opportunities idea poor
convergence		**assimilation**	
strength:	design decision making	strength:	planning formulating theory
excess:	premature closure solving the wrong problem	excess:	castles in the air no practical applications
deficiency:	no focus to work theories not tested poor experimental design	deficiency:	no theoretical basis for work unable to learn from mistakes

active experimentation — reflective observation

abstract conceptualisation

(b) Environmental Factors

A number of factors will be relevant in this area notably:

- communication

- socioeconomic characteristics

- formal and informal position and role

- physical setting

- learning environment

- developmental climate

(i) Communication

In problem-solving activity Allen (1970) has made some impressive studies indicating the role of communication. He draws particular attention to opinion leader (technological gatekeeper) figures, and to informal networks.

Adoption behaviour is also strongly related to communication; of particular relevance is the two-step flow model (Katz and Lazarsfield 1955) as distinct from the conventional 'hypodermic' model of information transfer.

Again the opinion leader has the key role, and is labelled variously as 'trend-setter' and 'Mr. one-jump ahead'. Rogers and Shoemaker (1971) list the following communication characteristics as significant independent variables in the adoption process:

- early adopters have more social participation than later adopters
- early adopters are more highly integrated with the social system than later adopers
- early adopters are more cosmopolite than later adopters
- early adopters have more change agent contact than later adopters
- early adopters have more exposure to mass media channels than later adopters
- early adopters have more exposure to interpersonal channels than later adopters
- early adopters seek information about innovations more than later adopters
- early adopters have greater knowledge of innovations than later adopters
- early adopters have higher degree of opinion leadership than later adopters
- early adopters are more likely to belong to systems with modern as opposed to traditional norms than later adopters
- early adopters are more likely to belong to well-integrated systems than later adopters.

Mcluhan (1967) illustrates well the effect that communications media have on shaping individual attitudes and opinions. Interpersonal channels are of significance and informal ones in particular (Shilling and Bernard 1964).

(ii) Socioeconomic Characteristics

Rogers and Shoemaker (1971) list the following characteristics as independent variables in the adoption process:

- early adopters are no different from later adopters in age
- early adopters have more years of education than do later adopters
- early adopters are more likely to be literate than are later adopters
- early adopters have higher social status than later adopters
- early adopters have a greater degree of upward social mobility than later adopters
- early adopters have larger sized units than later adopters
- early adopters are more likely to have a commercial economic orientation than are later adopters
- early adopters have a more favourable attitude towards credit (financial) than later adopters
- early adopters have more specialised operations than later adopters.

Evidence regarding influence of these factors on problem-solving behaviour is not so clear. Age does not appear to affect problem-solving although younger minds tend to have less constraints built into their thinking and may be more 'naturally' inventive. However, older problem-solvers have a wider repertoire of experience to draw from. Similarly, above a minimum IQ level, there is little clear correlation between education or intelligence and performance.

Wealth is a significant variable in that it will affect the degree to which a potential innovator can afford to take risks. Entreprenuership appears to be related to societal factors: Hagen (1963) argues that traditional society is associated with low creativity (cf traditional system norms in Rogers and Shoemaker's summary). The suggestion is made that entrepreneurs are essentially 'marginal, migratory and mobile' with respect to society; they do not 'fit in' and for this reason deviant behaviour (as in breaking rules and taking short cuts) is tolerated. Cosmopoliteness is strongly associated with this group. (Collins et al 1964)

(iii) Formal and Informal Position and Role

The importance of formal position for the innovation process emerges in the SAPPHO findings and also in the work of Witte (1976) and Geschka (1976). Success appears to be associated with key promoter figures, one of whom will be in a formal influential position - perhaps a director. He is the 'mach promoter' (power promoter). Pettigrew (1974) discusses the relative power of influential figures in their attempts to promote radical innovation decisions.

Allied to the mach promoter is the 'fach promoter' (product champion); his role is to supply the technical push to the innovation. Both these figures correspond to entrepreneurial types: in combination they represent a highly successful force for innovation. Witte (1976) analyses many key innovation decisions in Germany and suggests that the highest probability of success is associated with the two working in tandem. Power promoters can generate resources, facilitate decisions, push radical schemes and generally exert influence for change - but they may lack the technical flair to provide the ideas. Equally, the champion with low power and status may not be able to overcome organisational resistance on his own.

In this typology we can imagine the individual who combines both roles; he will be identified with the great self-made entrepreneurs who built up their empires from small beginnings by taking risks. Whitfield (1975) discusses examples of these.

Other positional roles of importance are found in the informal structure, which has an important communication value. Opinion leaders tend to be key links, but a range of other informal roles exists, for example 'counsellor', 'organiser', 'comedian' etc. The sociometric studies originated by Moreno (1946) highlight preferred working patterns amongst individuals: effective teams are associated with good informal relationships. This will be particularly important under the conditions of uncertainty associated with innovative activity.

Roles are often sources of problems; Handy (1976) suggests the following:

- role ambiguity due to unclear role expectations
- role conflict due to conflicting or overlapping roles
- role overload due to too many roles
- role underload due to too few roles

- in individuals, these problems will result in tension, low morale and poor communication.

He suggests that role stress (either stimulating as in a sense of pressure, or harmful as in feeling under strain) will be associated with individuals working in management, innovative or integrative areas.

Argyris (1965) argues that norms and values for problem-solving behaviour are essentially 'pyramidal' in their organisational structuring; thus those in senior leadership roles have a responsibility for setting the risk-taking pattern.

(iv) Physical Setting

There is little evidence to suggest a link between individual creative behaviour and physical environment. Ergonomics has developed from the proposition that there is a relationship between the individual and the physical environment in a more general task sense, however. Herzberg's work on motivation indicates that there may be a set of factors ('hygienes') related to conditions of work; these include physical factors. Maslow's (1954) theory suggests that high-level behaviour cannot take place successfully until lower order needs are satisfied; physical factors come under this classification.

Communication patterns are determined to some extent by physical proximity etc.; Allen (1975) discusses this theme in more detail.

(v) Learning Environment

Allied to the Kolb model of individual learning is the concept of learning environments. These will be defined as environments conducive to a particular type of learning - for example, rich in concrete experience opportunities. Matching individuals with a dominant learning style to environments best suited to this approach is an important management task.

(vi) Climate

Payne and Pheysey (1971) and Pheysey (1977) talk about organisation climates and identify three dominant climates which they term 'developmental'.
' - stimulation - a climate concerned with achievement and high standards
- support - a climate concerned with fairness and opportunity
- public spirit - a climate concerned with teamwork and social responsibility'.

These represented perceptions of climate by managers: arguably they bear a relationship to individual development. They appear to be related to factors like: occupational history, environmental features, level in hierarchy etc.

(c) Contingent Factors

There are two kinds of contingencies which we shall concern ourselves with here; 'subjective' and 'objective'. The former refer to internal characteristics, such as motivation, skills, experience etc. whilst the latter refer to external factors like type of task, special constraints and demands etc.

In practice, technological innovation is carried out by technical specialists; several features distinguish this group from other industrial occupations.

Research evidence, whilst extensive on general problem-solving and adoption behaviour, is limited in the area of technical specialist task behaviour or motivation. An exception to this is in the field of design activity, where a number of studies (e.g. Asimow 1962, Marples 1960, Archer 1965) were brought together by Gregory (1966) and Broadbent and Ward (1969).

Gregory (1978) suggests the concept of a 'technical activity outline' (Exhibit 9). This is based on Bartlett's description of technical specialist activity viewed from the standpoint of cognitive psychology - 'involving skilled performance of a responsible kind, rich in non-repetitive features'.

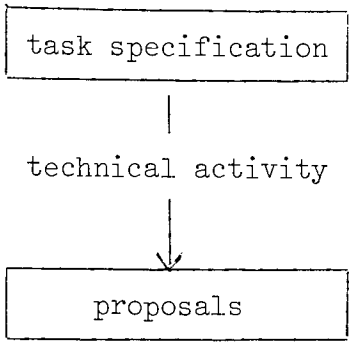
The principal tasks in which technical specialists are engaged include diagnosis, design, installation, commissioning operation and observation of symptoms.

Gregory further argues that this performance follows a 'contingent decision sequence'. This approach is useful since it relates to the development of individual strategies. Innovation generates high levels of complexity and uncertainty: thus specialists need to develop correspondingly sophisticated strategies for problem-solving and decision-making.

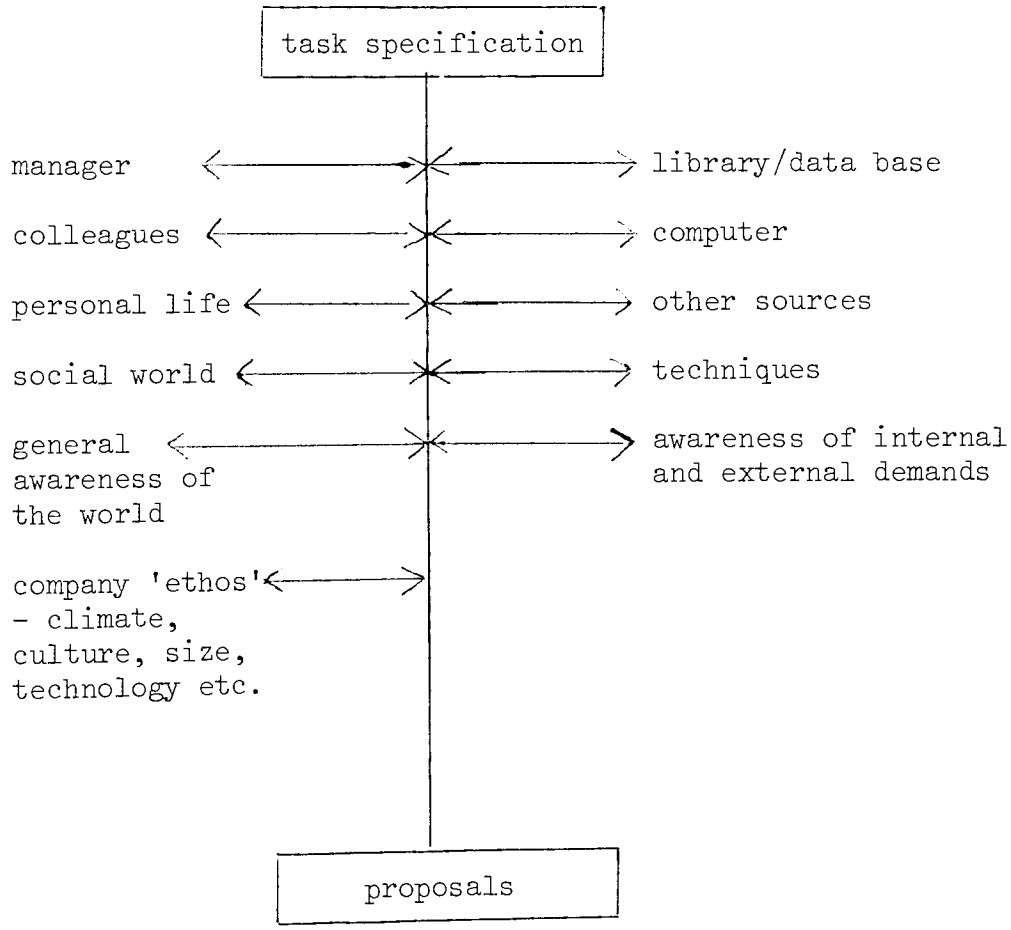
Other evidence (e.g. Pelz and Andrews 1966) suggests that this group values high levels of autonomy and freedom of action. the most significant environmental inputs are those providing support, encouragement and uncertainty reduction. Arguably technical specialists have a strong 'professional' orientation (as opposed to an 'organisational' one). This would lead to a condition of greater mobility in specialist careers and one would expect higher levels of job-satisfaction, since dissatisfaction could be alleviated by 'moving on' to a new job.

EXHIBIT 9 : Technical Activity Outline (Gregory 1978)

(i) simple view



(ii) activity line with interactions



(iii) TAO combining steps, interaction, and cyclicity

However, this view is complicated by a range of circumstantial factors: perhaps the most important at present is the relative glut of certain types of specialist - e.g. chemists. These groups are restricted in their mobility because of the difficulty of finding another job; thus dissatisfaction, alienation and other symptoms of non-integration within the organisation might be expected. It is suggested that the character and symptoms of this will be essentially similar to those described by Blauner (1964), Woodward (1970) and Shepard (1971).

For this reason, motivation of technical specialists becomes a major issue. In general terms, research (e.g. French 1957) has demonstrated the significance of motivational factors in accounting for variations in individual performance. Theories of motivation have advanced considerably from the 'dependence' model of John Stuart Mill, through Taylorism, to the current expectancy and path-goal approaches of Vroom and others (1970). Emphasis has shifted away from 'carrot and stick' methods towards individual need fulfilment on a contingency basis. Guest (1976) provides a short review of current thinking on motivation.

There is evidence that different specialist job groups have different motivation patterns associated with them (Hackman 1969). Anxiety, aggression and dissatisfaction are related to performance. Tasks involving high levels of uncertainty are likely to be high in anxiety but intrinsically satisfying and interesting.

Innovative activity, if organised correctly, need not give rise to negative motivational characteristics. The dominant need is for support in order to alleviate anxieties associated with high levels of uncertainty-handling (Mars, 1969).

The degree of integration which the individual feels with his job and environment will be expressed via his attitudes and his feelings of satisfaction. Research in this field has been extensive (e.g. Herzberg et al, Likert, Guttman, Bass) and a range of direct and indirect techniques for measurement have been developed (e.g. Webb 1971).

Information from this research is of value in reshaping jobs and environments to suit people better and enhance their performance. The Pelz and Andrews study is a typical example of this. However the limited evidence available about technical specialists suggests that their motivational pattern is more strongly associated with 'internal' personality factors than with external environmental conditions.

Attempts have been made, notably by McClelland (1965) to relate achievement orientation to risk-taking and entrepreneurial behaviour. These studies reveal that high achievers prefer to work on tasks of moderate difficulty and not to take big risks: this equates to characteristics associated with managers as opposed to technical specialists in the General Electric research of Meyer, Walker and Litwin (1961).

McClelland argues that professional specialists will have intermediate or low achievement scores since these jobs will not provide direct feedback of the kind needed by high achievers: equally they will be better disposed towards risk-taking.

Entrepreneurs are characteristically high-achievers, and tend to have strongly individualistic orientations. The 'product champion' represents the typical case of the technical specialist entrepreneur; he is not particularly inventive, but excels at promoting new ideas into practical achievements. McClelland points out that Nobel prizewinners generally had low achievement scores; by contrast, he equates national economic progress and development through history with high scores, i.e. high incidence of entrepreneurial behaviour (1961). The significance of the 'product champion' in knowledge push innovation is high: he is associated with promoting an awareness of need for the innovation. Because of the internal nature of the champion, he can be expected to break rules, take short cuts and force through ideas which he is committed to; this has significance in the introduction of innovations perceived as 'too radical' by the majority.

Bruce (1976) discusses entrepreneurs and attempts a simple typology: in particular entrepreneurs are very calculating. They have an attitude to risk which is essentially based upon an assessment of probabilities; he labels this exteroceptive behaviour. This involves 'a continual scanning of the environment for opportunities and dangers and evaluating these in the light of his distinctive competence, strengths

and weaknesses'.

Schrage (1965) reports that self-awareness and awareness of customers and colleagues correlate with performance; entrepreneurs and high achievers score well on these factors.

Other roles which have a bearing on the innovation process include managers and blue-collar workers. Studies of managers (notably Stewart 1976, Mintzberg 1973) suggests that their activities are fragmented and carried out under heavy time pressure. Sofer (1970) reports that managers like technical specialists, see themselves as resources waiting to be used; however little is known about the skills which are required for the task apart from a generalist orientation.

In the case of blue-collar workers, Goldthorpe et al (1968) contrast their approach to work (which is largely instrumental i.e. a way of making money to make available goods, services and leisure pursuits) with the high interest expressed by white-collar workers in their jobs. This fundamental view is supported by many writers (e.g. Wilson 1955, Blauner 1964, Sayles 1958, Cotgrove et al 1971) who suggest that whilst greater satisfaction seems to derive from extra levels of discretion and good supervisor relationships process workers still see their jobs in money terms.

Skill is an important contingent factor here: evidence suggests that levels of skill influence worker's approaches to changes or difficulties. Unskilled workers tend to be apathetic; skilled workers are more involved. Craftsmen are a special case in that their skill often gives them greater potential mobility; they value good workmanship (Mills 1957). Like managers and technical specialists they may have 'unfulfilled' job expectations (Wedderburn and Crompton 1972, Nichols and Armstrong 1976).

Another relevant factor here will be the individual's state of development. Dalc and Payne (1976) offer a model (derived from many disciplines, but notably Alderfer 1972) against which to evaluate this. They suggest that there are three key dimensions - awareness, will and resources - along which development can take place. Each dimension is in turn made up of three 'levels of development'.

The model suggests that individuals occupy various positions on each scale, and that development can take place along any or all of the dimensions. For example, resources can be developed by acquiring new skills or mastering existing ones. Awareness can be developed by increasing self-knowledge, understanding of others etc. It is also suggested that two kinds of development might be possible; within and between levels.

The former corresponds to an addition process whereby similar things are acquired - for example learning to operate a new machine or use a new technique. Between-levels development involves a more radical shift and a reorientation to a completely new pattern of relationships between things. Exhibit 10 illustrates the model a little more clearly.

One of the values of this approach is that it permits an evaluation of personal and externally applied development strategies. A common cause of failure to develop is that the strategy used is inapplicable to the actual situation.

Examples of individuals at each state of development may help in understanding the model.

(a) Awareness - level one (existence) - the person has little self-concept and is at the mercy of others to tell him what to do. He is defensive and protective, often turning this aggressively outwards. He has little insight into his own motives and emotions.

- level two (relatedness) - he is much more conscious of the outside world. Behaviour is dominated by the need to relate to other people and to understand what they want from him. Strong values are held about maintaining the social order and setting a good example to others.

- level three (growth) - standards are set by himself and he recognises the tensions between his own values, beliefs and perspectives and those of others and accepts them. He is a choosing, self-directing, self-guiding being.

The principal difference between levels 2 and 3 is that at level 3 he understands not just how things are but also how they came to be that way - and how they could be different. He moves from being a 'rule-recogniser' to a 'rule-maker'.

(b) Resources - level one (incompetence) - these are the minimum levels of skill: individuals learn from both 'nature' and 'nurture' influences and there will be some things that they have little or no knowledge of, whilst in others they are masters. An example might be the minimal understanding of behavioural issues in a high technology industry.

- level two (skill) - this is a level of competence which can be added to and developed: the distinction between this and level 3 is that between 'technician' and 'master'.

- level three (mastery) - this is moving beyond conditioned skills into unknown territory: of necessity an thorough level 2 grounding in skills is needed. Creative exploration, pushing the frontiers forward characterises this level.

(c) Will - level one (existence) - this is concerned with the motive behind changing relationships with the world, about making some difference or having an impact on that world. At existence level, the individual rarely commits himself even if he has talent, skills, understanding etc. - he is not a 'doer'. Or he is a passionate 'doer' who never actually achieves anything. Amongst the reaons for remaining at this level might be:

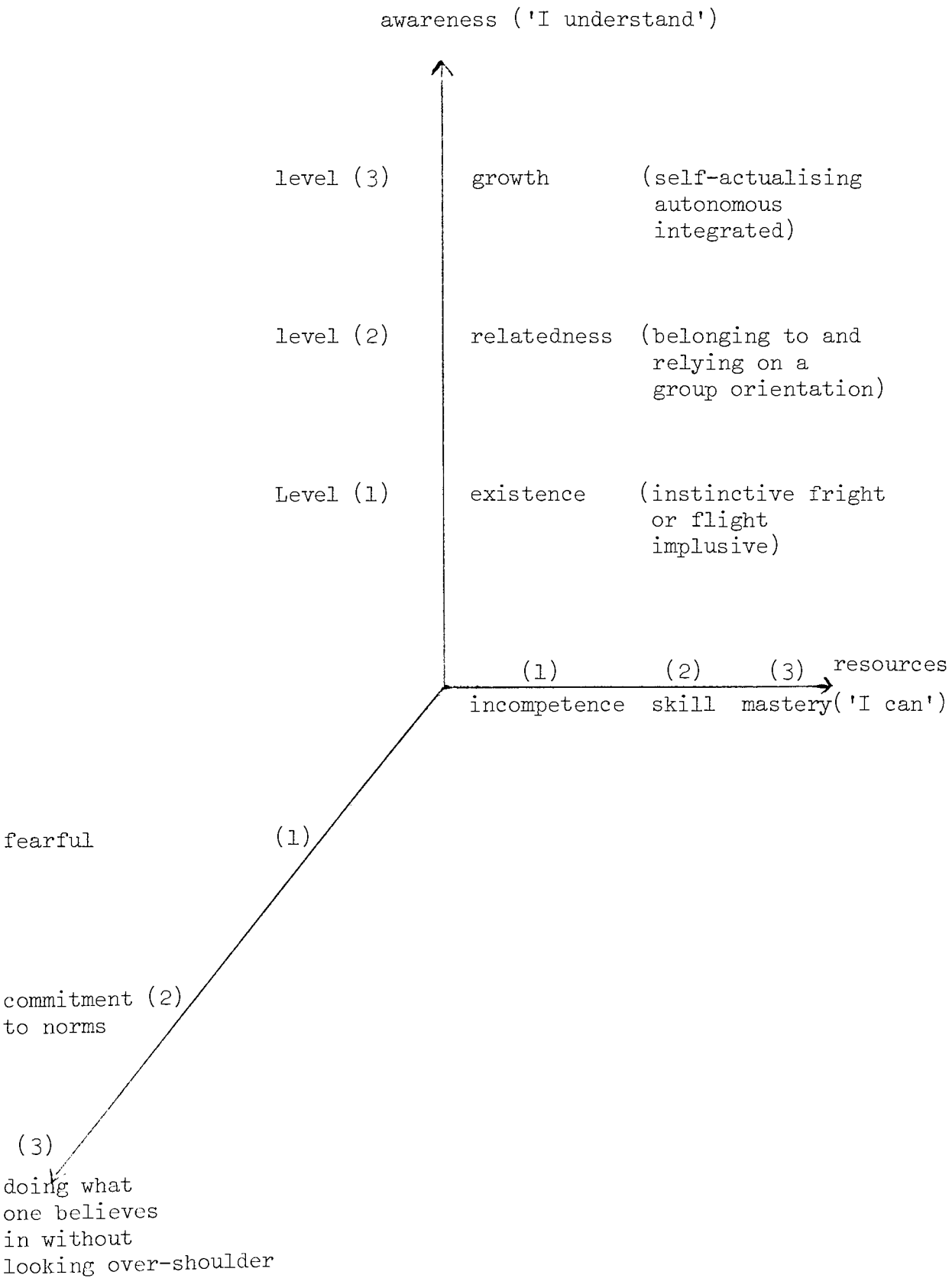
- feelings of powerlessness
- fear of looking foolish
- apathy and inertia
- ability to escape
- conflicts about what to do
- fear of change
- preference for observer/critic role
- principal rejection of competitive striving

- level two (relatedness) - here the individual does act, but in the way of commitment to something larger, e.g. the organisations, this action is thus restricted within the limits of an established situation which is itself not questioned.

- level three (growth) - this is the point at which the individual moves beyond the established frame of social reference, stops looking over his shoulder and looks forward to longer-term goals. A conditions of self-respect and self-enactment.

In many organisations level 3 people may be undesirable because they rock the boat and challenge conventional wisdom. However innovative activities have a major requirement for this type - in preference to level two people who work to preserve things as they are.

EXHIBIT 10 : Model of Development (Payne and Dale 1976)



Another study which relates individual development to performance is presented by Argyris (1965). This is of particular interest since it derives from his general work on individuals and organisations and refers specifically to innovation.

The central theme in his argument is that of 'interpersonal competence' - 'the individual's ability to produce intended effects in such a way that he can continue to do so'. In other words solving problems effectively so that they stay solved but cause no new problems. This refers particularly to interpersonal interaction: he suggests a number of categories which relate to behaviour: these he classifies into individual and normative dimensions

(a) Individual - owning up to/not owning up to: the individual is able to identify his behaviour, communicate it and accept ownership of it

- open/not open: the individual permits and encourages the reception of new information

- experimenting/not experimenting: the individual may be observed manipulating his internal or external environment in order to create new information - i.e. risk-taking behaviour

- helping/not helping others in the above behaviours

(b) Normative

- individuality/conformity
- concern/antagonism
- trust/mistrust

He develops a complex analysis procedure which he relates to performance in innovation processes. In particular he proposes a model to account for the deterioration of Research and Development performance over time; this historical perspective is interesting, for it raises issues like growth of rigidity and institutionalisation of conflicts. The stress on interpersonal incompetence is significant; even in poor performing cases 'the effectiveness of the technical activities was perceived as high'.

(d) Coping Strategies

Strategies are long-term patterns of activity designed to accomplish a particular set of goals; it can be argued that any unit in an organisation will adopt a number of strategies to achieve its various goals. These have been labelled 'coping' strategies since in many cases they will represent the best course of action (based on previous experience) for handling specific contingencies. They may not be the best way in absolute terms - hence the following section on improvement strategies.

Individuals have a number of personal goals and corresponding personal strategies which have little direct bearing on their organisational life. Miller, Galanter and Pribran (1970) discuss these. Task-related strategies characterise the kind of activity outline proposed by Gregory.

For example, in the case of problem-solving activity, Bruner et al (1956) identify four basic strategies which individuals use (Exhibit 11). Gagne (1972) and Newell (1972) emphasise the importance of strategies in effective problem-solving.

Adoption behaviour has been shown to follow evaluative strategies - trial, observation, comparison, knowledge acquiring etc. (Rogers and Shoemaker). Individuals tend to use strategies based on minimising dissonance (Festinger 1957).

Individuals cope with the organisation and its general demands in a number of ways. Maccoby (1977) indicates a range of possibilities. Exhibit 12 presents a model which offers options along a continuum of commitment to the organisation; the extreme case of alienation is withdrawal, and of commitment is actively shaping the organisation to new ends. Associated with positions on this continuum will be a number of strategies.

EXHIBIT 11 : Problem-Solving Strategies (Bruner 1956)

(i) simultaneous scanning: an individual investigates which of his hypotheses of how to solve the proglem are tenable and which should be refuted. In order to be effective the individual must plan carefully each step so that his decisions are maximally informative. After each decision the individual must remember which hypotheses have been disproved until the problem is successfully resolved.

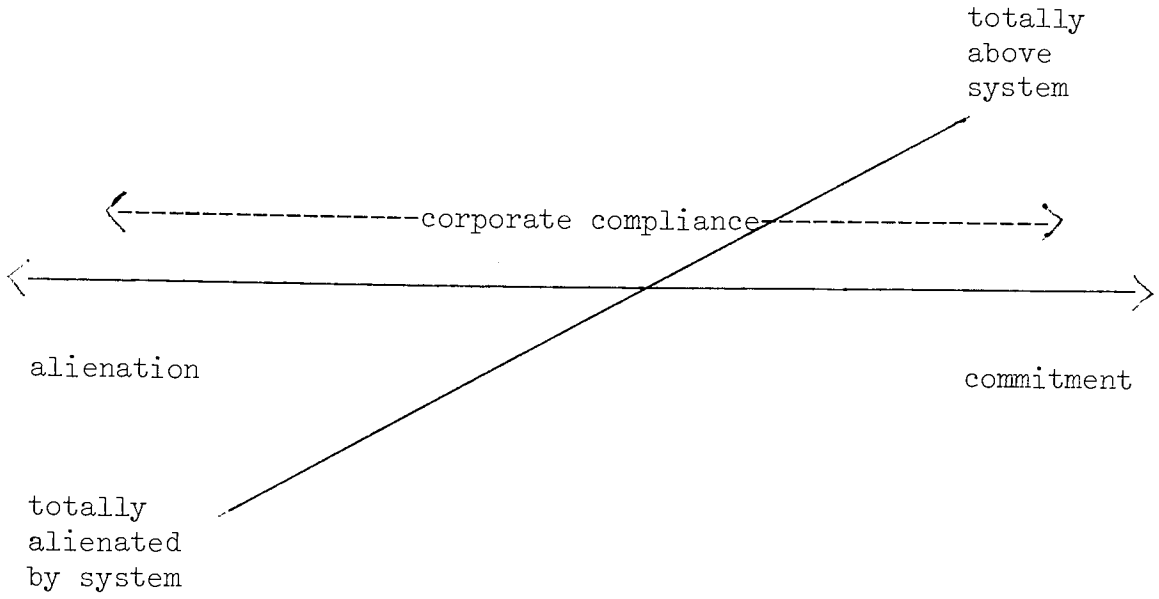
(ii) successive scanning: this involves testing a single hypotheses at a time. Having selected a given hypotheses, the individual restricts his decisions to those problem areas that directly affect his hypotheses. The individual does not need to remember eliminated hypotheses and consequently there is no cognitive strain. However, this strategy does not permit maximum informativeness of each decision. Nor is the individual able to regualte the risk associated with each decision.

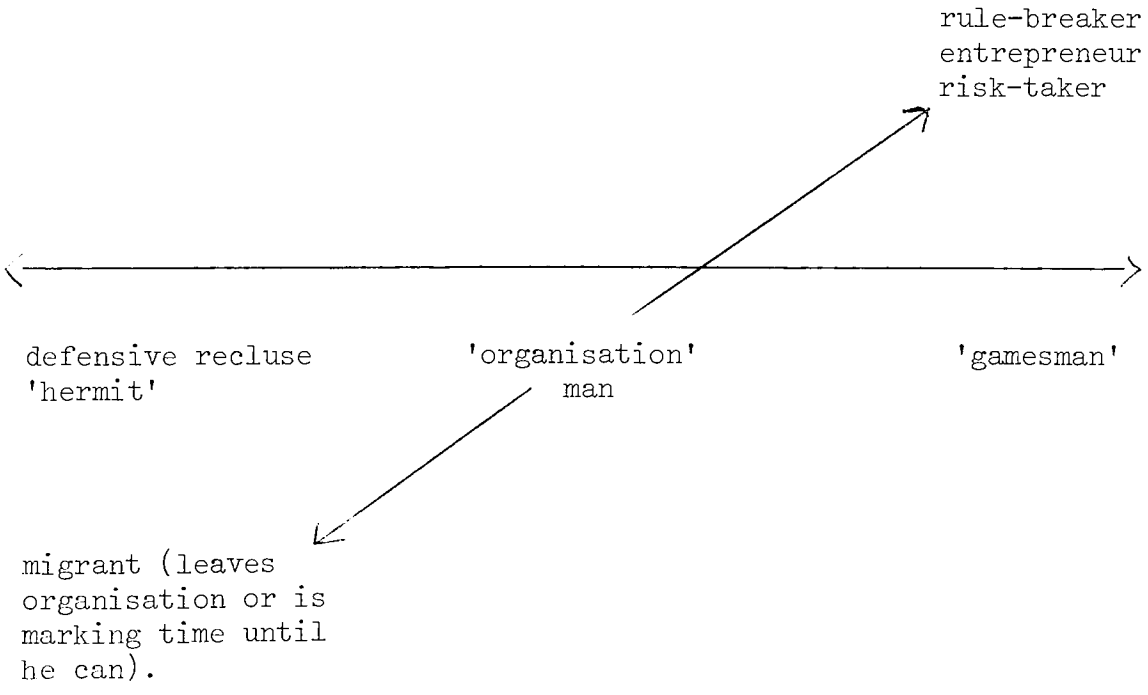
(iii) conservative focussing: the individual concentrates on one attribute of the problem at a time. Decisions are made cautiously. There is low cognitive strain and high informativeness of each decision. All decisions are low risk.

(iv) focus gambling: the individual attempts to manipulate more than one aspect of the problem at a time. The individual guesses which decisions should be made, despite the high risk of failure. Cognitive strain is low. The individual may maximise the informativeness of each decision. Although his decisions are made generally on little information.

In general individuals adopt several different kinds of strategy which might be said to characterise their problem-solving style. A given problem may be solved using more than one strategy.

EXHIBIT 12 : Individual Coping Strategies





(e) Improvement Strategies

The preceding overview of influences acting on individuals suggests a number of ways in which these might be managed to advantage: some examples are given here.

From a general motivational veiwpoint a number of guidelines emerge. Mars (1969) summarises the work of writers offering prescriptive suggestions for productive climates in Research and Development. In essence they confirm the view that technical specialists have a strong professional orientation and whose motivation is a more complex variable than can be accounted for by simple reward/punishment systems. Individual needs for autonomy, freedom, association, status and achievement appear to be significant.

Orth, Bailey and Wolek (1965) discuss the behaviour of scientists and engineers in organisations and discuss a number of motivating approaches both descriptive and prescriptive in nature. In general there is strong emphasis on the pattern of the job as dictating behaviour and hence the motivational and other components of improvement strategies (Sayles, 1963, Hinrichs 1966, Twiss 1974).

The contingency nature of this model of motivation is reflected in the strategies available and the varied success with which they have met. Early attempts were essentially aimed at job enlargement and rotation.

These approaches offer a broadening of experience which is significant since there is a tendency for specialists working in one area only to develop rigid frames of reference. Burns and Stalker (1961) and Lawrence and Lorsch (1967) both highlight the problems of differential orientations of specialist groups and suggest job rotation as an important integrating mechanism because it introduces an experience of alternative perspectives. Arguably this will improve problem-solving and adoption behaviour by breeding a more open-minded approach.

Job-enrichment represents a further development involving workers in a greater share of control of their jobs. It appears particularly applicable to professional specialists because it represents a way of providing more functional autonomy. Herzberg et al (1959) developed the concept of enrichment from their two-factor studies of motivation. Paul and Robertson (1970) describe extensive experiments using this technique within I.C.I.

Career development is another possibility; there is a growing belief that planned progression coupled with relevant training inputs can have beneficial effects on peformance. Of interest here are the attempts at providing a dual scale, managerial and technical for promotion in Research and Development. Technical ladders have problems however; Shephard (1958) lists the following:

- difficulty in defining the role of positions on the technical ladder

- use of the technical ladder as a reward rather than an opportunity

- use of the technical ladder as a shelf for senior staff found lacking either scientifically or managerially. A position on the technical ladder was consequently seen as a proof of inadequacy

- ambiguity of the technical ladder as a status symbol

- removal of the scientist from the main stream of activity encouraging him to leave the company

- a shortage of 'rungs' on the technical ladder

- less security for positions on the technical ladder

Formal development of skills, knowledge and attitudes is particularly important in Research and Development personnel since their background experience exposes them less to business or other environments.

Development options can focus on improving and updating 'traditional' skills or on introducing new skills to help individuals adapt better to their tasks. As Payne and Dale (1976) point out, not all inputs will suit all individuals since they will already be at varying states of development and thus receptivity will vary. The contingency factors affecting this will be multiple; Pheysey (1977) discusses some factors related to climates for management development, for example.

Many inputs of this kind use standard educative approaches which rely on passive involvement of the subjects. An increasing body of evidence suggests that the learning value of this type of experience is limited; emphasis is shifting towards the 'action learning' type of approach (Revens 1977). These have the advantage of being less-directive than traditional strategies for development and rely more on facilitating conditions under which the individual may learn. A good example of the philosophy and practice of on-the-job learning approaches appears in Rackham and Morgan (1977).

Training for adoption improvement centres on the need to 'sell' the new idea in terms which the adopter can accept. Understanding of individual constructs (Kelly 1955) and general belief systems provide useful additions to the more conventional sales-training syllabus. Promoting understanding of inter-personal interaction, particularly via novel approaches like transactional analysis (e.g. Carby and Thakur, 1975) is also of value.

Evidence on adopter behaviour suggests that opportunities for individuals to try out, to observe, to understand etc. will influence innovation acceptability at the knowledge stage. Understanding of the dynamics of persuasion, - e.g. use of key channels and opinion leaders etc. - will improve the chances for successful adoption.

Evidence suggests that the 'natural incidence of innovators (as an adopter category) and entrepreneurs is very low (around 2% according to the Rogers and Shoemaker studies). Risk-taking and willingness to consider new ideas are traits which can be trained, however. Aronoff and Litevin (1971) and McClelland (1972) report success with achievement orientation training, for example. Creative thinking tends to be associated with these concepts and thus 'mind-flexing' techniques whether group or individual oriented can be useful in this connection. Rickards (1974) and Rickards and Freedman (1978) describe and evaluate a number of these.

Interpersonal contact appears strongly correlated with information flow, particularly via informal networks. Allen and his associates at M.I.T. report extensive studies in this area and suggest a number of strategies to improve communication including architectural rearrangement of Research and Development workspace (1975).

In terms of management, innovative specialist activity presents a dilemma. Those conditions which appear conducive to inventive activity (high levels of autonomy, loose organic structure, high on support but low on control, individual freedom etc.) differ radically from those which offer the best chance of development success (high levels of overall control, functional integration, working to budget and deadline, etc.) For this reason management should develop strategies aimed at co-ordinating the activities of 'self-controlled' specialists rather than attempt to directly control them.

This raises a final important improvement strategy; as suggested in the section on individual development, the level of awareness will be significant. Inputs aimed at improving knowledge of self and of others, in a general and a task-specific connection will be of value in developing self-actualising individuals.

Integrated self-actualisers are advanced as ideal types by Argyris, (1970), Maslow (1954) and others. Interpersonal competence is a condition similar to high levels of development on the Payne/Dale model, and Argyris presents evidence for training in this mode. He has recently, in work with Schon (1976) developed the concept of an 'open loop learning cycle' which he is using as a development aid. He believes that changes in norms, values etc. (which are dominant elements in his system) should begin at the top in order to take effect; thus his programme has concentrated on leaders. However the inputs are applicable elsewhere in the organisation.

Another advantage of the Payne/Dale type of model is that it permits the evaluation of change inputs. Thus the applicability and change potential can be checked against an individual's state of development. This gives rise to the concept of 'customised' or 'tailored' inputs for individuals.

Section 2 - Group Level Influences

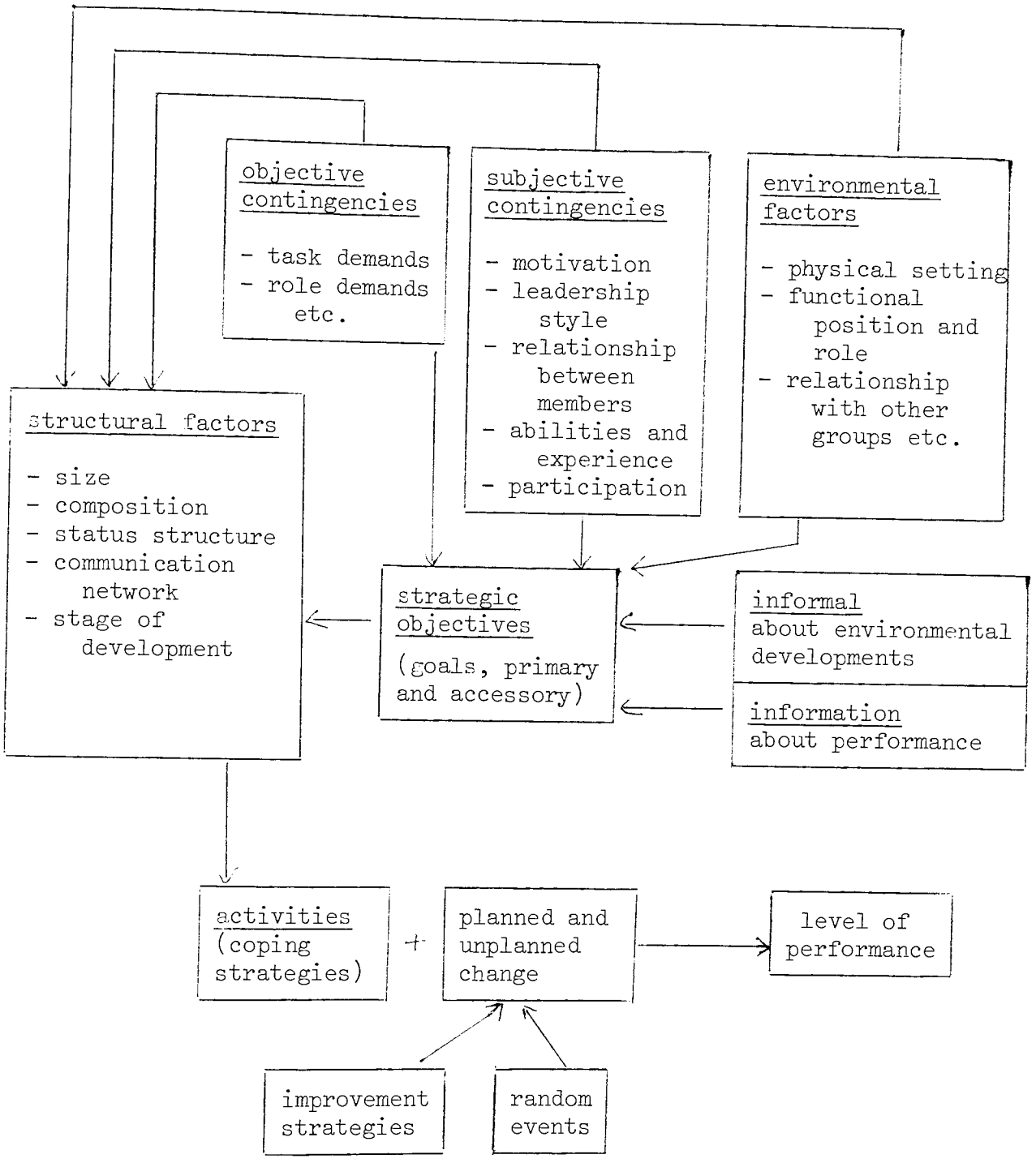
The group is central to many aspects of the technological innovation process since it is the unit of co-operative activity. Types of group involved range from formal functional groups, mixed project teams involving different specialists, decision-making and planning committees etc. to informal social groups of various kinds.

In general, groups can be considered in terms of the degree of interdependence and sharing of goals between individuals. Exhibit 13 indicates the possible range. Central to all groups is their goal-orientation: whether formally or informally defined there is mutual agreement and commitment to this.

Goals may be primary or accessory. The former constitute the principal objectives whilst the latter are associated with changing individual needs within the group. During the life of a group, goals will undergo a process of displacement (Blau 1955, Sills 1958). Group effectiveness is related to the degree of goal achievement.

Exhibit 14 indicates a model illustrating how this section is structured; this is similar to a model due to Krech et al (1962) to illustrate factors relating to group effectiveness.

EXHIBIT 14 : Group Level Influences Model



Structural factors - size, stage of development, communication networks, status structure, composition etc. are considered first. These are followed by an examination of relevant environmental factors - e.g. physical setting, functional position and role, relationship with other groups etc. Contingent factors are again considered under two headings, one relating to 'subjective' factors and the other to 'objective' ones. The former include group motivation, relationships between members, abilities, participation, leadership style etc. whilst the latter are concerned with the demands placed on the group in terms of task, role, culture etc.

Strategies whereby groups cope with contingencies and achieve individual and group goals are discussed next. Finally planned change strategies aimed at improving effectiveness are considered.

(a) Structural Factors

(i) Group Size - in general the most effective size for a group appears to vary with the task to be performed. Evidence suggests that the degree of perceived opportunity for an individual to participate is an important factor (Marquis et al 1951, Bales et al 1951, Stephen et al 1952).

In terms of idea-production and problem-solving, Gibb et al (1951) found that production increased with group size, but beyond a certain point, members felt inhibited by the presence of so many others. The level of formalisation of procedures was also related. Slater (1958) reports the responses of various-sized groups to questions about satisfaction; determinants included the need for order, amount of aggression and competition, level of inhibition, fear of alienation and destruction of the group.

(ii) Group Composition - in general, the following points appear important (McGrath et al (1966), Davis (1969).

- traits of co-operativeness, efficiency and insight as positive correlates of effective group performance. Aggressiveness, suspicion and coolness towards other group members as negative correlates.

- heterogeneous groups are generally more productive than homogeneous groups, particularly where novel solutions to problems are required.

- homogeneous groups are more cohesive and have higher morale than heterogeneous groups.

- compatible groups (interpersonally) are more co-operative than incompatible groups. They also demonstrate greater productivity than incompatible groups because of'assembly effects', i.e. 'when the group is able to achieve collectively something which could not have been achieved by any member working alone or by a combination of individual efforts' (Collins et al 1964).

Some of these propositions appear mutually exclusive e.g. (ii) and (iii). This highlights the principle that there is no one best way to compose a group.

Further, groups may not involve individuals in direct interaction; nominal groups exist in many situations.

Rickards (1974) discusses the problem-solving advantages of groups of this kind; the Delphi technique is based upon this principle.

Problems of compatibility are overcome by using groups of this kind, but there are accompanying communication difficulties involved.

(iii) Status and Hierarchy - in general, the following factors appear important (Burnstein et al (1965), Argyle (1969)).

- groups which have a stable status hierarcy are more effective and efficient in problem-solving than groups in which members are concerned with improving their status.

- status hierarchy may result in restraints on communication content. In mixed status groups, high status members tend to address few criticisms to low status members.

- the number of irrelevant communications (not task-related) is greater among low-status groups.

- 'status incongruence' results where the status level and tangible rewards given by a group are not related proportionately to performance. In this situation, a group is ineffective, members will attempt to improve the alignment of the different aspects of their status.

(iv) Group Development - a large number of accounts of the mechanisms of group formation and development exist. Amongst these, one of the best-known is that due to Tuckman (1965) who identifies four discrete phases; these are illustrated in Exhibit 15.

(On the basis of this model it may well be that project teams and nominal groups of various kinds do not perform effectively because they fail to reach the final 'performing' stage).

(v) Communication Patterns - defining communication as 'the transmission and reception of ideas, information, knowledge, feelings and attitudes which produce a response', it is apparent that mutual understanding must occur if communication is to be effective (Stewart 1968).

Bavelas, Leavitt, Shaw et al in a number of experiments (1950, 1954, 1954) studied a variety of communication patterns. They concluded that the most effective pattern depended upon the kind of problem-solving activity involved; for example, radial groups required less time than circular groups in solving simple problems. Dubin (1959) concluded from an interaction-analysis viewpoint that a circular pattern promoted open communication and maximum participation. Davis (1969) suggests that groups combining both these patterns appear to be superior in performance. It seems likely that there is no one best pattern available but that it will depend upon the task, resources and other contingencies.

Of more interest, perhaps, is the two-step theory of communication. Katz and Lazarsfield (1955) developed the concept of opinion leaders in their studies of election campaigns and Rogers and Shoemaker (1971) developed the idea in their model of the communication of innovations.

Allen (1970) in his extensive work at MIT on the various communication processes involved in Research and Development work coined the term 'technological gatekeeper' to describe a particular class of opinion leader. Certainly the evidence appears to support the view that some individuals in groups are better informed and have more information - giving influence.

(b) Environmental Factors

(i) Physical setting can have a bearing on the behaviour of a group in that it may provide support or make demands. An exaple of this might be the sense of unity and pride expressed by production teams who continue to manufacture high quality products under very poor, dirty, noisy conditions. Equally this group may express strong resentment of the Research and Development group for the fact that the latter inhabit expensive, modern, very clean laboratories and offices.

There appears to be little direct evidence of the effect of physical environment on group performance; as with individuals motivational and communication factors appear related to physical setting.

(ii) Functional Position of Group: - this variable is particularly significant in innovation because so many functional groups are involved. Members will perceive themselves as belonging to a specific group with values, goals and general orientations peculiar to that group. These will be shaped by factors like the functional task, the professional orientation, the task demands etc. This identity is maintaining the group under conditions of uncertainty and complexity.

Inevitably there will be differences in functional position - for example 'strong' and 'weak' groups. Research and Development are typically weak and often under attack because of their non-productive status: Burns and STalker (1961) talk of the pressure of 'constantly being expected to pull rabbits out of the hat'. Maintenance groups, by contrast, are often very powerful (Hickson et al 1971).

It is suggested that specialists involved in different groups exhibit distinct behaviour patterns; Sayles (1958) discusses this phenomenon with respect to blue-collar workers. Groups will develop particular strategies to cope with their position. For example, Research and Development under stress may induce responses along the following lines:

(a) withdrawal into an ivory tower - adopt a 'take it or leave it' attitude to innovation.

(b) unification against a common enemy (the rest of the company), strengthening of group identity.

(c) fragmentation, loss of group identity and low morale.

(d) 'marketing' - going out ot positively sell Research and Development to the company, restore confidence, redress the balance.

(e) attacking - going out to denigate all other functions, fighting back with similar weaponry.

etc. It is also possible within the group for different individuals to adopt different responses.

Other patterns can be derived; examples of elements which might differentiate groups include:

- history
- culture (sets of values, mythologies, ideologies etc.)
- leisure interests
- educational levels
- political strength or weakness

- autonomy/dependence
- strategic power/weakness
- commitment/alienation
- self-image
- confidence

etc.

Exploration of different groups on scales of this kind would, it is suggested, reveal significant differences which might lead to a tentative typology of specialist groups.

(iii) Interrelationship between groups: as many writers have argued, differentiation into a large number of specialist functional groups is a necessary consequence of organisational growth. Activities like technological innovation will require high levels of reciprocal interaction and thus integration becomes a central issue (this is discussed later).

Differences in group orientations will mean that their members have radically different ways of looking at the world. Inevitably this will result in conflicting opinions, goals, etc.; the danger is that the line between healthy competitiveness and stimulating challenge on the one side and destructive conflict lack of trust or confidence etc. on the other is very thinly drawn.

Many writers have addressed themselves to the problem of conflict between groups; this theme will be discussed elsewhere in more detail. It appears that some measure of competition between groups may be advantageous to high levels of achievement but inadequately resolved conflict can act as a significant barrier to effective interaction.

Another factor which relates to this issue is that of relative dependence; some groups are very dependent upon others for resources or services. The disproportionate power of maintenance groups over other functions is often cited in this connection (e.g. Hickson et al (1971).

Organisations are also political societies and we should expect to see manifestations of this kind of behaviour between groups. Efforts to maximise control of resources, to expand territorial claims etc. will be expected phenomena. In innovation particularly, where new resources are being created and committed, there will be considerable political focus: Pettigrew (1974) provides an excellent account of this kind of behaviour.

(c) Contingent Factors

(i) Task-Related Variables

Variability amongst the demands of functional tasks is associated with differentiation in organisations; typical elements of variability will be:

- task complexity
- time span of feedback
- uncertainty
- dependency (on other units)
- problem horizon (short or long term)
- information processing requirements

etc.

As has already been suggested, variability of this kind will result in there being a number of 'frames of reference' corresponding to different task orientations. Groups will tend to identify strongly within these and to develop social orders of values, norms, beliefs etc.: individuals joining these groups will quickly become socialised into 'production men' or 'marketing men' etc.

This differential orientation can be disadvantageous (in that it underlies conflict between groups - they're different from us' - or in that newly emerging groups are seen as encroaching on existing territory (e.g. Pettigrew 1974) or advantageous (as when project teams represent/

/a number of specialist groups to bring a spectrum of different experiences and ways of looking at the world to bear on specific problems).

(ii) Group-Task motivation: - in general, Cartwright and Zander (1968) report that:

- group goals are more acceptable where members are involved in their formulation.

- co-operative groups tend to be more effective, with a higher degree of member satisfaction than competitive groups.

- communications are more efficient in co-operative groups which put a greater emphasis on co-ordinating individual member's contributions.

- co-operative groups generate more pressures to achieve task objectives. In competitive groups achievement of a solution is mainly dependent upon one individual's contributions.

- group members will strive for success and attempt to avoid failure where; (a) they perceive themselves to be members of that group, (b) they perceive that the group has its own identifiable task.

Success or failure in previous activities may also be related to motivation and to propensity for risk-taking.

(iii) Group Cohesiveness: - in general, the following facts emerge (Krech et al (1962) Davis (1969)).

- highly cohesive groups are more effective.

- highly cohesive groups are more likely to agree on a common goal.

- cohesiveness increases in a cyclic manner with success on problem-solving tasks. Task failure or imperfect goal attainment tends to reduce cohesiveness.

- task failure may increase cohesiveness where the cause of that failure is attributed to factors outside the group or beyond their control.

Whilst cohesive groups are desirable, they may limit effectiveness along other dimensions. For example heterogeneous groups have been shown to have more value than homogeneous ones, particularly in problem-solving circumstances. Yet these groups are likely, by virtue of their differential membership, to be less cohesive.

Healthy competition within groups is valuable as a stimulus: this can be restricted by excessive cohesion.

Sayles and Chandler (1971) suggest that too-highly-integrated groups become 'insulated' from the rest of the organisational world and lose their receptivity to stimuli.

(iv) Relationships between members - there are two distinct patterns of relationships, formal and informal. Formal roles such as chairman, group leader, group participant, secretary etc. define formal patterns of relationships. However, all groups are in fact dominated by informal role relationships: Benne and Sheats (1948) give some examples of functional roles amongst group members. Process analysis (Bales (1951)) reveals a variety of behaviours (e.g. opinion giving and seeking, information seeking and giving, supporting etc.) which serve to describe the interactive display of relationships.

Other informal role relationships exist which are not directly task-oriented but related to individual personality; examples include joker, energiser, standard-setter, peacemaker etc. These are important in contributing to maintenance of the group.

Learning styles are also relevant in that some types may be incompatible with others: Carlsson et al (1976) discuss this phenomenon.

Sociometry (developed by Moreno (1948)) offers ways of analysing the relationships between individuals within the informal structure.

(v) Group Norms: - in general Davis (1969) identifies the following:

- norms vary in the degree of formality and the degree to which they are shared by group members.

- group norms pervade individual judgements.

- wide deviation from group norms tends to be discouraged. Tolerable limits of deviation are established within groups. Deviations outside these limits result in negative sanctions such as disapproval, rejection or expulsion.

- norm conflict may result in mixed-norm groups. In such groups there is a tendency towards establishing mutually-shared norms.

Norms are important elements in the historical development of groups since they become institutionalised; there is an accepted way of doing things. Newcomers to the group find themselves socialised into these value and belief patterns. Dale and Spencer (1976) discuss at length mechanisms whereby norms are created, upheld and changed: this has particular relevance to a discussion of innovation since new technology may violate norms concerned with accepted ways of doing things.

Norms represent shared beliefs about behaviour expectancies within the group: other cultural elements include shared values, attitudes, opinions etc. The cultural history of groups appear to play an important part in differentiation: variations between groups include ideological and even mythological differences.

(vi) Leadership Style - Style can be described as a pattern of behaviour and, in the context of leadership will describe the way in which the process of leading is carried out. Effectiveness of leadership will be measurable in the extent to which role responsibilities are discharged successfully and group goals are achieved. (Price 1972, Reddin 1970).

Research evidence on leadership tends to be confusing because of the absence of clear definitions. There appears to be little agreement as to what makes an effective leader, although a number of contradictory propositions have been advanced. Exhibit 16 summarises major theoretical contributions to the field of leadership style. Another type of representation of this data is given in Exhibit 17. Of particular significance is the contingency theory of Fiedler (1965) who argues that there is no one best style, but rather that style should vary with the demands of the situation.

Baumgartel (1957) examined leadership style in Research and Development administration and concluded that a participatory style ranked significantly higher than either laissez-fare or directive on dimensions of:

- overall satisfaction with leadership
- attitude towards Research and Development director
- importance attached to research orientation
- extent to which the job provided for a research orientation.

However, the suggestion is made (e.g. Twiss 1974) that the more highly programmed nature of development activities might be better suited to directive styles.

In the special case of problem-solving groups the match between leader and participants is important. Structured techniques like Synectics rely on process rather than task leadership and Saward (1976) discusses the various combinations of style matching under these conditions.

The function of leader varies enormously with different groups: some typical requirements are: decision-making, activity leading, planning, information channel, technical expert, support etc. For this reason, style will depend on the type and composition of group and its leadership requirements.

EXHIBIT 16 : Major theories of leadership and management styles

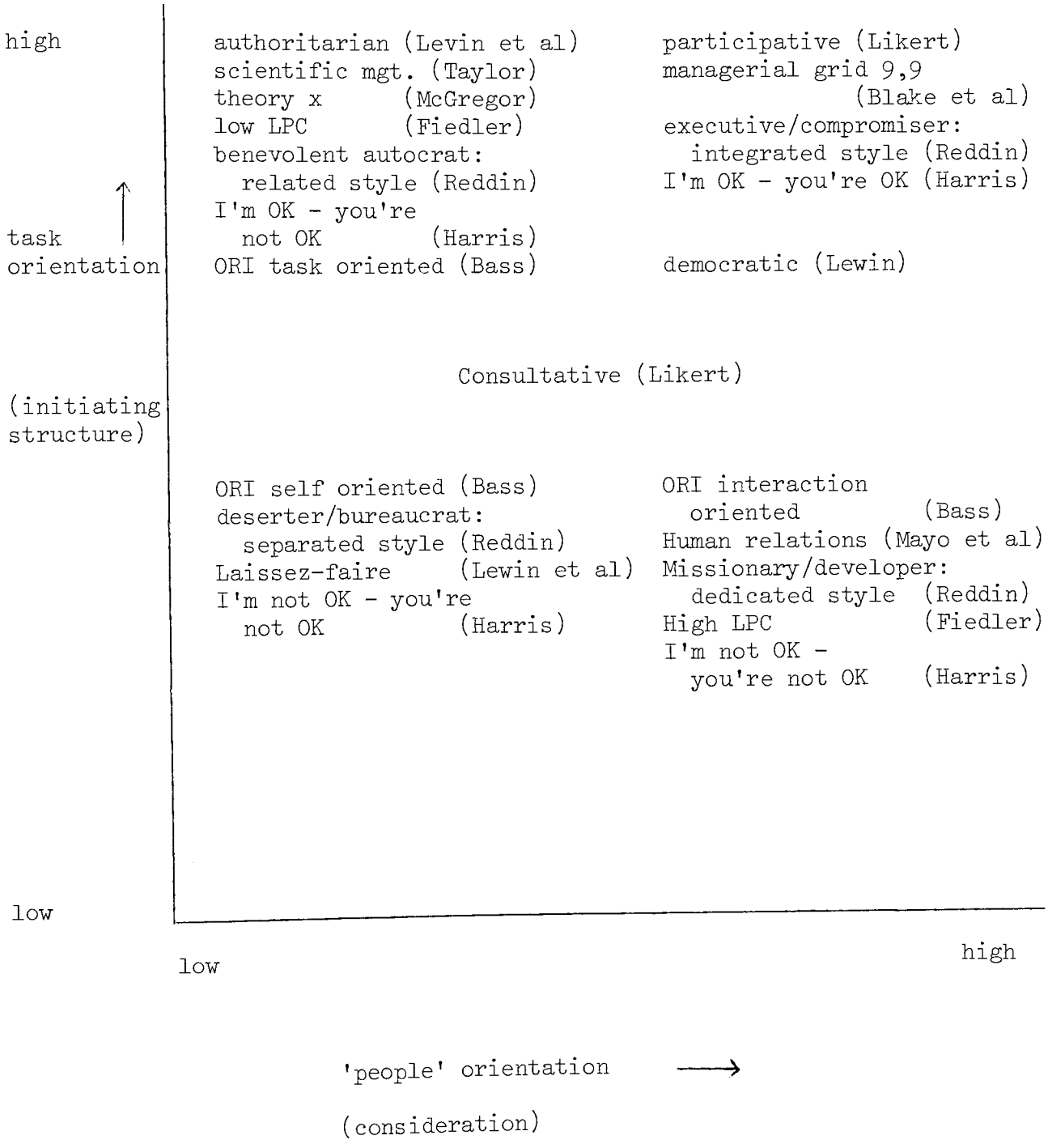
(Saward 1976)

date	author	base	central principle	major contention
1911	Taylor	'Scientific Management'	engineering	high task orientation best
1931	Mayo Roethlisberger Dickson	'Human Relations'	motivation	high social relations best
1938	Lewin Lippit White	Michigan State University studies	participation	democratic approach is generally best
1955	Fleishman Harris	Ohio State	consideration and initiating structure as key dimensions	no one style is best
1959	Herzberg	job satisfaction	motivation	use of 'satisfiers' leads to high motivation
1960	Bass	Orientation inventory	consideration and initiating structure	style must fit situation (contingency approach)
1961	Likert	Comparative management systems	participation	(movement towards System 4 is best)
1961	Berne	Transact-ional analysis	psychotherapy interpersonal behaviour	style match (I'm OK - You're OK is best)
1962	McGregor	Comparative management systems; theories X and Y.	participation	Theory Y is best.
1964	Reddin	3-D theory (extension of Ohio state)	consideration and initiating structure	style must fit situation (contingency approach)

date	author	base	central principle	major contention
1964	Blake, Mouton	Managerial Grid	consideration and initiating structure	9,9 style is best
1965	Fiedler	Multi-observation using least preferred co-worker scale	consideration and initiating structure	style must fit situation (contingency approach)
1968	Adair	Eclectic	action-centred leadership	fulfilment of of individual, group and task needs
1970	Argyris	Electic/ motivation	'self-actualisation'	individuals are most effective when they achieve self-actualisation
1971	House Dessler Stinson	path-goal (expectancy)	motivation	style must fit situation (contingency approach)
1976	Saward	Synectics groups studies	style match	combination of leader/member style is best

EXHIBIT 17 : Framework of Leadership and Management Style

(Saward 1976 after Gagne 1939)



(vii) Level of Development - The model proposed to illustrate development levels in individuals applies equally well to groups. As before, three key dimensions define the space in which development can take place: awareness (understanding), resources (ability) and will.

Groups, being made up of individuals, will have different development patterns. Resources may be highly developed insofar as the group can call upon a number of skilled specialists: this is the philosophy behind the project team. Equally a functional group may be deficient in a number of important skills because of a defensive orientation to outside contact. Since external complexity is increasing, it is likely that the incidence of new skills deficiency will also be growing: resource development is important.

Awareness - understanding of the group, its role and relationship to others and to the organisation is an area receiving much attention through interventions such as organisation development. The aspiration here is towards cohesive, flexible self-confident, 'self-actualising' groups which are well-integrated with the remainder of the organisation.

(d) Coping Strategies - Emerging from the preceding evidence are a number of general strategies; these include

- group size should vary with the nature of task
- group composition should aim for heterogeneity as opposed to homogeneity in personality characteristics
- group cohesiveness should be high (this may be an incompatible requirement with high levels of heterogeneity)
- group conflicts should be resolved rather than 'smoothed' over
- group status structure should be stable
- groups should operate at Tuckman's 'performing' stage of development
- group communication patterns should vary with the nature of the task being undertaken
- group behaviours should aim to be co-operative within and competitive between groups

Groups cope with achieving their goals in the organisational environment by employing a number of maintenance strategies. Some of these have already been discussed - e.g. the withdrawal of Research and Development groups into ivory-towered isolation when faced with strong criticism of their role and contribution. Political manoeuvering will be another way in which groups attempt to maximise their control over resources and their environments.

Improving group problem-solving has been the subject of a number of approaches, the most commonly known of which are brainstorming and synectics; Saward (1976) and Rickards and Freedman (1978) review literature on brainstorming and allied techniques.

(e) Improvement Strategies - In terms of strategies for developing group effectiveness, there are a number of available approaches. Much has been done in the field of group dynamics (as reported by Cartwright and Zander (1968), for example) and a great deal about effective group management can be trained. Inputs of this kind range from simple recognition of the value of the informal structure and development thereof to sophisticated interventions loosely classed under the heading of organisation development. Team-building and training is a popular exercise but there are many other options available. (Pfeiffer and Jones 1976).

Conflict resolution is another area which has received considerable attention (e.g. Filley 1977) and training in mechanisms for resolving unproductive conflict has been demonstrated to bear upon group effectiveness (Blake and Mouton 1964).

Of particular interest are activities aimed at developing effective groups of the nominal or short-life kinds - for example, project teams. Horsley and Henderson (1978) describe approaches adopted within I.C.I. for the large teams involved in commissioning major capital plants. A range of team-building and conflict-resolution training interventions were used and resulted in teams representing various functional specialisms which had a high and flexible problem-solving capability. They report that commissioning of plants in this way appeared fast and efficient, and that post-commissioning operating problems were also quickly resolved.

Section 3 - Organisational level influences:

According to Galbraith (1977) organisation 'emerges whenever there is a shared set of beliefs about a state of affairs to be achieved and that state of affairs requires the efforts of more than a few people'. He argues that, in organisations:-

- relationships among people become patterned

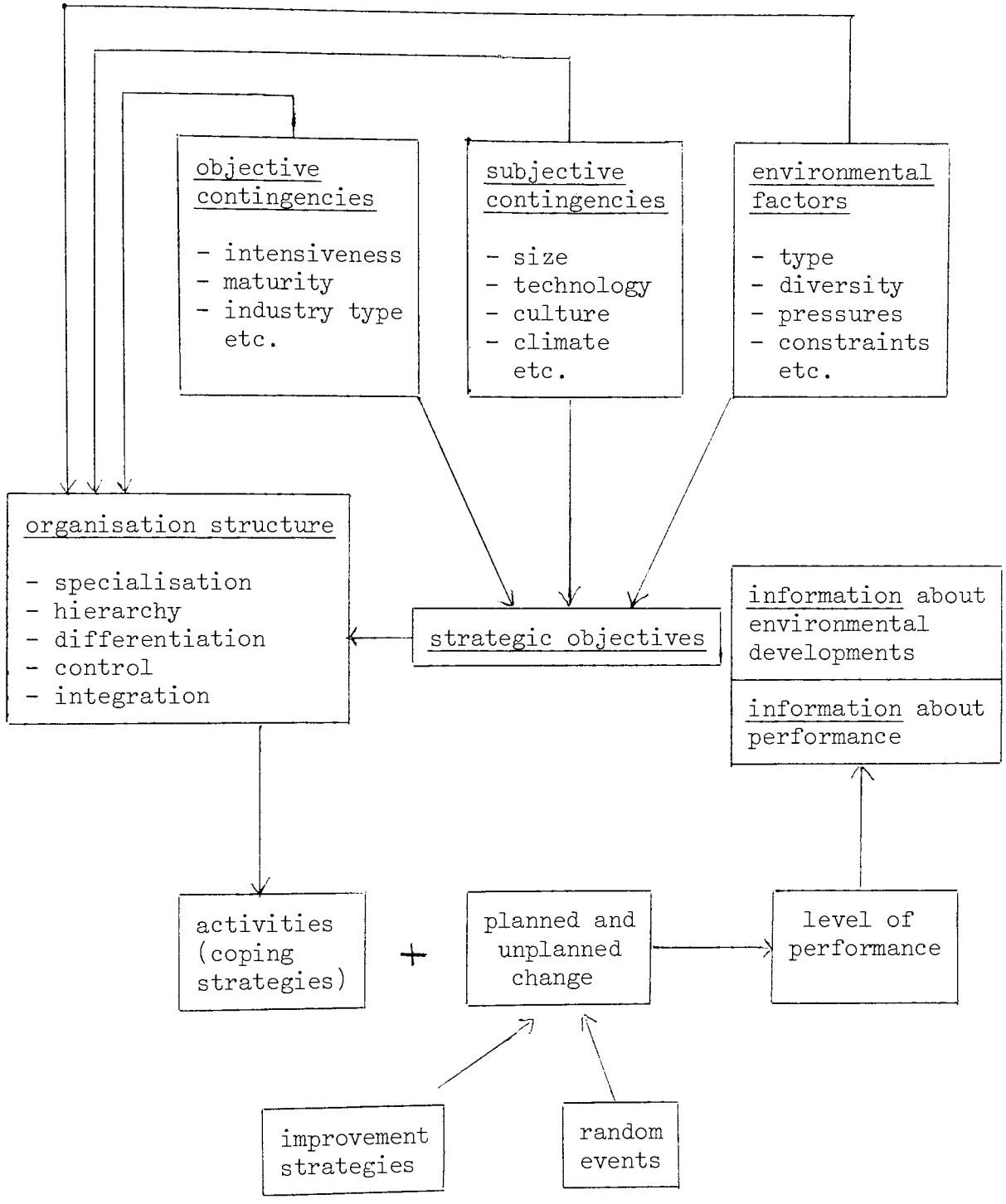
- the behaviour patterns derive from a division of labour among the people and a need to co-ordinate the divided work.

A working definition of an organisation might be: 'One or more groups, of people, who pursue some shared purpose, continuously through time, using a division of labour, integrated by information-based decision-making'.

In pursuing a shared purpose, some activities can be repeated in a routine fashion, but, for other activities, new ways of doing things will be required. New circumstances necessitate innovation.

Exhibit 18 presents a diagram indicating key elements in organising. Within this framework, innovative activities are influenced directly by structure, plans and policy, and indirectly by strategic objectives. All of these elements will themselves be affected by pressures and contingencies shown on the left: type of environment, technology, personnel, culture etc. Structural factors will be considered first.

EXHIBIT 18 : Organisation Level Influences Model



(a) Structural Influences

Child (1977) indicates the components of structure and the consequence of structural deficiencies.

Significant elements of structure are:-

- specialisation of jobs

- hierarchy and spans of control

- horizontal differentiation

- integration

- control, delegation, formalisation

(i) Specialisation

Specialisation is, in one sense, a necessary consequence of growth; as industries develop, so new knowledge and techniques arise which require the skills of specialists - the emergence of computers is a typical example. If is also, however, an element of dubious value in the sphere of operative work: carrying Taylorism to its extreme by reducing the range and increasing the output of operations performed by, for example, a manual worker.

These two aspects of specialisation have different meanings for innovation.

Specialisation by knowledge: this creates a wider range of resources and skills from which to develop innovation. A trade-off is involved, however, with accompanying increases in costs and complication of existing relationships and communication patterns. For this reason qualified specialists are not a sufficient condition for innovation success, despite the suggestions of some general studies.

Research over an international sample suggests a relatively typical curve relating specialisation to size.
Child (1977): this argues that specialisation is a consequence of growth. Conflicts between staff and line managers have been reported in detail (e.g. Dalton 1950) and Pettigrew (1974) provides an excellent descriptive study of the emergence of, and resistance to, a new specialist group within an established organisation. Since innovation often creates new areas of knowledge, skills resources etc. it will be responsible for the generation of new specialisms.

Apart from political issues associated with control of new resources etc., specialisation may give rise to problems of fragmentation of outlook, understanding and perspective. Conflicts of the 'us and them' variety between specialist groups are common: equally there may be different values and allegiances between the organisation and 'professional' specialist groups. These factors will bear on innovation success.

Specialisation by subdivision: In the case of operative jobs, trends have been towards greater subdivision, simplification and standardisation; this approach is criticised on a number of grounds. In the first place, highly specialised and routine jobs provide little opportunity for workers to find higher levels of need-satisfaction (e.g. Maslow's model 1954). This has demonstrable adverse clinical effects (US Department of Health, 1975) and less obvious but potentially more damaging psychological and sociological ones.

Education has raised the standard of ability in most developed countries so that expectation of the degree to which people wish to use their own judgement has also risen. HIghly specialised and standardised jobs tend to require less judgement, in opposition to this trend, and thus will provoke frustration and strain leading to actions detrimental to efficiency. Absenteeism, strike action, sabotage and high labour turnover can all be viewed as symptoms of dissatisfaction.

A warning example of this might be the Lordstown plant of General Motors which, in terms of technological process innovation, might otherwise be regarded as a major advance. Cycle times per job are as low as 36 seconds - but the plant has consistently failed to fulfil its potential due to industrial 'guerrilla' activity. With the strength of trade unions in the UK, the possibility of process innovations in labour intensive industries - e.g. automation of chemical works - is likely to be strongly resisted on the grounds that it may erode still further the degree of worker satisfaction and involvement. It would also create redundancies and might well result in political consequences during periods of high national unemployment.

Little has been done to try and modify the effects of operative specialisation; the most notable examples follow the directions of job enhancement and job enrichment. In the case of job enlargement, attempts have been made to broaden the tasks performed whilst maintaining vertical control of the operation. Job rotation essentially follows a similar strategy. Often this has involved a shift of emphasis from the individual worker towards work groups adn favourable results such as increase in satisfaction, higher efficiency despite longer cycle times etc. have been reported. (Trist and Bamforth, 1951, Miller and Rice 1967).

Job enrichment is essentially a development of this theme; following Herzberg, many writers now believe that 'adding one Mickey Mouse job to another still only gives two Mickey Mouse jobs'. Thus the trend is towards involving workers in the control aspects of their jobs as well as expanding their operational range. Much has been heard recently about various Swedish experiments in this field (Volvo, Saab/Scania, Orrefors Glass etc.) and similar experiments have been reported in most Western countries and Japan. 'Group technology' - the rearrangement of grouping of machines etc. by function to their contribution to a common product - has also been extensively tried with some success; this method sets up relatively self-contained work groups and provides the opportunity for increased flexibility and decision-making. In general efforts in the field of job enrichment have attempted to reduce specialisation so that:-

- each employee sees a tangible result of his labour relative to the whole product.

- each employee is aware of the quality of this result via some form of direct feedback.

- each job contains some personal challenge beyond the exercise of mere mechanical movements.

- each employee can organise his work to suit his own rhythm, pace and capabilities.

Such experiments have not always succeeded and Hackman ( ) indicates some of the likely reasons for this. However, as Child puts it, 'if greater satisfaction can be provided through the restructuring of jobs in ways that link its achievements to the economic requirements of the organisation, then the effort is well worth making'.

Innovation, as we have already seen, requires the commitment of all those involved and approaches like those indicated above, seem likely to better provide for this than more traditional methods of job structuring. A further benefit may well be that increase in worker autonomy will generate more creative attitudes amongst work forces, and give rise to suggestions for improvement of products or processes.

(ii) Hierarchy and spans of control

(1) Hierarchy

The debate about 'tall' and 'flat' organisational hierarchies is well-argued: the general conclusion is that in developing organisations, there should be a trend towards broadening managerial spans of control and thus a 'flattening' of hierarchies.

In the case of innovation, which relies so much on individual motivation, initiative and commitment, this trend must be seen as potentially advantageous since it offers an increase in control over activities and personal responsibility for them.

Hierarchical structures are usually defined by the number of levels which are involved in an organisation of a particular size. 'Tall' then refers to a high number, 'Flat' to a relatively low number for a given size. Research on this factor (Pugh et al, Kieser and Child 1977) indicates that hierarchies follow a distinct pattern.

Superficially, there is little to support the continued existence of tall structures: they give rise to problems like:-

- high administrative overheads

- communication problems

- dilution of top management control

- ambiguity of role and task

- reduction of subordinate motivation

(2) Spans of Control

Problems associated with wider spans of control act to resist the trend towards flatter structures. Classical theorists (e.g. Fayol 1949, Urwick 1953) argue for a limit on managerial control spans - principally on grounds of personal limitations of attention, memory, energy etc. Graicunas (1933) demonstrated that an arithmetic increase in the number of subordinates is accompanied by an exponential increase in the number of relationships to be managed. The desire to restrict control to the top of an organisation is incompatible with this principle. Only in the small organisation can spans of control and levels of hierarchy be restricted: this suggests one set of administrative advantages associated with small size.

The real issue involved is control over what. Activities which are programmable and predictable will offer low supervisory burdens and thus low limitation of spans of control. By contrast, uncertain, non-programmable activity such as innovation will place a strain on simple supervision. Woodward (1965 suggests the following determining factors:

(i) degree of interaction between personnel and units under supervision.

(ii) degree of dissimilarity of activities under supervision.

(iii) degree of physical dispersion of activities.

(iv) incidence of new problems in supervisor's unit.

(v) extent to which supervisor must carry out non-managerial duties and demands on his time from other people and units.

Aspirations of individuals towards autonomy requires that a balance be struck between their capability and the technical complexity of the overall operation. The discretionary content will be limited by knowledge, experience and task-related contingencies. In the case of innovating groups, integration of different specialists is important; high levels of cohesion are required to cope with uncertainty and new information. Size of such groups should be restricted: research suggests that beyond eight members, conflicts between factions emerge, participation decreases and the number of relationships to be managed increases. There is thus an argument for a number of small innovating teams loosely grouped under a formal umbrella function.

Motivation is relevant here: one argument for widening spans of control and reducing hierarchical levels is that people tend to respond in positive fashion to increased scope and responsibility.

(iii) Horizontal Differentiation

As vertical differentiation poses problems about the best configuration of levels and spans of control, so the grouping together of the range of jobs in an organisation is also important. Amongst the principles under which grouping can take place are:

- according to function: members of organisations sharing common expertise and drawing on common resources (even when working on different projects).

- according to process or technology: examples of this might be production units making different products using the same plant, or Research and Development using pilot plant for different trials.

- according to product: specialist tasks often contribute to the same product or family of products which are essentially similar in terms of market and technical factors.

- according to time horizon: tasks can be linked together when they share similar time horizons: operations like production have a day-to-day orientation whilst others like Research and Development are concerned with long-term future events.

- according to geographical location: specialists grouped by situation, e.g. Research and Development or production units on their own separate sites.

These arrangements can, in practice, be combined in various ways. Choice depends largely on size and complexity in the organisation: as small firms grow, it becomes necessary to group via more formal arrangements. In many cases, functional grouping is the natural arrangement until problems of diversification arise. If an organisation continues to grow and become subject to tighter time constraints in adopting new products or processes, then the simple functional system will begin to break down under the strain. Product structures begin to emerge when an organisation produces two or more distinct ranges of products or services, which are different in their technical make-up, production requirements or types of outlet. Giant corporations, especially multi-national ones represent the extreme case of this, where separate divisions have totally different areas of activity. Innovation is an important determinant here; the higher the rate of technical change and the greater the pressure for rapid response to external changes, the more the product system will emerge as more appropriate than the simple functional approach.

Walker and Lorsch (1968) report a comparison between two similar firms operating functional and product systems respectively. They found that in the functional structure specialists tended to identify with their departmental goals, with other members of the same functional areas, had a generally short-term outlook and was characterised by a high degree of formality in procedure, job definition etc. By contrast, the product-system firm had a higher awareness of common goals within the firm, a wider range of time horizons adopted, had more effective communications and resolved conflicts more openly. They conclude that in conditions demanding some change and active problem-solving a product form may prove superior because it encourages more intensive communication, confrontation of issues and integration of effort.

Structures can be seen as networks through which flows of information and resources pass; thus the decision on the grouping arrangement will largely depend on the demands of the flow system. In an activity like innovation which requires a high level of integration and flows between a wide range of specialisms, it is likely that a simple functional grouping will be insufficient.

A number of 'mixed' structures have been experimented with: 'systems' models and matrix organisations are the two best known. In the former case, usually practised between divisions of large organisations, there is a central pool of resources in certain specialist areas from which various functions can draw - e.g. corporate research or computer systems.

A matrix structure whether temporary, as in the case of a multidisciplinary project team, or permanent, is characterised by a product logic grouping within a broader functional framework. It draws together resources from a wide variety of functions in order to accomplish some specific task. The principal advantage of this arrangement is that formalised lines of lateral communication are superimposed on the vertical hierarchies of functional departments - i.e. there is a formalisation of the informal communication structure which normally exists between departments.

This method raises some problem issues. Of necessity it will give rise to role ambiguity and uncertainty for individuals involved; the formalisation of conflict between functional and project criteria will inevitably lead to mixed objectives and responsibilities and political activity will emerge at a high level. The problem of 'serving two masters' may well represent major difficulties for organisations trying to implement matrix structures.

In terms of the positive aspects of matrix organisations, they help to preserve flexibility within the rigid constraints of most structures. Burns and Stalker (1961) argue strongly for the adoption of 'organic' systems to cope with the creativity and speed of response required to changes in a dynamic environment - such as the adoptive activities involved in innovation. Matrix arrangements can be viewed as an attempt to move towards organic and away from mechanistic systems which assist an organisation to match its degree of internal flexibility to that required by the complexity, change and uncertainty of its environment.

Other advantages are:-

- stimulation of competition within an organisation

- delegation of authority to less senior managers (improving motivation and management development)

- increasing participation (giving everyone an involvement in significant decisions)

- exposing specialists to a wider range of considerations (broadening outlook).

In essence matrix structures represent an attempt to retain the advantages of functional grouping such as economic operation and development of technical capability, whilst trying to co-ordinate resources in a way which applies them effectively to a variety of organisational outputs.

(iv) Control, delegation and formalisation

This element is essentially concerned with regulating activities within an organisation to remain in line with expectations of policies, plans, targets etc. Traditional views emphasised the vertical nature of control from above, but this method has devious limitations because it does not admit feedback or the need to secure motivation from those directed. Complex and diverse organisations force some measure of decentralisation of control to sub-units by virtue of problems of size and communication.

As Child puts it 'control involves the definition of what people and units are to do, the establishment of criteria against which the performance of their activities is to be assessed, and a feedback of information as to what has, in the event, taken place. There should also be provision for feedforward control in which predictive forecasting information is used as a basis for assessing whether adjustments to plans are necessary'.

So the choice of control method should be compatible with the needs of the operating situation, and with the motivational needs of those involved. This may well prove a difficult decision because of the need to strike a balance between orderly administration and unity of action on one hand, and encouragement of initiative and contribution on the other.

Child identifies basic dimensions of organisational choice with respect to control:-

(a) Centralisation vs delegation. These two do not necessarily represent poles of a continuum, since it is likely that a mixture of them will be required - e.g., it is sensible to allow for delegation of routine operational tasks to allow senior management freedom to cope with more significant work. Carlisle (1974) lists the following advantages for centralisation.

- if decisions are made at one point, it is easier to co-ordinate the activities of the sub-units or individuals who report up to senior management.

- from their position in the organisation, senior management are better placed to make decisions which will accord with agreed policies and be consistent with the interests of the entire organisation.

- centralised control provides a way of keeping the various functional areas in an appropriate balance with one another.

- centralisation can economise on managerial overheads.

- top management have much experience by the time they reach senior positions and thus it is arguable that they will be particularly capable of making good decisions and exercising appropriate judgement.

- centralisation encourages strong leadership by focusing power, authority and prestige onto a 'central key position, and affords an opportunity for speedy decision-making in response to unexpected crisis.

Arguments for delegation are:-

- it relieves senior management of some of their burden of responsibility, reducing stress and leaving them free to cope with policy matters of longer-term consequence.

- motivational consideration suggest that people are willing to give more to their jobs when they have a high degree of individual freedom, discretion and control over their work, as in a delegated system.

- by developing judgement, ability to copy with uncertainty and other skills associated with assuming responsibility, delegation helps provide senior managers of the future with relevant experience.

- it permits greater flexibility and a more rapid response to change at operating levels in the organisation because decisions do not have to be referred up the hierarchy unless they are exceptional in nature.

- so long as he is aware of,understands, and accepts corporate policies, the man on the spot is likely to make better decisions for reasons of greater awareness of local condition in which the problem arises.

- by establishing relatively independent sub-units within an organisation where managers are responsible for their own operations, delegation can result in more effective controls and performance measurement.

From evidence available (e.g. Child and Kieser) it appears that choice of control will depend on a number of contingent factors: Carlisle lists the following:-

- the basic purpose and goals of the organisation

- the knowledge and experience of top-level managers

- the skill, knowledge and attitudes of subordinates

- the scale or size of the organisation

- the geographical dispersion of the organisation

- the scientific content of the technology of tasks being performed

- the time frame of the decisions being made

- the significance of the decisions to be made

- the degree to which subordinates will accept and are motivated by the decisions to be made

- the status of the organisation's planning and control systems

- the status of the organisation's information systems

- the degree of conformity and co-ordination required in the tasks and operations of the organisation

- the status of external environmental factors such as governments, trade unions etc.

In general, there appears to be a strong connection between the degree of centralisation/delegation and the information-processing requirements of an organisation; the less stable the conditions, the greater the need for delegation. Only in quite small organisations does concentration of decision-making make for superior adaptation to external changes. As uncertainty increases, it becomes more efficient to bring the points of decision down to the areas where information exists. Increasing employee discretion alone introduces the problem of ensuring that choice will consistently follow lines appropriate to the organisation. This can be done by increasing the degree of professional specialisation so that employees become responsible for their own areas. Goal setting (management by objectives) can be used to integrate local group goals to overall policy; within specified

constraints, the local group is free to make decisions and to use its discretion. When planned targets are exceeded or constraints violated, the problem is referred upwards through the hierarchy; so called management by exception.

(c) Formalisation vs Informality. Policies, procedures, rules, definitions etc. are all attempts to maintain control via formal mechanisms; these are often complementary to centralised systems and will be best suited to stable conditions. Research has indicated that the degree of formalisation increases as the organisation grows in size (e.g. Webber 1974); this is necessary in view of the greater complexity to be controlled. However, there are disadvantages to this mechanism of control, such as:-

- it is poorly adapted to the rapidly changing demands of a complex, unstable environment.

- it threatens people's informal mechanisms for doing things and may be seen as an intervention designed to limit their discretion and autonomy.

- it may introduce new and unattractive methods and procedures.

- it may reduce innovative contribution and sense of direction.

There is an important trade-off to be made here; centralised firms may use formal systems to 'delegate' decision-making etc. whilst retaining a measure of control, and evidence suggests that delegation/ formalisation strategies are the most effective in terms of financial criteria. The critical issue, particularly for innovation, would seem to be one of organisational flexibility vs rigidity.

(v) Integration

One of the inevitable consequences of organisational growth is increasing vertical and horizontal differentiation: the dangers of breakdown in this system are apparent, particularly when the organisation comes under stress. Results of lack of integration are delays, inefficiencies and frustration, the elements of the organisation using their energies in a destructive, internal fashion, rather than a productive external one.

The 'centrifugal' tendency (Child 1977) of organisations means that, beyond a small size, where informal integration is possible because everyone knows everyone else and shares common goals, there will be a need for formal solutions to the problems created by differentiation. The problems often have the following characteristics:-

- communication links tenuous, people tend to communicate within, rather than between, departments.

- identity with own department at expense of integrating with other groups.

- different tasks, processes, time horizons etc. harden into 'us and them' attitudes.

- disputes over resource allocations.

- variations in norms and values between groups.

In the case of an organisation carrying out work under stable conditions, integration can be performed by standardised procedures, regular meetings and referral upwards of difficult decisions. However, for the case of a complex and demanding environment which requires rapid decisionsand frequent adaptation, these procedures will be insufficient. Since the rate of change, and the complexity of problems faced, are increasing for most growing organisations, achievement of progressively higher degrees of integration becomes a major priority for management.

Child (1977) identifies the following areas where integration may prove an important issue.

- relating 'peripheral' to 'core' groups (e.g. branches to headquarters).

- securing and evaluating information from outside the organisation for planning purposes.

- promotion of innovation and integration of the specialists involved into the mainstream organisation.

- creation of effective production management teams.

- co-ordinating complementary services offered by different professions.

Lawrence and Lorsch (1969) in their study of the management of differentiation and integration show that performance is directly linked to integration capability of a firm. The most successful firms adapted their structures to suit the demands of the environments in which they were operating: in several cases, the firms were involved in the plastics industry and their product innovation process was characterised by high levels of technological and market uncertainty. From their and other studies it is possible to identify a number of integrating mechanisms most of these fall into one of Thompson's (1967) three categories.

(a) integration by standardisation - this involves the establishment of rules and procedures which channel actions of differentiated units into a consistent pattern.

(b) integration by planning - this involves planning and scheduling of activities so that they can be brought together: this method offers more flexibility in that plans are amenable to modification at short notice.

(c) integration by mutual adjustment - in Thompson's terms, this involves direct transmission of information between people and the mutual adjustment of their actions in the light of that information. Examples are:-

- direct contact between individuals sharing a problem will be the simples method: here the problem is solved by direct discussion and action and avoids referral upwards.

- where there is a more regular and higher volume of contact between groups engaged on sub-tasks - e.g. development and commissioning activity - it may be necessary to set up a liaison role to handle intergroup contacts.

- where there is contact between several groups - e.g. research, testing, production etc., it may be necessary to extend this principle to setting up a task force with the responsibility for resolving interdepartmental problems.

- creation of a general integrating manager role to provide an element of leadership in large-scale co-ordinated activities, e.g. project manager, product manager etc.

- matrix structures - discussed earlier

- project teams - " "

Evidence (Van de Ven, Delbeaq and Kuenig 1976) indicates that the use of lateral co-ordinating mechanisms increases with task uncertainty as the use of rules and procedural mechanisms declines. Also hierarchy remains a constantly used point of referral, and organisations tend to use several co-ordinating mechanisms simultaneously.

Bureaucratic organisation forms, which are the prevalent model for most industrial firms, rely heavily on the first two of these forms of integration. For stable operating conditions, this is probably the best arrangement since it is simple, cheap and depends upon plans and procedures, on people knowing where they stand.

Moving out of these conditions will force a gradual breakdown of this system, however, and integrative mechanisms of the third category will have to be sought. Innovation invariably involves an organisation in complex, unstable areas of activity, and thus it is for integrating mechanisms of the mutual adjustment type that firms involved with technological change should be concerned.

A fourth approach should also be mentioned here: as outlined by Beer (1973), it represents a cybernetic view of organisation. He argues from Ashby's Law of Requisite Variety that increasing complexity (= variety) in the system must be matched with an increasingly complex regulatory system. Eventually (and he argues that we may have already reached this point) it will be impossible to operate such a complicated system. Strategies to cope with this kind of breakdown would have to involve structural changes aimed at producing 'variety sponges' to absorb excess variety and leave the system controllable.

(b) Environmental Influences

Type of Environment

Attention has been drawn to environmental qualities in the section reviewing characteristics of innovation: these findings will be briefly reiterated here.

Environments vary along dimensions of simple/complex and static/dynamic (Duncan 1975). Dynamic environments are those in which changes are difficult to predict and which involve departures from previous conditions. Complex environments are those in which the organisation is involved in many interacting and diverse sectors and is required to monitor large amounts of external information.

Both of these factors contribute to the uncertainty involved in organisational response to the environment and thus have important strategic implications. A number of writers have identified possible organisational responses which relate to successful performance in uncertain environments. (Burns and Stalker 1968, Lawrence and Lorsch 1969, Duncan 1975, Khandwalla 1972).

These include:-

I. reduction of need for information processing. Galbraith (1977) suggests this can be achieved by environmental management, creation of slack resources or creation of self-contained tasks.

(a) environmental management is an attempt to reduce uncertainty by controlling the environment: this is usually achieved via vertical integration. Other mechanisms include mobilising support of influential groups, e.g. public opinion, entering into joint agreements and cartels which control the competitive aspect within limits etc.

(b) creation of slack resources is an attempt to reduce uncertainty by lowering the level of performance expected; this reduction in tension means that constraints are loosened on projects and there is a greater likelihood of success.

(c) creation of self-contained tasks is an attempt to reduce uncertainty by breaking the major task down into a series of sub-tasks. Each sub-task is handled by a group which has all the resources and complete responsibility for carrying it out.

II. Increase capacity to process information - this can be done by investing in vertical information systems or by creating effective lateral relations.

(a) investment in vertical information systems will allow an organisation to process information acquired during the performance of uncertain tasks without overloading the hierarchical communication structure. Mechanisms for providing this extra capacity would include computers and a growing range of management information systems.

(b) creation of lateral relations will involve moving the level of decision-making down to where the information exists rather than bringing the information up to the point of

/hierarchical decision.

III. high levels of internal differentiation: environments with high uncertainty characteristics force an organisation to place specialists at its boundaries to link with the outside world; this proliferation of specialist differentiation is often accompanied by greater delegation (as above).

IV. high levels of integration: these are usually achieved through flexible, participative processes rather than formal, mechanistic ones. Demands of differentiation will require that integration between specialist areas co-ordinates them effectively so that the organisation can continue to adapt to high levels of external change and uncertainty. There will be a need for effective conflict-resolution mechanisms, e.g. confrontation, and for low-levels of formalisation and high levels of delegation.

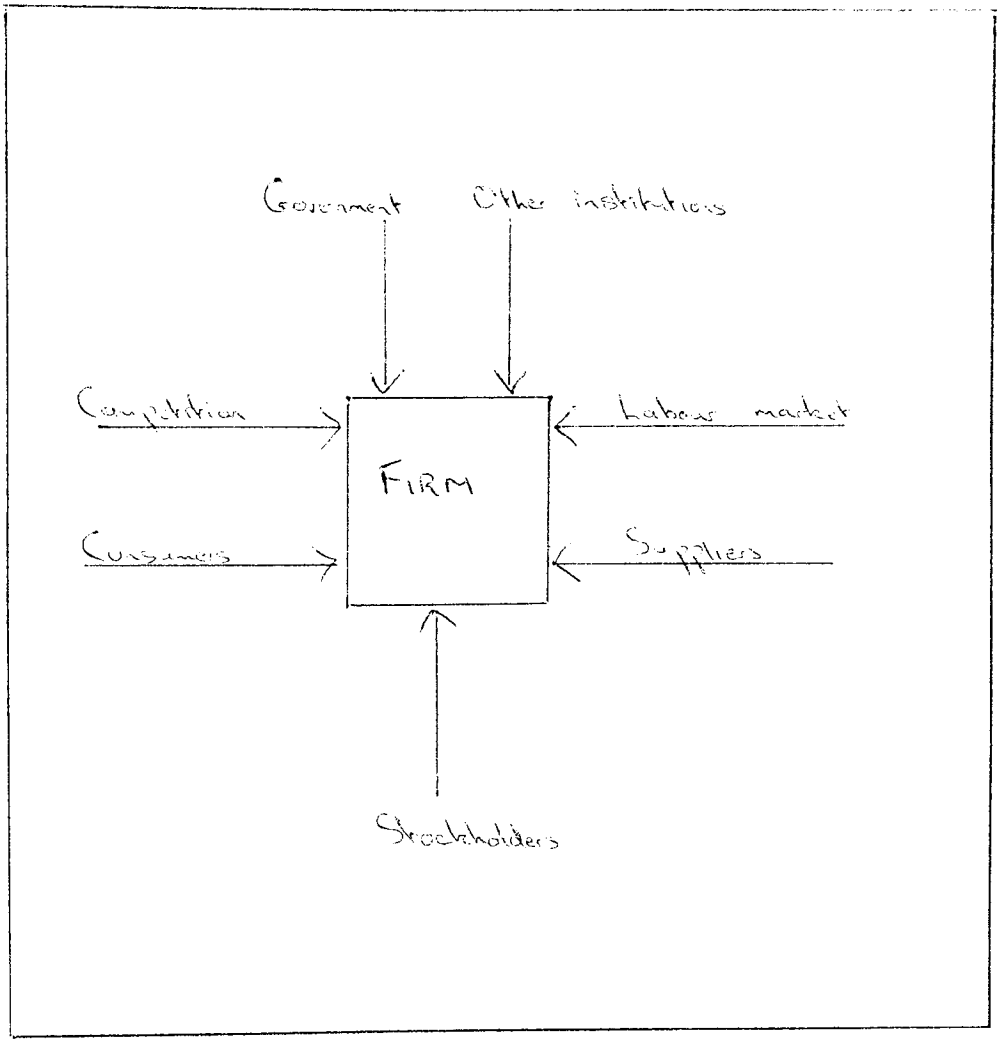
Diversification is another important strategy which large organisations tend to make use of: it represents a special case of delegation whereby autonomy for working in certain areas of business is granted to divisions. Evidence e.g. (Stopford and Wells 1972) indicates that companies which have 'divisionalised' their operations tend to be superior performers.

Another important study (Estafen et al 1970) indicates some of the factors which differentiate American companies as more successful than European ones in the management of environmental factors. In general they have a far more mobile and fluid approach to the world; information,men and materials all seem to move more quickly and easily in the American company. A model of the firm/environment interaction is suggested (Exhibit 19). Exhibit 20 illustrates comparative strategies to cope with these interfaces: it is clear from this that the American approach offers superior guidelines to operation within complex, dynamic environments.

Many theorists argue that tasks of organisations will become more technical, complicated and non-programmed, as environments become increasingly interdependent, turbulent and longer-term projects become the norm (e.g. Schon 1970). They argue that the key defining feature of contemporary society is change rather than stability and thus that organisational requirements will be different in character, involving diverse/

EXHIBIT 19 : Model indicating elements of company/environment interaction

(Estafen et al 1970)



and highly specialised competence (e.g. Bennis 1961).

Implicit in this is a need for organisational (= structural and social) innovation to match the demands of a rapidly changing world.

EXHIBIT 20 : Comparison of interfacial management characteristics of American and Spanish Firms (Estafen et al 1970)

Interface	Characteristic	Spanish	American
(i) Stockholders	ownership	family-owned	one-parent company
	management	few owner-managers	few owner-managers
	value of equity (1963 - 7)	more or less constant	increased 58%
	supplies	land and buildings rented from owners	capital equipment and raw materials from parent firm
	information to owners	little, infrequent	detailed and frequent
	other business or social organisations	utilised	not utilised
(ii) Competitors	firm's ranking of competitive priorities	(1) price (2) quality (3) service	(1) quality (2) service (3) price
	competition by new product development	little or none	three firms
	change in relative competitive position over 1963-7 period	unchanged	improved by new product, better market distribution
(iii) Suppliers	Supplier of materials and money	small number	large number, information readily available
	informal contacts	infrequent	frequent - more than twice a week

Interface	Characteristic	Spanish	American
(iv) Consumers	number of clients	1800 (wholesalers only)	1500 (many retailers)
	marketing managers	not hired from customer's firm	one or two from customer's firm
	credit	same terms as American firms	greater percentage of long-term credit sales
	emphasis of advertising	quality of product	(1) new products (2) familiarisation with product name
	industrial products sale	occasionally provided technical information after sale	always provided technical information after sale
	(sales (1963-7)	up 75%	up 143%
(v) Government	government restrictions	no complaints	tax, import and labour tax
	taxes paid 1963-7	up 100%	up 124%
	reports to government	complied with law	twice as many as Spanish firms
(vi) Labour	total employment	20-30% more than US firms	more white-collar workers
	salaries for unskilled workers (1967)	792 ptas/wk.	887 ptas/wk. and more fringe benefits
	salaries 1963-7	up 193%	up 44%
(vii) Other Institutions	outside groups contacted	Barcelona Chamber of Commerce plus plus one industry association	long list of professional and industry
	educational donations	made by two firms	made by many many firms

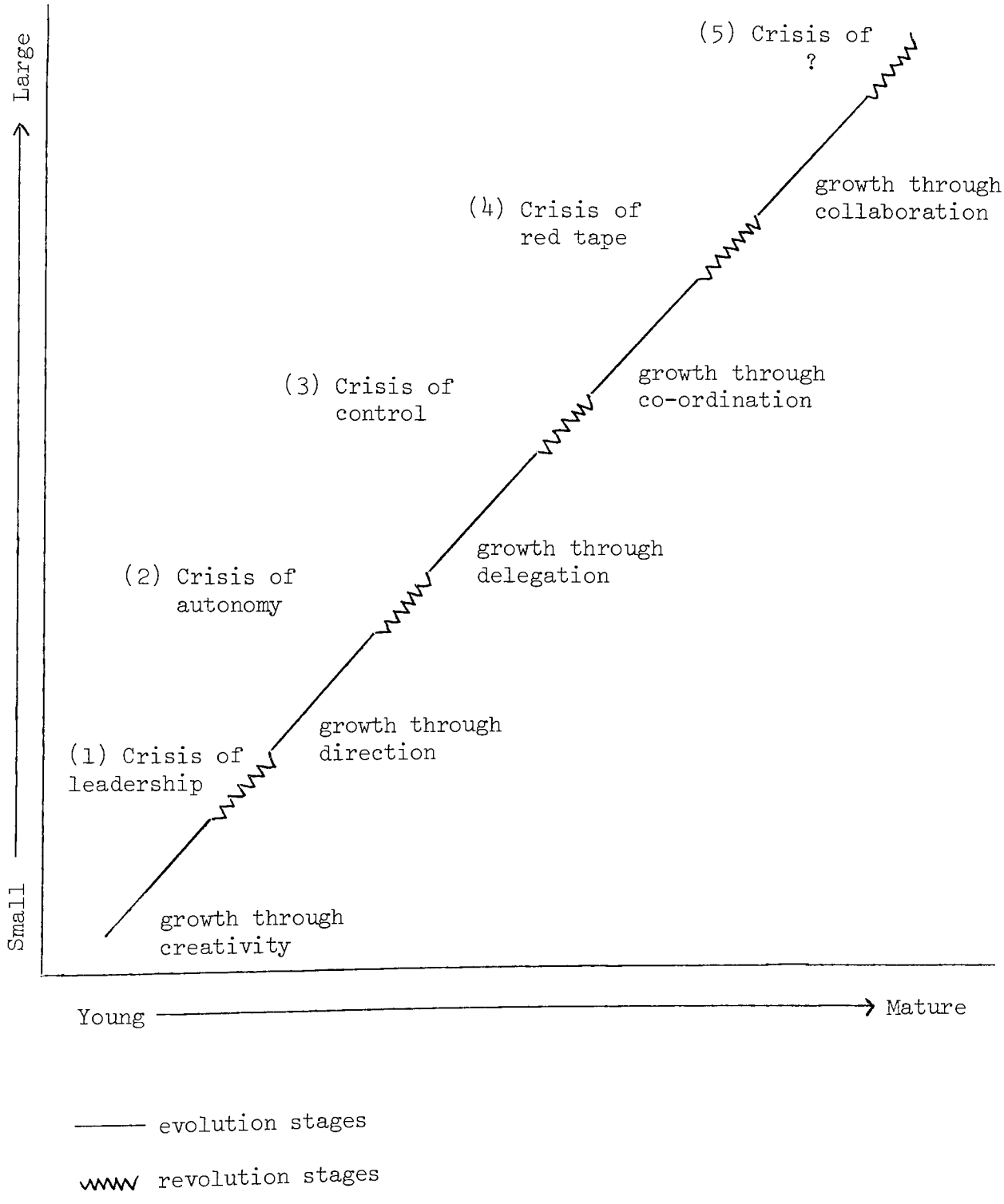
(c) Contingent Influences

(i) Growth and Size

It is a necessary condition in striving for equilibrium that organisations change their size: in most cases this will be a growth activity. Whether growth is a good thing is a matter for concern: Marx argued that accumulation was the inex orable logic of capitalism which would be pursued until exploitation of people and resources rose to an intolerable level. Certainly large organisations face a crisis in growing further since there is an increasing level of complexity to be dealt with within the organisation, and a decreasing level of clear relationships with the environment. In systems theory, this is to be expected as the system tries to integrate more and more of the environment into its structure - with increasing difficulties.

Greiner (1972) suggests that growth is a process of confronting and successfully overcoming a series of crises: this pattern is clear in the experience of real organisations until the upper limit of size is reached; what lies beyond that crisis point is unclear because it represents the present state of the largest organisations (Exhibit 21).

EXHIBIT 21 : Greiner's model of organisational growth (1972)



Innovation is essentially a growth of activity, whose aim is to expand the organisation's adaptive capability; this represents not only an organisational response, but also the fulfilment of individual goals and aspirations, since these are also concerned with development and growth.

Strategies of growth mean that it is possible for organisations to do more than simply expand in size; options such as diversification are also open. Associated with changes of this type will be a series of structural pressures (which will be discussed later).

In early stages companies will tend to focus their operations on a single product or range; as the domestic market will be relatively constant, it will become necessary to expand into alternative markets. This can be done either by modifying the product range or by expanding into export markets. If the company chooses to remain with the single product range, the option of vertical integration is available.

Vertical integration involves the acquiring of sources of supply or of market outlets by the firm itself, so as to increase control over its operations. This arrangement often brings with it economics of scale and efficiencies of operation, since it will involve merging a series of small units into a streamlined large one. Another advantage of particular significance to the innovation process is that vertical integration will bring about a reduction of uncertainty in the environment. However there are disadvantages as well such as the loss of opportunity for moving into other product areas. Putting efforts into a single product range also involves risks should the market for that product alter; monopoly legislations also exert constraints on expansion within a single area.

For these reasons, vertical integration policies do not offer growth advantages as effective as horizontal integration, i.e. diversification. Performance figures support this view. In this case, an organisation moves into new product or market areas, setting up separate units as it moves across into new fields: operations which reach a certain size may well be constituted into separate divisions or companies within a holding.

Evidence suggests that companies achieve better financial performance if they adjust their organisational form to these strategies: in particular, Child (1977) reports:-

(a) that firms which diversify into product areas related to their previous operations tend to secure higher profitability than those which do not, in this sense, seek opportunities for 'synergy' and which diversify into unrelated areas.

(b) that firms which match their organisation structures to their strategies tend to perform somewhat better than those which do not make this match.

Other strategies whereby growth can be achieved are:

- increasing competitive power through increased efficiency or technological development.

- establishing a secure operating field by protecting areas of activity or making co-operative arrangements with other organisations.

- developing organisational flexibility to react to threatening external changes.

Chandler and Scott (Exhibit 22) suggest a model illustrating stages in growth.

The trend exists in larger companies towards increased formalisation and delegation: despite the arguments of the 'small is beautiful' lobby (Schumacher 1974), evidence suggests that, with larger companies in particular, bureaucracy is associated with superior performance. Only in small firms was better performance associated with minimal formal organisation.

Further evidence suggests that 'the rate at which companies tend to develop bureaucratic structures as their size increases varies according to their environment and performance in the following sequence:

low

(i) below average performers in stable environments

(ii) below average performers in variable environments

(iii) above average performers in variable environments

(iv) above average performers in stable environments

high

rate of development in bureaucracy as size increases

EXHIBIT 22 : Model of stages in organisational growth (Chandler and Scott)

Company Characteristics	Stage 1	Stage 2	Stage 3	Stage 4
Product line	single product/ range	single line	multiple lines	multiple lines in multiple geographical markets
Structure	little or no formal structure - 'one man show'	functional specialisation	specialisation based on product/ market relationships	grid structure based on product/ market relationships and regions
Distribution	One channel/set of channels	one set of channels	multiple channels	multiple channels
Product/Service transactions	not applicable	integrated (A) (B) (C) → markets	non-integrated (A) (B) (C) → markets	non-integrated
Research and Development organisation	not institutionalised guided by owner-manager	increasingly institutionalised search for product and process improvements	institutionalised search for new products as well as improvements	as left
Performance measurement	personal contact subjective criteria	increasingly impersonal using technical and cost criteria	impersonal market criteria	impersonal market and political criteria

Company Characteristics	Stage 1	Stage 2	Stage 3	Stage 4
Control system	personal control of both strategic and operating decisions	personal control of strategic decisions with increasing delegation of operating decisions through policy	delegation of product/market decisions within existing business with indirect control based on analysis of results	as left with area of control of business also delegated
Strategic choices	needs of owner vs. needs of company	degree of integration; market share objective; breadth of product line	entry and exit from industries; allocation of resources; rate of growth	as left

(ii) Technology

This has been a major area of study and debate ever since Woodward's pioneering work on the influence of factors in the workflow organisation within firms on their structure and performance. Early conclusions from her study of South-East Essex firms suggested that 'it was possible to trace a cause and effect relationship between a system of production and it's associated organisational pattern and, as a result, to predict what the organisational requirements of a firm are likely to be, given its production system'.

Later research by members of the Aston group (Hickson et al 1970) and by Child and Mansfield (1972), Blau (1976) and others have modified the early conclusions about the role of technology although there is still extensive debate in this area. In particular the early categorisation of technology by 'production systems' ranging from small batch and unit through large batch and mass production to process production was found to be inadequate; later workers added the concept of 'work-flow' integration. In both cases, the attempt is to identify the controllability and predictability of the production process.

Gillespie and Mileti (1976) identify two strands to research into this variable: the impact on the behaviour and attitudes of people within organisations, and the impact on the structure of the organisation as a whole. Examples of the former would be the work satisfaction studies of Walker and Guest (1952) and the socio-technical system approached, developed from Tavistock institute studies (Trist and Bamforth (1951), Rice (1958). Blauner's (1964) studies of alienation of workers is also important here.

(iii) Organisational Climate and Culture

There have been a large number of studies of organisational climate and almost as many definitions have been advanced. For the purposes of this analysis the notion of organisational culture will be used, of which climate represents the subset of beliefs and additudes which obtain at a specific instant in time, relative to some organisational activity - e.g. innovation.

Dale and Spencer (1976) suggest a hierarchy of social order (Exhibit 23) which indicates the relationship of various cultural elements. The importance of considering culture as a variable in our study of influences can be seen with reference to the 'organisational iceberg' diagram

due to French and Bell (1973) (Exhibit 24). In this the limits of formal control over organisations as groups of people are clearly seen; the extent of influence of 'noninformal' and 'nonirrational' factors is clearly much greater and will thus provide an important focus in strategies for managing organisational influences. This is the rationale behind much of the Organisation Development movement.

Whilst all of the elements of social order are inevitable and relevant influences on any organisational activity, the concept of organisation climate represents a useful representation of the micro-cultural environment in which activities take place. Studies of 'climate' began in the field of psychology (Stern, Pace 1967) but the concept has also been developed and used in the wider fields of social science (e.g. Payne and Pheysey 1971). Several innovation studies have made attempts to introduce this contextual element, notably the POMRAD programme at North-Western University (Rubenstein et al 1976) and Bar-Zakag (1974).

Typical elements of organisational climate as suggested by Litwin and Stringer (1968) are:

EXHIBIT 23 : Hierarchy of social order (Dale and Spencer 1976)

Culture:	language, myths, norms for interpretations
Social values:	beliefs, ideologies, creeds etc.
Norms:	conscious and unconscious, including laws as a special case, standards, 'shoulds', 'oughts'.
Goals:	objectives, purposes etc.
Roles:	
Behaviour:	(including norms in the sense of regularities of action).

- these can be represented as a hierarchy of levels

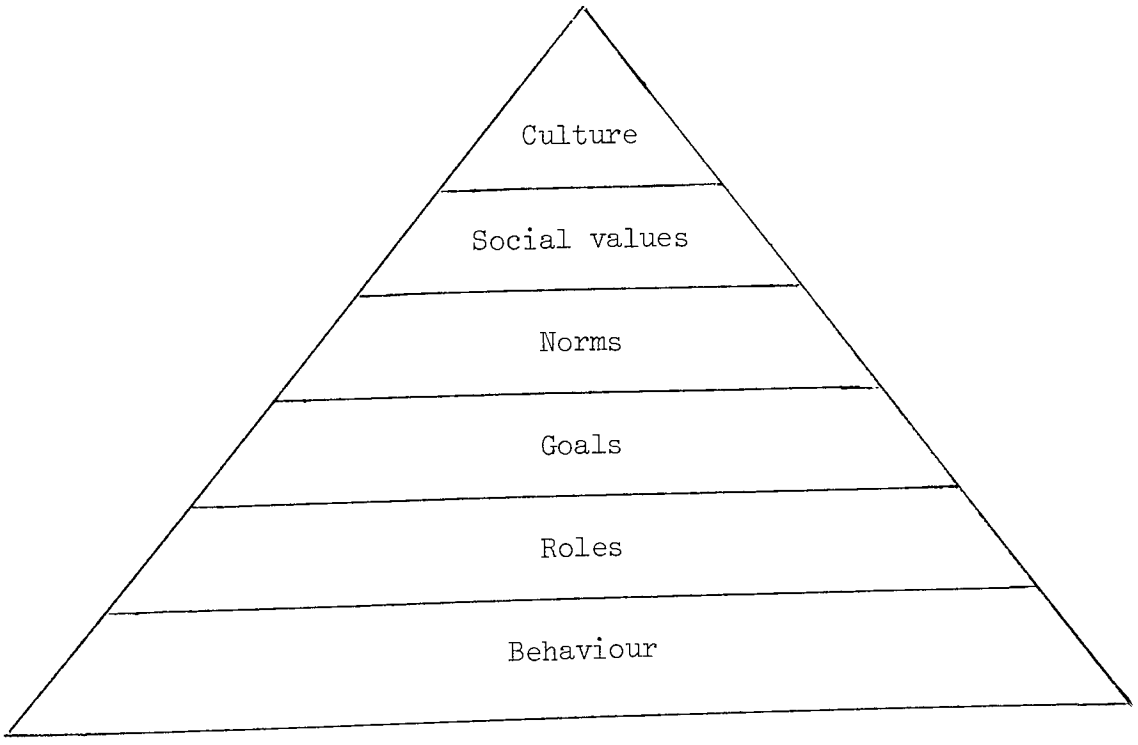
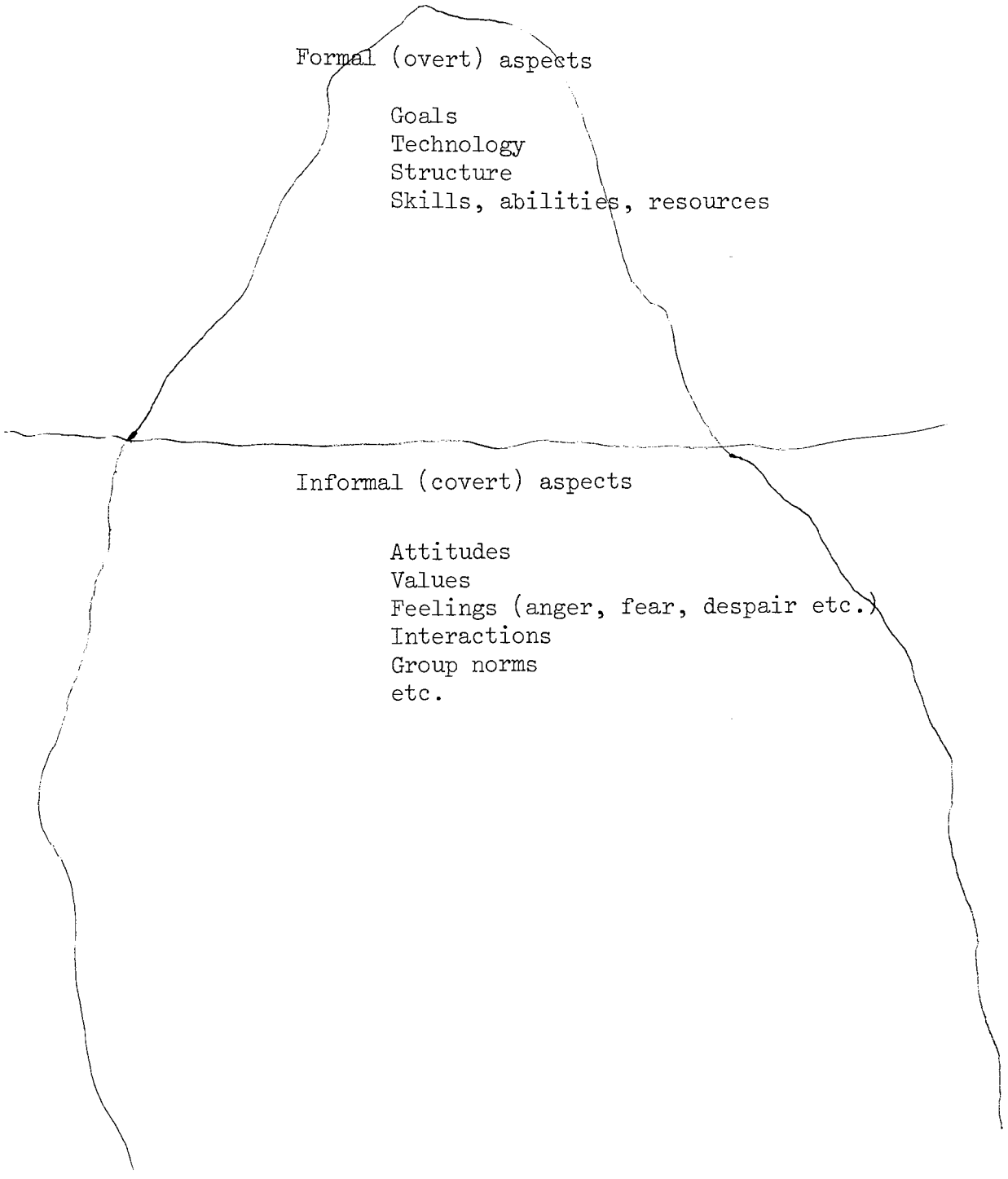


EXHIBIT 24 : the 'organisational iceberg' (French and Bell 1973)



- emphasis on individual responsibility
- warmth and support
- approval and disapproval
- conflict and tolerance for conflict
- organisational identity and group loyalty
- constraints of structure
- risk and risk-taking
- openness

The relevance of climate for innovation is that it provides an indication of the general atmosphere in which activities take place in the organisation. Extending the weather analogy, it describes what kind of conditions are prevalent; choice of activities and strategies will depend on this. For example, an organisation which had a climate which involved high levels of conflict, low levels of risk-taking, openness etc, low levels of identity with overall organisational goals etc. would not be in a favourable position to innovate successfully since these internal factors would tend to militate against the process.

Climate has been an extensively studied aspect of social order in organisation: however other studies are also relevant here. In particular, attempts have been made to identify organisational ideologies (Kamenz 1977) and even dominant mythologies (Dale and Spencer 1976).

The role of key individuals, particularly in influential positions, in developing normative patterns which become institutionalised and later culturally adopted as myths, legends etc., is also discussed.

Payne and Pheysey (1971) found climates related to dimensions of organisational progressiveness; arguably this provides an indicator of readiness to innovate.

(iv) other contingencies: some other factors appear related to the specific nature of the industry: these might include:

- capital intensiveness. investment-intensive firms (e.g. petrochemicals) will exhibit different organisation patterns to non-intensive firms. Supervision of investment, from a technical as well as an economic point of view, will be extensively practised and planned for. Internal teams for commissioning, design etc. are likely to exist on the permanent staff.

- technical intensiveness. This differs from the Woodward/Aston definition of technology which related to the production process and workflows. Here a distinction is argued about the level of technology - for example, the electronics industry is essentially 'high' (as in sophisticated) technology. Patterns associated with this kind of organisation will include a higher proportion of technical specialists, higher levels of automation, higher rates of innovation, high rates of growth (consequent on rapid development via innovation) etc. Supervision of the technical functions will be important.

- energy intensiveness. In the same way, those industries which are high energy users will have different patterns to those low energy firms. Supervision of energy resources will be a major function and programmes for energy conservation will have priority in process innovation. Control of power generation may well be within the firm so that depending on outside suppliers (a potential threat) is reduced

- market intensiveness. Here the distinction is between firms whose operations are extensively market-related (e.g. consumer goods) and those whose relationship is on a simple level.

Intensive industries will have highly developed sales functions incorporating feedback mechanisms, market research and intelligence, market planning etc.

- labour intensiveness: on the same principle, we would expect labour intensive industries to develop extensive personnel and industrial relations specialisms to cope with the 'people' problems.

- Research and Development mix: the distinction between 'research' and 'development' activity has already been made. Since the nature of tasks is essentially different, the balance will affect organisation patterns.

- Research and Development ratio: levels of; investment will determine the relationship to overall corporate objectives and hence the degree of influence which innovation has.

- maturity: there are several types of maturity to consider:

  (a) product life cycle - short cycles will mean rapid technological advance or unstable markets. This will predispose certain organisational patterns and

require high knowledge levels.

(b) process life cycle - rapid changes in process technology will require flexibility in moving to new methods and sophisticated skills to handle changes.

(c) technological maturity - the extent to which radical step changes are possible in either product or process innovation. This will affect strategic emphasis in Research and Development - e.g. on unit cost reduction instead of new product development.

(d) market maturity - highly developed markets which involve extensive competition may become saturated and allow for limited extension only. Other, newer markets may be rich in opportunity: since innovation is strongly market-pull influenced the level of stimulus from the market will be a significant conditioning factor.

(v) Level of Development

Applying the Payne and Dale (1976) model of development to organisations, the same set of dimensions (awareness, resources, will) can be applied.

For example, on the awareness dimension, the methods of organisational regulation can be plotted. 'Existence' level management is based on stumbling from crisis to crisis with few procedures or rules. Level 2 management is based on rules and procedures, even if these may be inappropriate at times. Management by objectives would be near the transition from levels 2 to 3. At level 3, objectives become openly questioned and the values behind them clearer; the status quo may be challenged and a new organisation might emerge.

Similar examples for resources and will dimensions could be drawn. At present there is much interest in the concept of organisational learning. Carlsson et al (1976) discuss Research and Development organisations as learning systems, for example.

(d) Coping Strategies

Organisations exist in a given configuration of contingencies - the environment in which they operate, the scale of operation, the level of diversity, the technology, personnel etc. Strategy is concerned with placing an organisation in the most favourable configuration for performance maximisation.

The object of corporate planning and policy is to make strategic choices about the organisation along the lines of the elements listed above. An indication of the internal structural choices available is given elsewhere. Since innovation is essentially a matter of strategic policy, the consideration of these elements is of central importance. As Ansoff puts it, 'since the middle fifties, a significant trend in business firms has been towards explicit and formal strategy formulation.....among several reasons for this.....has been the marked acceleration in the rate of change in the environment of the firm and particularly in its product/process technology. This put an increasing premium on ability to anticipate change, to take quick advantage of new opportunities and timely action in avoiding threats to the firm. Corporate strategy is the first and major step towards such ability'.

The most effective model for examining the influence of strategy will be that derived from contingency theory; here it is argued that strategy represents a pattern of choices most likely to optimise the organisations position relative to these contingencies. Child reports the common contingencies to be dealt with as: size and growth, environment, technology,

/diversity and personnel. (Exhibit 25).

The question of strategic objectives needs consideration; most writers agree that simple 'growth' or 'profit maximisation' targets are insufficient indicators of overall objectives. As Cyert and March (1963) suggest, 'the goals of a business firm are a series of more or less independent constraints imposed on the organisation through a process of bargaining among potential coalition members and elaborated over time in response to short-run pressures. Goals arise in such a form because the firm is, in fact, a coalition of participants with disparate demands, changing foci of attention and limited ability to attend to all organisational problems simultaneously'.

In terms of capitalist economics, at least, the primary goal would appear to be that of obtaining a satisfactory return fro the shareholders (Buckley 1972). Subsidiary goals have been identified by many writers; Exhibit 26 lists some of these. Easton (1974) also supplies data ranking these in order of priority amongs senior decision-makers. His work involved actual studies of behaviour in strategy formulation.

EXHIBIT 2 : Organisation strategies and related structural changes

(Child 1977)

(1)	organisation growth in size	- increased vertical differentiation - increased horizontal differentiation - increased formalisation - increased delegation - economies in administration, offset by increasing problems of administering complexity
	- via diversification	- increased specialisation - divisionalisation of sub-units - increased formalisation, especially of planning and resource allocation - increased delegation
(2)	technological development	- growth of specialist staff - increased specialisation of skills and functions
(3)	acquiring a secure domain through non-competitive means	- establishment of new roles especially to manage relationships with other organisations - increased delegation - more active internal communications via lateral relationships
(4)	creating organisational flexibility	- depends on methods adopted but associated with - establishment of new roles to promote lateral and vertical co-ordination and information flow - more active internal communication via lateral relationships - increased delegation

EXHIBIT 26 : Subsiduary organisational goals and objectives

- profitability
- market standing
- productivity resources
- innovation
- manager performance and development
- worker performance and attitude
- public responsibility

Drucker (1970)

- product quality
- expansion and diversification
- variation in sales (control of)
- health and safety legislation (response to)
- budgeting
- management development
- pricing
- allocation of finished goods
- responses to trade union activity
- stock loss

Pugh et al (1976)

- growth in E.P.S.	(priority score 9.1)	
- return on capital	(8.2)	
- superior to competition	(7.5)	
- profits growth	(7.4)	
- social and moral objectives	(7.4)	Easton (1974)
- advance in products	(7.0)	
- share price appreciation	(6.7)	
- growth in size	(6.5)	
- dividends growth	(6.4)	

Strategy for Innovation

As far as innovation strategy is concerned, there are a number of alternatives to consider:

(i) 'offensive' vs 'defensive': as the names suggest, these strategic options refer to the market competition environment. The problem here is to decide on the balance between activities which will strengthen and defend an existing market position - cost reduction, quality improvement, etc. and these more radical activities which will attack new areas or threaten competition areas - new product introduction, cost reduction of a competing product etc.

As we have already seen, preferred innovation strategies will be those which focus on in-house process changes of an incremental nature and away from open market product introduction of a radical nature. The governing principle here is one of uncertainty control: thus the key strategic decision-making activity will be based on a judgement of how far the organisation is capable of managing uncertainty. Ideally a portfolio of projects should be undertaken with varying uncertainty - some short-term low risk work and some long-term high risk projects. Providing this arrangement is successful, the short-term work will generate the 'bread and butter' innovation necessary for immediate survival whilst the long-term work will ensure a future competitive position.

In practice this is rarely the case since uncertainty means it is impossible to guarantee success.

With increasing capital charges and external competition, industry is faced with a need for more and more defensive activity: large-scale radical innovative projects can threaten the overall stability of an organisation. For this reason, strategic decision-making related to innovation policy will depend on availability of information and on mobilisation of influential support (cf Pettigrew 1974).

Another complicating factor will be the variation in project life cycles. It will be necessary to adjust innovative strategy to cope with maturity and fall-off of both products and processes. A number of predictive techniques - e.g. Boston learning curves - can be used in this connection.

(ii) Horizontal Diversification

This involves the addition of products or processes which have a close relationship with existing lines. In product terms, this strategy offers the advantage of a common 'point of departure' for breaking into a new market, thus limiting the risk and effort involved. The high level of competition existing in most markets means that knowledge of the market and customer relations are of particular importance in new product introduction.

However, there are disadvantages associated with this strategy, especially if a large number of companies attempt simultaneously to penetrate new but closely-related markets. Hake (1971) gives some examples of this 'bandwagon effect'.

(iii) Vertical Diversification

This involves the integration of products or processes into the line which were previously purchased as inputs or sold as outputs by the organisation. The advantages of such a strategy are that it ensures greater stability and control via 'captive' suppliers or customers; however this may be offset by the increasing vulnerability arising out of commitment to a large area of a particular sector. Vulnerability exists on two fronts: the overall performance of the sector will have a larger influence on the organisation, and it will find itself in competition with former suppliers and customers if it wishes to expand into open market operations as well as 'internal' ones.

The option open to resolve this dilemma is that adopted, for example, in the basic plastics industry by firms like Hoechst, I.C.I., Du Pont etc. Here vertical integration as such is not practised but instead 'applications engineering' is used. When potential new applications for plastics are found, the large companies promote these with extensive practical and financial assistance whilst leaving the actual production and sale of these to the customer company.

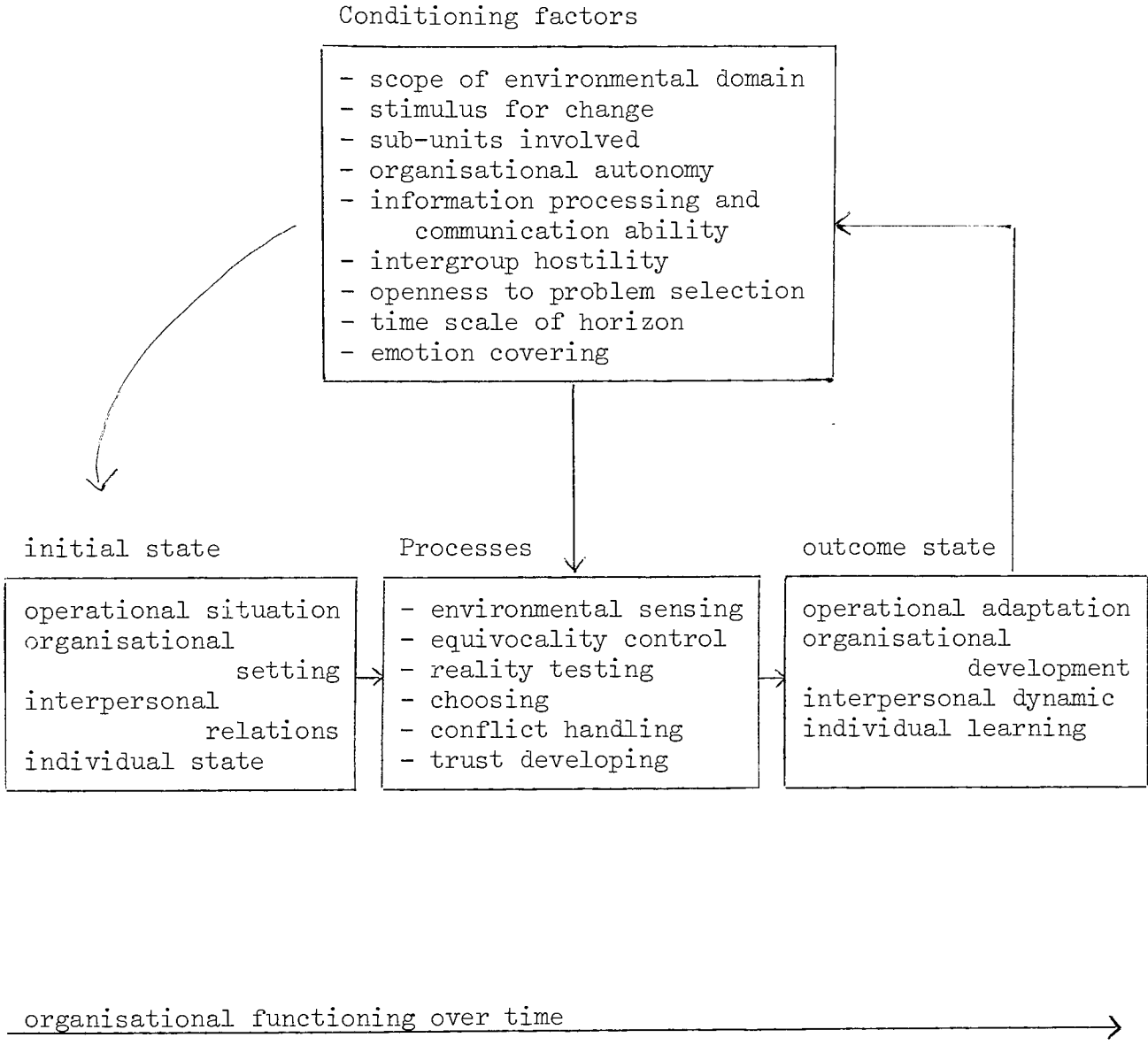
Strategic Decision-Making

Before concluding this section, it will be useful to consider briefly the issue of strategic decision-making, since this is the process whereby strategy is determined and practised. We have already discussed the contingency approach to strategy formulation: an understanding of the dynamics of the process will also be of value.

By virtue of their non-programmed character (March and Simon 1956) strategic decisions are unstructured in nature. Nevertheless as Mintzberg (1976) argues, they do follow a basic structure. A variety of studies of strategic decisions have been carried out (Cyert, Simon and Trow 1956, Witte 1972, Carter 1971, Pettigrew 1974, Mumford and Pettigrew 1975).

Theories of decision-making suggest that it involves a choice between a set of alternatives, each of which produces a set of outcomes which are evaluated. Simon and his associates (1957) introduced the notion of 'bounded rationality' and suggested that the criterion of acceptability is improvement relative to preceding outcomes, rather than optimisation of the 'pay off' - the 'satisficing' model. Psychologists (e.g. Festinger 1962) suggest that various ego defence mechanisms can produce commitment to severely sub-optimal decisions via a process of 'unconscious rationalisation'.

EXHIBIT 27 : Model for description of decision processes (Pugh et al 1976)



Other theorists (e.g. Cyert and March 1963, Weber 1968, Strauss 1962 and Pettigrew 1973) introduce the ideas of power mobilisation and exercise to influence decision outcomes.

Pugh et al (1976) report attempts to study the decision processes in several fimrs from a contextual standpoint: they suggest a tentative model for describing these. This is reproduced in Exhibit 27.

A number of attempts have been made, notably in the field of operations research, to put decision-making on a more rational, quantitative basis. Byrnes and Chesterton (1973) give some examples of this approach applied to innovation and new venture decisions. The difficulty with decision-making of this kind is that it takes place under conditions of high uncertainty: Baumann (1967) argues that the 'perfect' planning process is an impossibility. Thus rational 'optimising' or 'maximising' approaches will tend to be too simplistic; even sophisticated approaches find it difficult to cope with accounting for elements of negotiation and mobilisation of informal influence which characterise decision-making of this kind.

Simon's (1965) notion of programmed and non-programmed decisions is valuable here. The more programmable (and regular non-programmed decisions become programmable to some extent) the decision, the more susceptible they are to quantitative approaches. Rose (1977) considers major investment decision-making under uncertainty in this way.

(e) Improvement Strategies

Changing Organisations

The first part of this section has been concerned with an examination of key elements in organising and with trying to indicate their likely influence on the process of technological innovation. One problem with an analysis of this kind is that it is essentially static, valid for only the instant of observation. Whereas real organisations are dynamic, changing constantly as a result of planned and unplanned factors which interrelate in a highly complex fashion. A brief discussion of organisational change is attempted here.

Change is an inevitable process in any organisation and results from a number of factors: Exhibit 28 lists some of these. To some extent, changes can thus be seen as unplanned and natural consequences of the organisation's existence.

However, it is possible to introduce an element of 'planned' change into organisations. As writers such as Bennis (1961) have suggested, change rather than stability is the dominant issue for management concern. With an increasing rate of change, the notion of active intervention aimed at adapting an organisation to cope more effectively with changing circumstances is growing in popularity.

EXHIBIT 28 : Some common causes of change in organisations

- variation in external environment	- economic climate - relationships with competitors - relationships with suppliers - relationships with customers - relationships with government - relationships with general public
- variation in internal environment	- organisational climate - change in individual beliefs and values - change in social norms - changes in way of doing things

Numerous reports representing different schools of thought on this subject have emerged: of particular interest in this area is the Organisation Development movement.

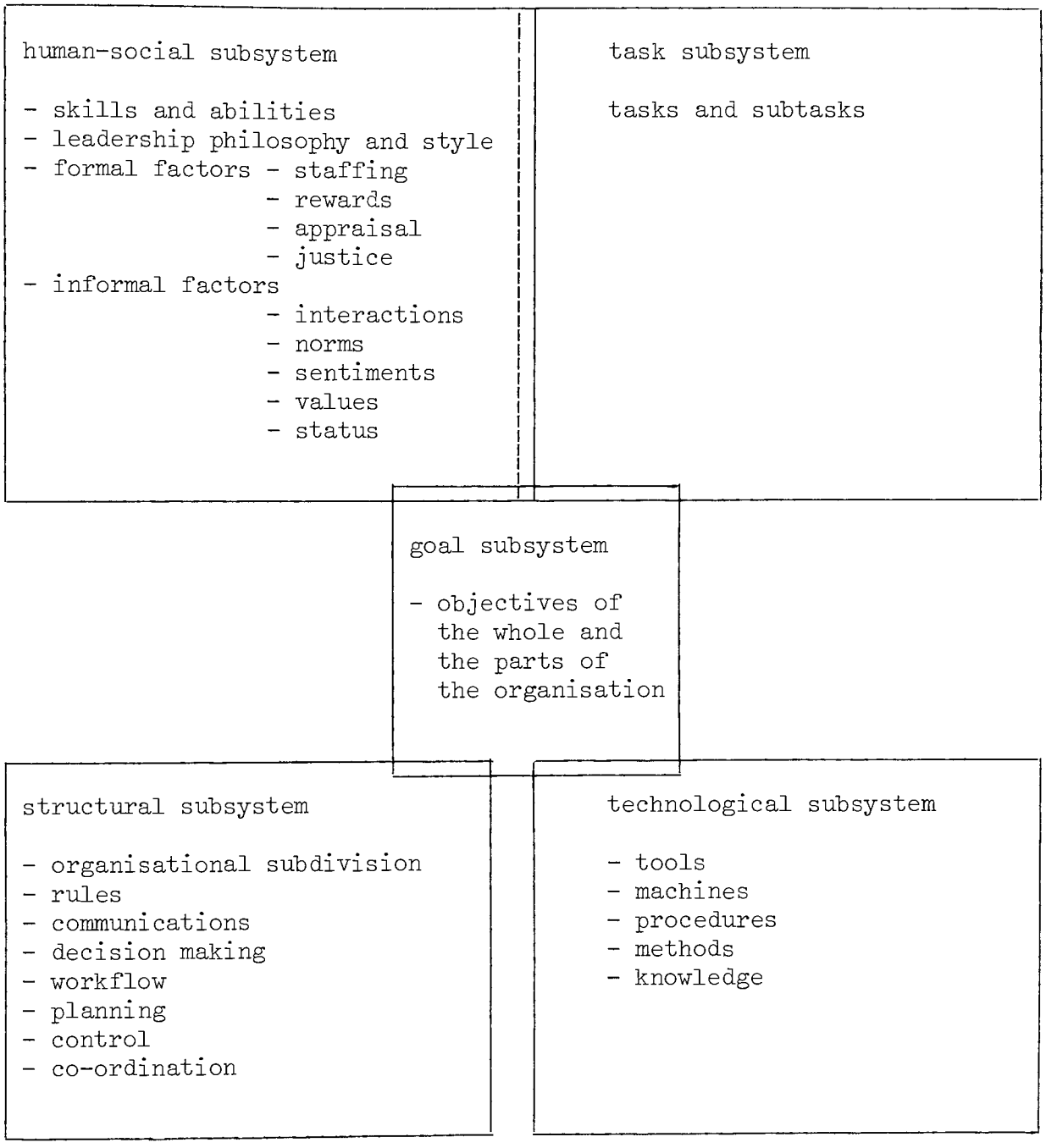
French and Bell (1973) define the typical aims of this approach as:-

'a long-range effort to improve an organisation's problem-solving and renewal processes, particularly through a more effective and collaborative management of organisation culture'.

The concept of 'renewal' mentioned above derives from Gardner (1963) who defines it as 'the avoidance of organisational decay and senility; the regaining of vitality, creativity and innovation; the furtherance of flexibility and adaptability; the establishment of conditions that encourage individual motivation, development and fulfilment; and the process of bringing results of change into line with purposes.

Organisation development is essentially concerned with change in the human/social subsystem; this area of focus can be better seen in Exhibit 29.

EXHIBIT 29 : Major organisational subsystems (French and Bell 1973)



(each of these subsystems is interrelated with the others).

Another planned change is to consciously structure the organisation - the 'organisation design' approach. Galbraith (1977) defines this as 'a decision to bring about a coherence between the goals or purposes for which the organisation exists, the patterns of division of labour and interunit co-ordination and the people who will do the work.....the notion of strategic choice suggests that there are choices of goals and purposes, choices of different organising modes, choices of processes for integrating individuals into the organisation, and finally a choice as to whether goals, organisations, individuals, or some combination of them should be changed in order to adapt to changes in the environment'.

The importance of this contingency approach based on strategic choice may not be immediately apparent because we have been used to accepting structures as largely 'given' frameworks in which we 'muddle through', coping with changes on an heuristic basis. An example of this might be the still-largely unchallenged dominance of bureaucracy (Weber 1904) as the organising system in most firms. This, despite articulate criticism on a number of issues by writers like Child (1977), Crozier (1964), Gouldner (1964) etc., all suggesting that, for certain contingencies, it may not be the most effective method of organising.

One of the reasons for this may be a general lack of understanding of the dynamics of organising and the complex interrelationships between variables; problems which cannot be met with simple responses. Beer (1973) goes so far as to suggest that we need a new way of discussing the problems using meta-language.

Other change efforts incorporate both structural and social changes, either implicitly or explicitly. Sofer (1964) discusses criteria for measuring the success of planned change efforts; he points out that, whilst changes in flexibility etc. may be desirable they may not give rise to clearly identifiable results in terms of productivity. In particular,

- the purpose of an organisation change is not necessarily to increase productivity.

- there may be a question of the most appropriate time period over which to relate changes in productivity to deliverate changes in organisation.

- increases in productivity achieved concurrently with organisational change may have little or nothing to do with the desirability or otherwise of the particular organisational changes introduced. (i.e. the 'Hawthorne' effect) (Roethlisberger and Dickson 1939).

- during a period of organisational change, workers may deliberately manipulate production as a general manifestation of anti-management sentiments, to secure some end of their own or to convince management that a particular scheme designed to increase production will not in fact work (Walker 1957).

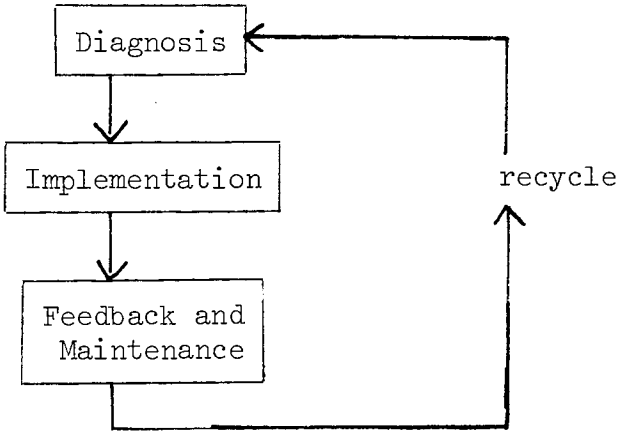
- there may be a question of which unit's behaviour are to be measured - and how does this unit relate to the whole.

- there are major difficulties involved in measuring the productivity of non-manual workers.

He discusses other criteria against which the success of change efforts can be evaluated; these include labour turnover, absenteeism and employee attitudes.

Introducing Organisational Change

There are important factors involved in the introduction of change of any kind, whether structure of people orientated. The general organisation development paradigm is of value in indicating the way in which change can be brought about. i.e.:



(a) Diagnosis

Change does not have to take place as a consequence of crisis or in the wake of major strategic development; it can also represent a continuous response to the incremental changes in operating conditions and other contingencies. However there are common symptoms which may provide indications that a need for change exists - e.g. lack of integration, low morale, damaging conflicts, lack of innovation, lack of control, withdrawal from work - and, of course, falling performance in the market-place.

Having once decided that a need for change exists, it is important to arrive at a correct diagnosis of the problem. Criteria for diagnosis should include:-

- scope of the problem

- source of the problem

- frequency of the problem e.g. recurrent, temporary, crisis

- level at which problem is located

and may well require the services of an independent agency to provide clear evaluation.

Typical diagnostic strategies employed in Organisational Development are shown in Exhibit 30.

(b) Implementation

Gaining acceptance for any organisational change is of critical importance. Johns (1973) suggests that change will only be successful if there is some measure of consultation, principally because of the capacity of organisational members to resist its introduction or to subvert its operation, and because of the value their positive contributions to the design of a change can make.

EXHIBIT 30 : Diagnostic strategies in OD

(a)	communication patterns styles and flows	identify:	climate character direction degree of 'filtering' blocks and barriers etc.
(b)	goal setting	identify:	mechanisms degree of participation degree of skills range and time span etc.
(c)	decision-making and problem-solving	identify:	mechanisms effectiveness degree of participation use of resources skills available satisfaction with present processes etc.
(d)	conflict resolution	identify:	location involved groups management current coping mechanisms causes, direct and indirect
(e)	management of interface relations	identify:	relationships involved goal clarity responsibility problems
(f)	superior/subordinate relations	identify:	styles problems

Resistance to change arises as a natural consequence when groups feel their interests to be threatened in some way, e.g. breaking up social groups, altering valued roles, changing status. It can take several forms e.g. playing out of political battles, lack of co-operation, strike action etc. Most writers conclude that a participative approach will offer the best chance of success because it mobilises commitment rather than hostility to change.

(c) Feedback and Maintenance

Organisational change should be seen in cyclical terms, rather than as a linear activity; the outcomes, anticipated or otherwise, should be used to provide diagnostic data for the initial phase of the next change.

Section 4 - Management of Innovation

Up to this point, the chapter has dealt with general influences at individual, group and organisational level. Some attention has been paid to the case of innovation, but the majority of influences apply to all activities. Such a framework might provide a useful starting point for a 'general theory of action' - a way of looking at those factors which influence and dispose the carrying out of any activity.

Arguably the management of innovation represents a particular subset of this larger model. A brief discussion of the literature related to this specific field is given here.

Broadly speaking there appear to be tnree approaches:

(i) 'how to do it' - prescriptive approaches generally based around a specific set of techniques.

(ii) 'how I/we do it' - case descriptions from practising research managers etc.

(iii) 'how it appears to us' - general studies aimed at a theoretical contribution to the subject.

In case (i) the prescriptive approaches are typified by offering theoretical evidence of key issues in Research and Development and innovation management - derived from studies like SAPPHO - and then offering a set of techniques aimed at handling these issues. In this way certain management 'schools' of thought have grown up; Research and Development management by operations research and decision theory (e.g. Byrnes and Chesterton 1973) by project selection and planning (e.g. Twiss 1974), by systems analysis and information flow (e.g. Heyel 1968), by effective management of people (e.g. Hitchens 1966) etc. Each of these approaches has a significant contribution to make, but there does not appear to be a tendency to prefer one approach as the solution to all problems. For example, Twiss suggests in the preface to his book, that the important issues are 'the big decisions' not 'the minutae of managerial problems'. His treatment of the subject is thus 'big decision-centred'.

The limitation of this approach is that the nature of most big decisions appears to be strongly influenced by the minutae, to suffer from non-rational manipulation (e.g. Mumford and Pettigrew 1975), to be intrinsically uncertain and unplannable (Baumann 1967) to be at best only loosely structured (Mintzberg 1976) etc. So the development of excellent techniques, models etc. for handling this area of Research and Development management will be of limited value unless related to a wider scheme. There is a danger in assuming one approach or set of techniques as the answer to all the problems in innovation management.

This criticism applies equally to the 'layman's guide' type of approach. Here individuals who have had extensive experience in the practical aspects of innovation management often tend to present personal theories and recipes for success. These are interesting and may contain a wealth of useful practical detail, but they are limited again by offering singular approaches. Once again there is a tendency to ride hobbyhorses; a manager who has had some success with idea-generation techniques may build his enitre approach around these. Another may argue for planned project selection, or information systems, or network planning - in each case the approach is limited. There are surprisingly few general sources on innovation management presented from an overall viewpoint.

A notable exception to this are those 'anthologies' (e.g. Cole 1967, Cetron and Goldhar 1970) which present a large number of contributions on specific elements in the Research and Development management area. They incorporate a mixture of academic and practical perspectives; in the range of subjects which they cover there is thus an element of debate.

The third type of study is less prescriptive and attempts to describe the problem of innovation management in theoretical terms. Most 'general' models belong in this category - e.g. Burns and Stalker (1961), Lawrence and Lorsch (1969).

Emphasis in literature on innovation management covers these areas:

- understanding of the process

- understanding of the environment (economic, social, political)

- planning and strategy

- technological forecasting

- project selection, monitoring, evaluation

- management of creative personnel

- budgeting and control

- Research and Developmetn decision-making

- creativity training

- organising (structure) for innovation

- coupling with other units/environment

- information systems

Most recent texts build upon the findings of general studies of innovation - SAPPHO, 'Wealth from Knowledge' etc. Consequently there is a gradual diffusion of awareness about the important factors in success and failure. Emphasis on quantitative approaches and 'plug in' techniques to achieve these conditions has led to a development of management thinking and the newer generation of 'how I do it' studies (e.g. Burns 1975, Parker 1971) illustrate this.

However there does not appear to be any great contact between the behavioural sciences and this area, despite the growing view that human factors may be the most significant source of variation in the process.

(A notable exception to this is the excellent 'anthology' by Orth, Bailey and Wolek (1965) which uses case study approaches to illustrate academic viewpoints). Only recently has interest focussed on the human variables to any extent: mechanistic and quantitative models are gradually being modified (e.g. in the field of strategic planning and decision-making Duncan (1975), Pettigrew (1974) and Mumford and Pettigrew (1975) have opened up the discussion by introducing political and other variables).

Allen's (1970) work on communication patterns and information flow has demonstrated the value of informal structure. Pelz and Andrews (1966) guidance on productive climates is also of value in managing scientists. However general levels of sophistication in those books written by practising managers remain low; some concepts which SAPPHO and other studies demonstrated to be of importance - like integration - are only lightly treated.

Apart from the Lawrence and Lorsch (1969) studies, and Sayles and Chandler (1971), the concept of integration for managers has been dismissed as a structural issue - 'put the blocks together in the right way and it'll be OK'. The ways in which integration can be achieved, and the sources of poor integration are not well understood particularly in the innovation area; many writers assume that integration is a problem only in very large organisations.

Attempts have been made to develop something of a contingency approach to innovation management. That is, that the demands of different operating situations will require different patterns of management. Cetron and Goldhar (1970) develop such a model from their mammoth anthology incorporating many different perspectives.

Overall, the management of innovation is well-represented in the literature but there tends to be a great deal of similarity in approaches offered. Diffusion of knowledge about what affects innovation success and failure has been widespread but there is still a lack of guidance in the area of behavioural variables. In the SAPPHO presentation an updating of conventional wisdom in the light of their findings was given (see chapter 2); it is argued that this updating needs to be continuous and that there are gaps in current wisdom. These will be discussed later.

Section 5 - Critical Review

The preceding sections represent an attempt to identify important influences on the process of technological innovation. Inevitably this must read like a catalogue because the potential range of influences is so great. Almost anything may have an influence on the process: the question is which are the important ones.

This rich variety of influences raises the problem of contingency versus general theory approaches. Whilst the latter are limited in their applicability to varied situations, the argument that every situation is unique and thus requires its own theory is also of little value. What we require is sufficient direct evidence of the case study type to support more general models already available in the literature.

The three-level model is presented in this chapter as an attempt at a unifying framework which indicates some degree of parallelism in the effect of influences. That individuals, groups and organisations behave as information-processing, problem-solving decision-making organisms is the central assumption. Strategies and heuristics are developed as ways of coping with environmental contingencies on the basis of learned experience. Development can be viewed as taking place along dimensions of awareness, will and resources; this can take place additively (within-levels) or discontinuously (between levels), aspiring towards a highly-integrated self-actualising state.

Presented in this form, the model has some coherence, but in practice, the pattern becomes a little blurred. The contribution of external contextual factors - individual psychology, global economic systems etc. - is impossible to consider without expanding the frame of reference in the model. But in order to account for every influence, a frame of reference the size of the world would be needed - and thus the model becomes the world. INstead selected influences corresponding to a highly-specific frame of reference have been used; this is offered as a temporary model which requires further refining.

As has been suggested elsewhere, this might represent a first step towards a 'general theory of action. That is, almost all the influences described bear on any activity, not just on innovation. Therefore a treatment of this kind provides a framework for considering the factors which dispose and influence action in a general sense.At the individual level, surprisingly little is known about what technical specialists actually do, or about their values, cultural orientations etc. Sayles (1958) gives accounts of blue-collar workers and Mintzberg (1973), Stewart (1976) and others discuss managers, but there is little available on specialist groups. Most evidence attempts to group technical specialists under the umbrella label of 'professionals'; whilst this may account partially for the rules and roles of the group, there is a task-related component which does not appear to have been considered in any detail. How does a production specialist or a commissioning expert think and behave, what does he believe in, etc.?

Motivational theories have already shifted from the categoric (need-satisfier, motivation-seeker etc.) towards a contingency-linked approach; what turns people on varies enormously. This proposition appears particularly true for technical specialists since intrinsic factors like interest in the work itself play such a strong part. However guidelines for management which result in prescriptive suggestions about motivating specialists should be viewed with caution: it is likely that autonomy and freedom, professional values, association etc. will be important - but it is by no means true of every individual. There is no single 'best' approach to motivating: thus attempts should be made to provide opportunities for individuals to design and control their own management, via participation and delegation.

Theories of creative mechanism may be impossible to prove (except perhaps by neuropsychological research) but observation at close quarters in 'blow by blow' fashion would provide valuable clues about this. As yet there is little evidence of this kind. Similarly close studies of problem-solving and adoption behaviour are very sparsely reported, especially in the field of incremental innovation. What studies there are of individuals involved in innovation over time tend to be concerned with major and radical projects.

Understanding of the motivation behind risk-taking behaviour seems limited; certainly the achievement motivation construct is of value but the effect of external factors on individual propensity to take risks is less clear. Will a product champion always emerge because of his own psychological make-up forcing him forward, or will there be certain environments which inhibit him?

Groups have been extensively studied and much of general application is known about processes and structure. However, studies of specific types of group, particularly certian task-related ones are less widely reported. Problem-solving groups are discussed at length but few accounts exist of the behaviour of these groups in real situations; this criticism is particularly true of Synectics, brainstorming and other 'special' approaches to problem-solving. How far these techniques are used in practice is not clear; neither is the way in which they are used, what sort of problems they are used on etc.

An encouraging approach to study of groups is the action research model. Here attempts are made to understand and develop aspects of group behaviour in an essentially pragmatic fashion. Payne (1976) argues strongly for feedback and reality-testing of research hypotheses. Arguably this kind of research, which involves group members in participative fashion, is likely to be of value in developing a clearer picture of how specific task groups operate.

Nominal groups and project teams which involve specialists of different functional orientation with varying degress of interaction and interdependence represent special cases since they are usually put together to accomplish short term tasks. Consequently there will be different processes taking place compared to a single function, well-established group: the determinants of effectiveness for these groups need clarifying. How far are conflicts of interest, political jockeying, differential perception of problems etc. relevant?

There appears to be little information about how groups see themselves, especially in task-situations. That individual members perform formal and informal roles is well-known but how these are apportioned, whether individuals are aware of them etc. is not clear. Similarly the mechanisms whereby group values, beliefs, norms etc. relating to task orientation are developed are poorly understood. Once again the criticism is that information of a general nature is extensive but limited in its task-specific aspects.

The dominant research perspective at the organisational level has been the macro-model. In order to provide useful guidelines for improved management, there is a need for close-up information of a descriptive rather than a prescriptive nature. Contingency approaches to organisation theory and design are gaining support amongst many authorities. However variations in factors like technological maturity, capital intensiveness, technical sophistication etc. do not appear to have received study as influential contingencies.

The problem for many managers is that an appreciation of problems in general terms - e.g. 'poor integration between groups' - is followed by the use of 'plug-in' solutions. Thus project teams, matrix structures, co-ordinating groups, job rotation and a range of other options may be tried: however their applicability will depend on specific contingencies which need to be more fully understood. Arguably regular updating of conventional wisdom (similar to that provided by Project SAPPHO) is required so that managers can benefit from growing understanding of the innovation process. At present there is widespread appreciation of the factors affecting innovation success and failure but little guidance as to how these evolve or how they may be controlled. What guidelines there are tend to be in the nature of mechanistic techniques of the 'plug-in' variety; there appears to be little understanding of relevant behavioural variables. This, despite a general agreement that human factors account for the bulk of variation in the innovation process.

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System Model

Innovation does not take place in a vacuum. The shrieks from the 'doomwatch' lobby are clear reminders that the consequences of innovation are felt outside of those areas where technology has actually been applied. The process takes place in a context which is at once social, economic, political, psychological etc.: thus any approach to a real understanding of it must come from studies placed in context.

If we take a simple 'black box' model of our organisation, then the innovation process can be seen as one of the transformation mechanisms within the system wherein inputs (of resources etc.) become converted into outputs (in the form of new technology, products, etc.). However, it is of fundamental importance to see innovation as an active adaptive mechanism as well, changing the system as it responds to the environment.

In systems theory, organisations can be considered as goal-directed organisms. They exist in an environment according to a set of dynamic interactive rules: Exhibit 1 describes these, based on an analysis by Feibleman and Friend (1945). Organisations can be considered as existing in a state of dynamic equilibrium - (von Bertalanffy (1950)) - with their environment.

Response to stresses set up strains in the organisation, but the organisation has no power to initiate, i.e. the stimuli always come from the environment. Exhibit 2 indicates the range of stimuli and response possible: it can be seen that there is an optimal band of stimuli which evoke a response, and a set of alternative organisational responses to that stimulus.

The three responses indicated - tenacity, elasticity and self-determination represent the survival options for the organisation: total failure to respond would result in extinction. Choice of these responses will depend upon the structure of the organisation itself: the process of interaction is an attempt to achieve perfect homeostasis and various combinations of these responses may be tried during the life of the organisation. In general the dominant theoretical goal in organisations is to achieve a state of zero interaction with the environment, i.e. a condition in which it has absorbed and integrated all elements within that environment.

The point about this approach is that we are considering technological innovation as one of the key mechanism of interaction. As organisations grow (through adapting to and interacting with the environment) they become more complex and differentiated. This is partly in response to the increase in complexity in the environment (which is itself a dynamic system) and partly in response to the increasingly complex quality of interaction. What happens is that the number of sources of variation increases within the organisation: this poses a problem in control.

EXHIBIT 1 : Elements of Interaction Dynamics

(Feibleman and Friend, 1945)

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1. Organisations are defined as wholes which operate in dynamic relation to their environment: this relationship is one of reciprocal election, i.e. the one necessarily involves the other. This dynamic view is to be contrasted with the static one which sees organisations in isolation.

2. Every organisation is in constant change or motion: this activity is of two sorts. The environment changes the organisation and the organisation changes the environment: there is an action and a reaction effective in every instance of change.

3. Availability is a characteristic of a limited part of the environment of an organisation - that part which, determined by the nature of the organisation, importantly affects and is affected by it. Virtual indifference is a characteristic of that less limited part of the environment - that part which, determined by the limited nature of the organisation, hardly affects or is affected by it.

4. Equilibrium is the condition in which the influence exerted by the organisation upon its available environment and the influence of the available environment on the organisation are in balance. Disequilibrium is the condition in which this balance does not exist.

5. Saturation is the condition of an organisation in which all parts share and all sub-parts are shared. Insufficiency is the condition where all parts share and there are some unshared sub-parts. Superfluity is the condition where there are some unsharing parts and all sub-parts are shared. A saturated organisation hardly reacts with the available environment. An insufficient organisation can only obtain saturation or superfluity by interaction with the available environment so as to acquire parts. A superfluous organisation interacts with the available environment in order to lose parts and achieve saturation.

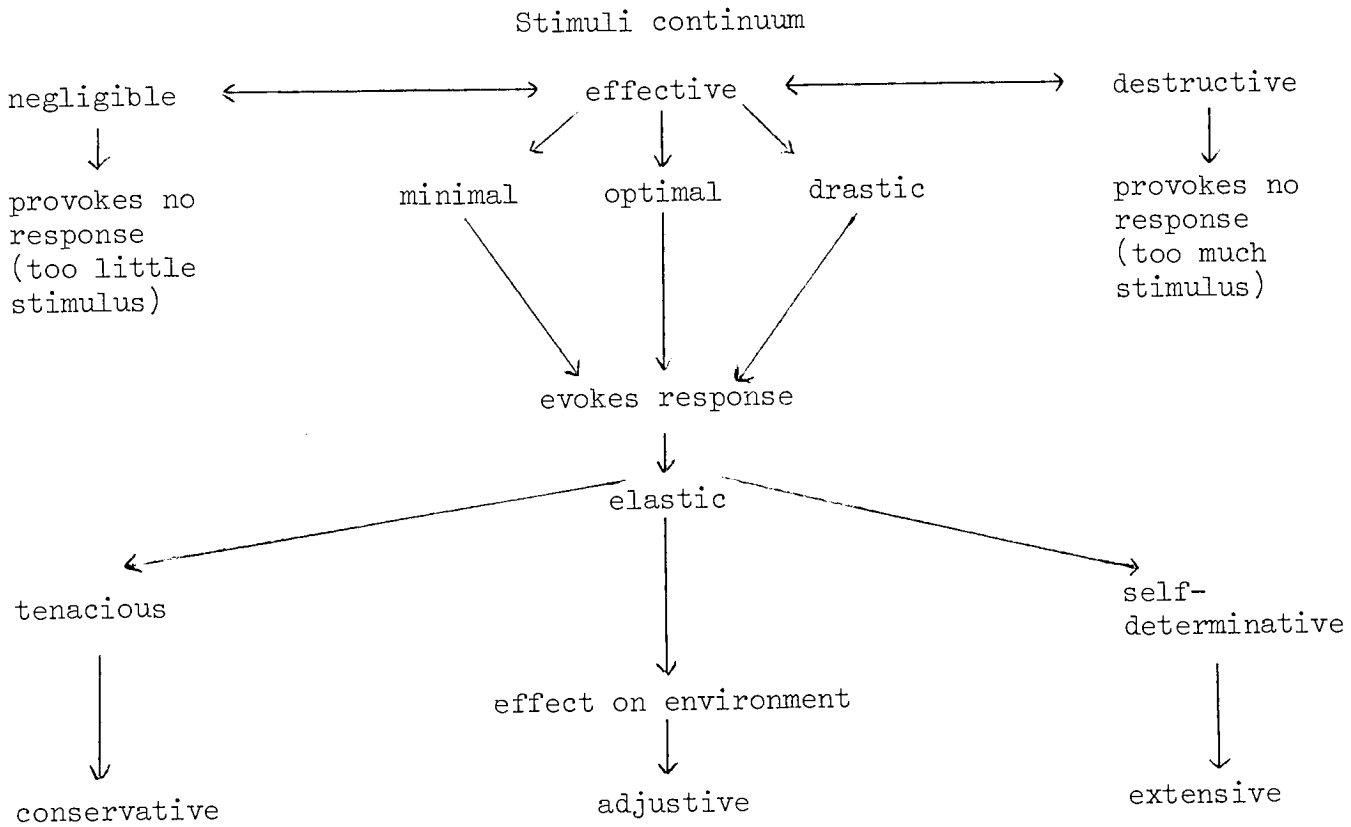
6. Flexibility is the capacity of an organisation to suffer limited change without severe disorganisation. Rigidity is the absence of this capacity.

7. Stability is the capacity of an organisation to remain in equilibrium. Instability is the absence of this capacity.

The rules of interaction, involving these elements, are:-

(a) Every organisation elects some other organisation(s).
(b) In every action there is a sharing and an interchange.
(c) All action is occasioned by the available environment.
(d) Available environment is limited by interaction with organisations
(e) All organisations strive toward equilibrium.
(f) Saturated organisations remain unchanged.
(g) Insufficient and superfluous organisations tend to change.
(h) Flexibility is a condition of growth.
(i) Rigidity is a condition of maintenance.

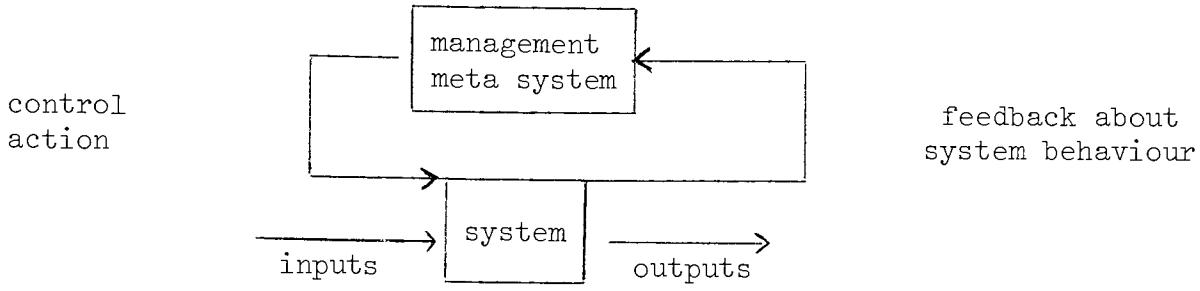
EXHIBIT 2 : Stimuli/Response Pattern for Environment/Organisation



In the preceding chapter we saw that thinking on a wide range of influences on the innovation process is coming around to a contingency view: Chapter 2 demonstrated that this approach also applies to theories of the process itself. We are becoming more aware of the complexity implicit in organisational elements: it is suggested that this is a unidirectional phenomenon and that complexity will only increase in time.

Faced with rapidly escalating complexity, it is argued by many writers that we may be approaching problems of an order which we are not capable of controlling with existing mechanisms. In processes such as innovation, which involve high levels of uncertainty and complexity - non-programmed activities in March and Simon's view - we would expect to see early symptoms of this. Our study of the literature repeatedly referred to a need for integration: this is a reflection of the growing number of differentiated elements in the process.

This research is concerned with the effective management of innovation: from the above it is argued that the central management problem in this process will be that of variety control (Ashby 1956). From a cybernetic viewpoint we can view the management system as a 'meta-system' with responsibility for control (Beer 1975).



This control system has the task of managing the main system to best advantage within an active and uncertain environment. It functions by processing information input from within the system and from the environment and by producing decisions which direct the behavioural response of the system. This function is an attempt to provide purposive rather than random responses to influences acting on the system.

Gregory (1978) suggests that, whilst it is impossible to specify individual influences, the classes of influence remain relatively constant. He offers nine for consideration (Exhibit 3).

Ashby's law of requisite variety suggests that the system will respond to the variation imposed on it by factors of this kind by internal variation to match it: consequently the complexity of the system will increase.

Faced with growing complexity, the control system needs to find ways of absorbing variety. In terms of programmed activities, this can largely be achieved by the use of rules and procedures - mechanistic system in Burn's and Stalker's terminology - and relying on management by exception principles. However, highly complex and non-programmable activities like innovation will require much more sophisticated organic systems to bring about the required level of integration.

Exhibit 4 summarises this model in diagrammatic form. The purpose of this chapter is to relate the information on influences to an overall model of the process of innovation management, drawing particular attention to problems of complexity and integration. This is the expected model: it can be compared against the real experience of the research study.

EXHIBIT 3 : (Gregory 1978)

THE VARIETY OF INFLUENCES UPON PROCESS COMPANIES

In attempting to summarise the past and prepare for the future it is useful to invoke the 'Law of Requisite Variety' which indicates that a system best responds to variation imposed on it by using internal variation of appropriate kinds. Further, it is suggested that categories of influences may not change greatly, although specific influences may well do so. Nine categories are proposed:

World Economic Influences

World business activity, trends and cycles
Groupings: regional, commodity-producers
Shifts in wealth, power
Resources availability

Technological Changes

Computer developments
Information handling changes
Radical process technology
Internal changes with specific technologies

Knowledge Changes

Understanding of individuals
Understanding of organisations
Grasp of way in which human-based activities occur

National Economy Changes

Inflation
Currency value fluctuation
Decline of 'traditional' industries
Shifts to post-industrial jobs

Government Influences

Laws
Taxation
Directives, controls
Incentives
Political fluctuations

Consumer/Citizen/Employee

Rise in expectations
Demand for 'fair' shares
Demand for participation in decision making
Industrial group pressures
Environmentalist pressures

Significant 'Random' Events

e.g. North Sea oil
Flixborough

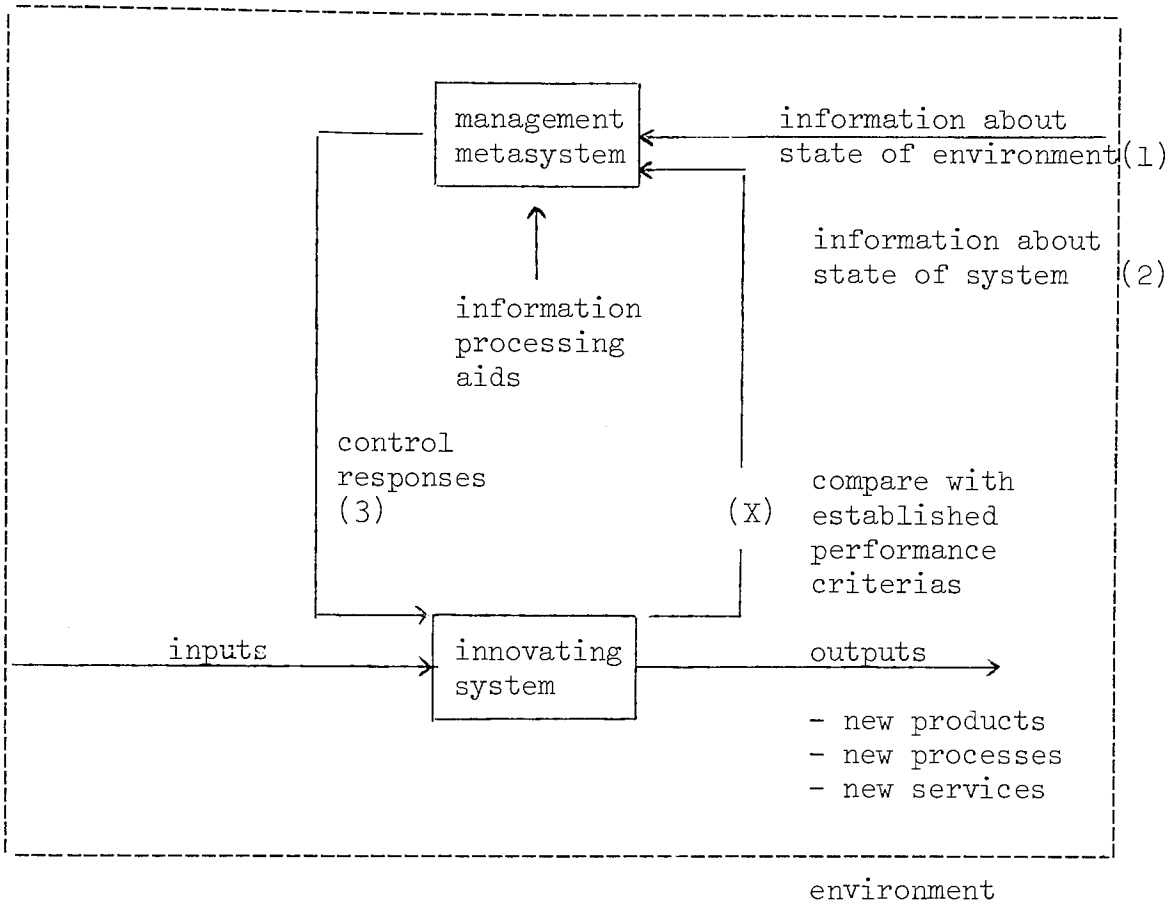
Within-company Influences

Profitability
Ability to change
Changes in corporate 'ethos', including ways of throught, applications of techniques
'Fit' with the situation

Manpower Resources

Quantity
Quality

EXHIBIT 4 : Simple System Model



(1) information about state of environment - influences as detailed in Exhibit 3 for example

(2) information about state of system - influences as detailed in Chapter 3 for example

(3) control responses - strategy and policy, structure and other key management decisions

CHAPTER 5 : Methodology

A range of formal and informal observation and measuring techniques linked by the basic approach of participant observation are described. The philosophical basis to this approach is essentially one of 'grounded' as opposed to 'grand' theory.

Using the principle of 'triangulation', a large number of research situations were studied: it is argued that these represent a reasonable cross-section of influences acting on the process of technological innovation. Recommendations for future research methodology are also made.

The sections in this chapter are as follows:

(i) introduction

(ii) participant observation overview

(iii) data collection

(iv) constraints on observational methods

(v) feedback

(vi) measuring techniques

(vii) critical review of research methods and techniques

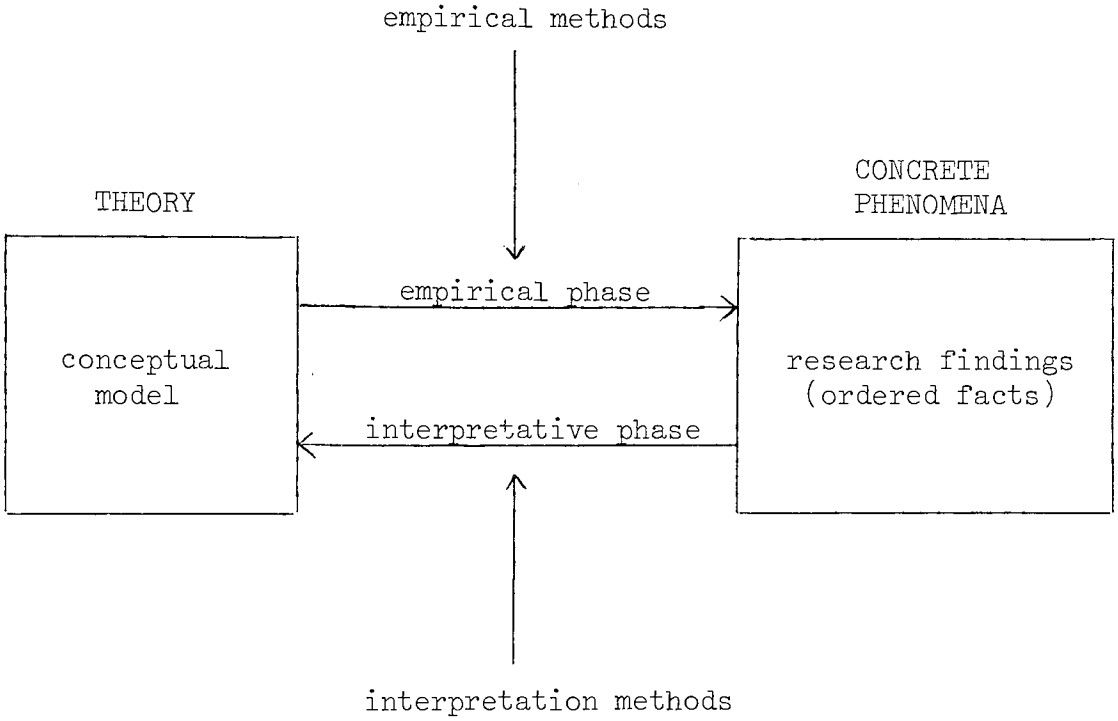
(i) Introduction

This section is essentially about the 'how' of the study: an examination of research approaches and philosophy and a description of the various methods and techniques employed.

Exhibt 1 indicates a simple model of the general research process relating theory and empirical findings. The more traditional 'grand theory' approaches (which are largely concerned with resolving issues of interest to other theorists) may not be suitable for the following reasons:

- the subject of the research (the process of technological innovation) depends upon a range of contingencies. These include special characteristics of the organisation - size, wealth, history, technology, strategy, structure etc. - and special characteristics of the environment - the type and mobility of markets, time-span of feedback, role of competition, legislative and other pressures etc. As indicated in Chapter 2, writers (e.g. Downs and Mohr 1976) argue that these represent factors which are 'specific to innovator' - in other words, in many respects each organisation is unique. Any comparative theory will be severely limited: a single 'general' theory of innovation may not be possible because of the extent of variation between organisations

EXHIBIT 1 : Model of the research process



- the arrangement wherein this research was set up required feedback and recommendation on improving the problem situation in the host organisation. This interactive approach differs markedly from traditional researches and belongs loosely to the so-called 'action research' school (e.g. Clark 1970).

The limitation on 'grand theory' approaches can be redefined as posing a general conflict for students of social organisations. On the one hand there are the approaches which seek to develop and extend theoretical knowledge and conceptual frameworks which are not easily related to the day-to-day needs of sponsoring systems. On the other hand, there are those approaches which seek to provide practical guidelines for improved functioning of sponsoring systems.

The debate itself may be irreconcilable: however, for the research described here, the suggestions of writers such as Clark will be used for a methodological framework. 'Action research', as defined by Rapopart (1970) aims 'to contribute both to the practical concerns of people in an immediate problematic situation and to the goals of social science by joint collaboration within a mutually acceptable ethical framework'.

Glaser and Strauss (1968) also argue convincingly for a 'grounded theory' approach to link practical experience to a body of existing theory. Essentially this is an integrative approach based on the generation and linking of modest hypotheses grounded in practical results. One consequence of this pragmatic approach is that sources of data traditionally rejected by researchers as having bias - e.g. anecdotes, subjective judgements etc. - can be legitimately used to enrich theory.

There is a growing tendency towards such approaches to research situations of this kind (e.g. Revens 1976). Payne (1975), in an excellent critical paper, argues that traditional positivistic approaches to subjects like organisational behaviour fail to meet important criteria. These include: reliability, concurrent validity, predictive validity, control of alternative propositions, representativeness and fit with established theory.

He suggests that we are left with some very general propositions (truisms) which can act as guidelines for research into organisational behaviour. Examples of these (which are relevant to the way the research study reported here was carried out) are:

- approach problems from a systems theory perspective

- involve people in a participative manner to generate valid data (true for that situation)

- be concerned with feedback processes and their importance to learning and development.

The interactive nature of research like that undertaken means that there will be an effect upon the organisation studied: the degree to which this is planned is important from both research and practical viewpoints. Dale (1975) proposes the model illustrated in Exhibit 2 to indicate the mutual learning and change process involved: this is similar, particularly in its cyclical nature, to models advanced by Clark (1970) and members of the Organisational Development movement (e.g. French and Bell 1973).

Another paper (Dunn and Sweirczek 1977) attempts to identify the development of grounded theory in the field of organisational change strategies - Organisation Development, Team Building, Participative Management, Socioorganisational Design etc.

Whilst sharing similar criticisms to those advanced by Payne for the limitations of logico-deductive theories and approaches, they identified only 3 of 11 (possible)? hypotheses which received consistent empirical support. The similarity of these general propositions to Payne's 'truisms' will be apparent.

(i) change efforts in which the mode of intervention is collaborative will be more successful than change efforts undertaken with other modes of intervention.

(ii) change efforts in which the change agent has a participative orientation will be more successful than change efforts in which change agents share a different orientation.

(iii) change efforts employing standardised strategies which involve high levels of participation will be more successful than those which involve low levels of participation.

From their wide comparative study, they suggest the following strategies.

(a) Case materials that differ maximally in content and methods of reporting (e.g. anecdotes and field experiments) provide a broad empirical domain with which concepts and hypotheses can be generated as well as applied and tested. Multiple sources of information - e.g. qualitative descriptions as well as statistical generalisations - are likely to reflect more adequately the conditions actually present in change efforts (internal validity).

(b) The sampling of reported cases provides a basis for developing empirical generalisations.....without sacrificing qualitative data in the form of anecdotal reports. Further, while statistical findings comprise an essential part of the data base, there is no reason to assume in advance that particular methods are more capable than others of typifying conditions actually present in a given universe (external validity).

(c) Multiple sources of information permit the generation of new concepts by constantly comparing information obtained by different methods. Cases may be compared in terms of concepts initially derived from existing theories.....at the same time, new concepts may be generated from particular cases and subsequently employed to re-analyse and re-interpret others (reflexivity).

(d) Multiple sources of information also provide a more adequate basis for interpreting and clearly communicating the content and meaning of concepts used. Since the outcomes of planned change efforts depend on multidirectional processes of communication, the generation of concepts with minimum abstraction should promote understanding among groups with conflicting frames of reference (translatability).

With the limitations of traditional methodology and the action-research recommendations as to research strategy in mind, it was decided to adopt an unstructured, participant-observer based approach as the most appropriate methodology to use in the innovation study. Analysis of the literature in the field of technological innovation revealed a gap in the area of specific case studies: almost all hypotheses were founded on statistical data and dealt with high levels of generality. (See chapter 1 for a fuller discussion of the limitations of traditional studies). Based on this analysis, a need was identified for a long-term, in-depth study from an 'insider' viewpoint of one organisation. Such an approach might be expected to lead to the development of a tentative contingency/probabilistic model of innovation within organisations.

The actual organisation of the research was of significance; it was conceived from the outset as a collaborative process whose outcome would benefit the company as well as add to knowledge about the process of technological innovation.

The researcher was to be a full member (participant) in the organisation but the appointment was seen as providing for more than simple observation. It combined the roles of change agent and researcher - a sort of facilitator/commentator with the added feature that the role was never defined exactly but was shaped according to a combination of organisation and research needs.

In particular emphasis was placed on the study of the relevant 'behavioural' processes associated with technological innovation since there appeared to be very little evidence available in this area. Pettigrew (1974) discusses the considerations in studying social processes and concludes that longitudinal studies incorporating extended case methods, historical data and situational analyses will be most revealing.

He uses a research approach suggested by Webb et al (1966) which was felt to be equally applicable to the research reported here, i.e. 'the issue is not choosing among individual methods. Rather it is the necessity for a multiple operationalism, a collection of methods combined to avoid sharing the same weaknesses'. This gives rise to the concept of 'triangulation' (Denzin 1970) which is basically concerned with multiple approaches to the study of the same phenomena. Extension of this multiple method approach to involve multiple sources of data would seem to be a valuable strategy.

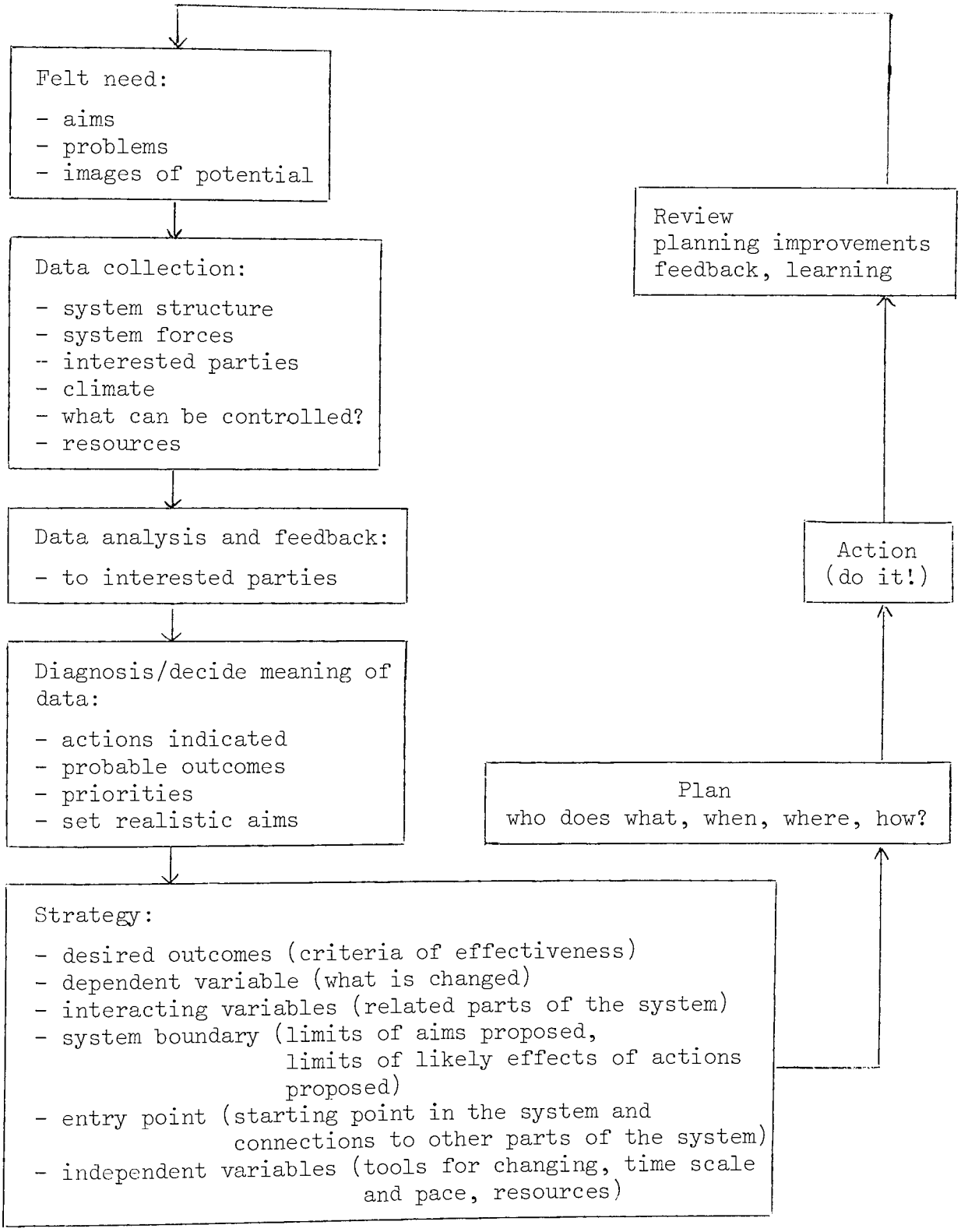
Consequently the proposed research design was as given in Exhibit 3: it should be stressed that the approach used was open-ended, and that much of the strategy for later stages in the study was suggested by situational components rather than by abstract analysis.

It might be useful to close this explanation of the overall philosophy underlying the chosen methodology with a quotation from Homans (1949)

'People who write about methodology often forget that it is a matter of strategy, not of morals. There are neither good nor bad methods, but only methods that are more or less effective under particular circumstances in reaching objectives on the way to a distant goal'.

EXHIBIT 2 : Action approach to organisational learning and change

(Dale 1975)



(ii) Participant Observation

As an established research methodology, participant observation has been extensively studied; some views on this subject are presented in the appendix. What follows here is a very brief overview of the approach to explain how the research was carried out.

Essentially participant observation is what its name suggests, the study of situations from the standpoint of a participant. In this it can be easily identified as the sort of approach used by anthropologists (who live in the communities they study): however it has much wider application as a research approach.

Such an approach will commend itself to many investigators for reasons of simplicity and applicability. However its 'general' nature has meant that it has not received the detailed and codified study which has been devoted in a rigid, quantitative as well as qualitative sense to other sociological methods. The whole problem of researcher involvement and the 'subjective' nature of the data produced via this methodology is the subject of much debate: although of great interest, this issue is not directly relevant to the study reported here.

Participant observation is essentially an approach which depends on situational definitions for its responses: these must in turn be synthesised from the researcher's previous experience of the culture being studied. Thus the whole research act of participant observation is a complex learning process where situational and personal interactions are the key elements.

Its breadth as a technique makes formal definition difficult: McCall and Simmons (1969) suggest: " a characteristic blend or combination of methods and techniques that is employed in studying certain types of subject matter.....this..... involves some amount of genuinely social interaction in the field with the subjects of the study, some direct observation of relevant events, some formal and a great deal of informal interviewing, some systematic counting, some collection of documents and artefacts, and open-endedness in the directions the study takes".

Junker (1952) suggests that there are four clearly defined roles: complete participant and complete observer. Although each of these can be separately defined, the demands of a complex multi-level study such as that described here will require that all four are played at some time during the research. The role adopted as primary in this case was intended as complete participant but soon shifted to participant as observer: later work with senior management had to be conducted on a purely observational basis. It was quite possible to use the full spectrum of roles in a typical research day.

(These research roles are discussed in greater detail in the appendix).

The model for research design in Exhibit 3 suggests that there are discrete phases in participant observation: this is in keeping with other writers on the subject and Exhibit 4 compares some of these. A more detailed discussion of each of these role-making phases follows.

EXHIBIT 3 : Basic Research Design

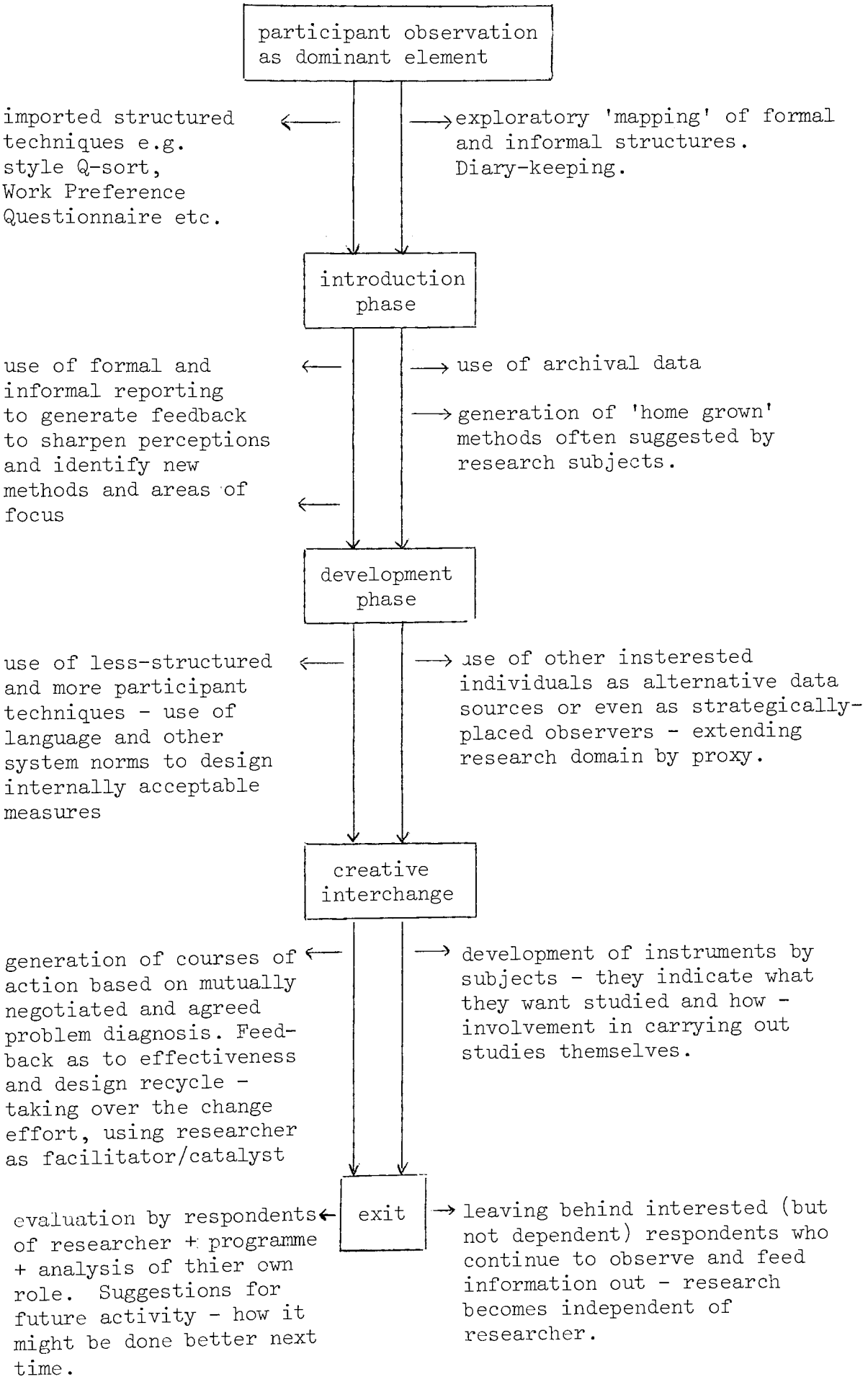


EXHIBIT 4 : Phases of Participant Observation

Janes (1961)	Olesen and Whitaker (1974)	This study (1978)	
Newcomer	Surface Encounter	Introduction	
Provisional Member	Proffering and inviting	Development and role definition	
Categorical Member	Selecting and modifying		
Personalised Member	Stabilising and sustaining	Creative interchange	
Imminent Migrant			
Exit	Exit	Exit	
roles of observer -centred	activity -centred	activity -centred	

Relationships in participant observation

(a) Introduction

Argyle (1970) has written a very readable account of the way in which social interaction takes place particularly at its early stages. There is a strong formal content to any contacts made at this time, but it is also possible to detect clearly the suspicion and anxiety which the arrival of a researcher generates. It is suggested that one of the key factors involved in these early stages may well be proximity: based upon the notion that the longer the contact, the better both parties can make an assessment. The 'emotional mapping' stage cannot be avoided - indeed, it is as necessary for the observer as for the subjects - but it can be put to very good use. An early display of openness, frankness, and honesty about oneself will often have a disarming effect on the elaborate social defences of the subject: here again, the advantage of the open participant-as-observer role can be seen.

In the case studied, the initial procedure was to spend as much time as possible talking to anyone who could spare the time to chat. The role definition on entry here is significant: the researcher was a qualified chemical engineer joining the Research and Development section of a chemical company.

Thus there was an opportunity for a complete participant role to be played: in the event, the acceptance of the researcher developed to a degree which did not require that he practice as an engineer. However, in the context of the introduction phase it is significant that the researcher was prepared for a purely formal, task-oriented contact: this potential 'one-of-us' role may have had a considerable bearing on early acceptance.

Whilst promoting as much contact as possible during the day periods, it was very necessary in the early stages of the work to carry out integrating operations at home during the evening. Diary-keeping and other impressionistic records probably have their highest value at this point, since the sensitive faculties are open to information of a wide variety, nearly all of it quite novel. (Later, as the researcher becomes socialised into the system, the quality of these records will fall because all but significant information will be 'gated out'). The requirement is for a detailed awareness of how the system functions, the geography and hierarchy, a formal map of the organisation etc. before the researcher can begin to carry out any kind of role within the system. But, at the same time, the information supplied in any of these categories by any of the subjects will contain a wealth of 'hidden' clues as to the informal distribution of attitudes, power, motives, goals etc. expressed indirectly by gesture, tone of voice etc. or occasionally directly, usually in a confidential undertone.

Thus, the process of interaction during the first weeks will give the appearance of questioning purely for the sake of information gathering - in the same way as any new employee will ask his way. It is here that some of the major socialisation takes place and thus as detailed a record of this process as possible will be of immense value.

By carrying out a detailed integrative study at home, it is possible for the researcher to arrive quickly at a perception of both the formal and informal structures and systems of the organisation. This can then be tested and modified by feeding 'loaded' questions or statements back to individuals in interaction situations. The value of this is twofold: on the one hand it provides confirmation or modification of hypotheses, whilst on the other it signals to the subjects that the researcher is beginning to understand the system in their terms of reference - i.e. that 'socialisation' to their pattern is taking place. This helps to promote the researcher as 'one of us' amongst individuals and will quickly break down the major barriers of suspicion.

So far the effect is on the researcher: for the subjects the problem is to allay suspicion and to direct the research towards a partnership as quickly as possible. In this respect, much can be done with the defining role which the subject group make use of. It is suggested that the researcher in this study was categorised as 'a student', a 'a man with at least an engineering background', 'a youngster' - even 'a dupe of the university/company in taking on this kind of research!' All of these have in common a relative harmlessness of role connotation - 'nobody listens to students, therefore I'm safe to talk to him.....' - which even moved towards helping behaviour, as between experienced man and youngster. The value of this can be seen in the contrast between Olesen and Whitaker's study, in which they were categorised as students, registered nurses or faculty and which proved a successful participant role and with Pettigrew's (1974) study, which, whilst providing a valuable observational insight, did record problems in setting up the relationship because he was categorised as a social scientist, academic etc. As Olesen and Whittaker suggest,'it is possible, therefore, that the less the actor (subject) knows of the research role and the greater the number of possibilities for placing the researcher in life roles, the sooner the parties will embark on the second phase'.

One other important element in this stage of the work is the detachment of the researcher. Because roles and relationships are in the formative stage, it is a simple matter to retreat off the site to regenerate the research motivation or to adjust to the demands placed by the situation. Thus the introduction process is characterised by a gradual 'getting to know' style which permits both researcher and subjects to adapt in their own time and style to the radical changes which such a study may present to their established life patterns.

The key concept in the transition between stages in the relationship is acceptance: the issue of formal versus informal systems appears yet again in this connection. Formal signals of acceptance appear very quickly - people will cooperate very quickly within the confines of their formal role - and it is thus possible to deceive oneself that acceptance has taken place. It is, as will be argued elsewhere, the informal culture of an organisation which dictates its norms, values, attitudes etc. and thus it is only when demonstrable evidence of acceptance on these terms is available, that transition to the next stage may be said to have taken place. Examples of this kind of expression would be invitations to participate in conversation, join a specific informal group for coffee or lunch, join the football pools syndicate or be invited to celebrate some off-site activity - e.g. marriage or birth etc.

(A list of some typical acceptance symbols is elsewhere). The period for this initial phase is obviously a variable dependent upon the relationships with given individuals but, on average, the period to achieve general acceptance was about two months.

(b) Development

In the second phase, there is a strong element of mutual definition both of role and of self. Olesen and Whittaker term this 'proferring and inviting' which is an effective descriptive term, implying the dynamics of the process whereby knowledge and awareness of the other (and consequently, trust) is built up. Once again the basic openness of the research role will be of major significance here but it is also at this point that too intimate a contact can introduce bias. (This bias does not even need to be actual, in the research context: in one situation a friendship which had grown out of the research partnership, and which had managed to remain at once impersonal and intimate was regarded by many of the subjects as biasing the reporting by the researcher). In keeping with the notion of 'coaching' (Olesen and Whittaker), the subjects were invited to define the role which they wished the research to play, and to what extent they were prepared to adopt a major role in a research partnership.

Simultaneous to this was the proffering and inviting of information relevant to individuals in their 'real life' roles. This represents a major departure from purely formal study to getting information about aspects of the informal structure which may not be accessible in on-site situations. It also has the advantage of further dispelling suspicion since the observer's offer of information about himself (itself a very open gesture) may well offer new points of common contact with others and promote further informal acceptance. (Examples of this type are also given later).

It is perhaps important to remember the issue of ethics in this connection - much information directly supplied to the observer may in itself be confidential, or at least deemed so by the giver. A good observer will be able to pick up much more from a variety of sources, by deduction and inference and by storage and integration of any relevant data. Thus, personal contact with subjects must be regarded as a trust in which information of a highly confidential nature may be placed. The value of building up a 'profile' on a given subject may be great to the observer, since he can use that information in planning and interpreting his research - but should this trust be betrayed, the damage might not be confined to the loss of research opportunity alone.

The transition into the third stage, of creative interchange between research partners is difficult to identify but it is essentially characterised by an involvement in or sharing of the research direction. Typically, signals of this would be requests for discussions, inputs to meetings, feedback on reports, people 'wanting to set the record straight' etc. all of which imply some kind of commitment, however small.

(c) Creative Interchange

As Janes comments, in this third stage of the relationship, the researcher is assumed to have both a high level of knowledge of the community and also an awareness as to the dynamics involved. Thus issues are discussed on a very strong 'insider' basis - this is particularly true in the informal structure, where information and knowledge are stronger currencies than status. The period of time elapsed would typically have been six months or more and the research role would have been clearly established: it is under these conditions that a rapport (to use Janes' word) could be established. However, the demands made upon the research now require a return on the 'information investment' of the previous months and it is here that input generation or stimulation may be possible.

Reporting becomes a major part of the work and some techniques such as mirroring (described elsewhere) become valid functions for the researcher to perform. It is at this stage, when the subject organisation can identify useful functions for the research to fulfil, within the context of the research itself, that the process can be said to have reached fruition.

(d) Exit

The final stage of the process is that of leaving the organisation and Janes describes this as a sudden transition. Interaction became much more concerned with the contents of his final report and there was a strong desire to leave a good impression. It must be borne in mind here that the breaking of relationships which were set up in such a careful and gradual fashion should be similarly executed: best of all, the maintenance of useful, close contacts may provide useful evidence and data long after the researcher's departure.

Conclusions

Inevitably, this phase process will be one of 'leads' and 'lags' since the subject organisation is not a homogeneous group of people. It will be convenient to make use of a checklist, due to Richardson (1960) which recaps on the salient points of field relations and their problems. These are

(i) gathering of background data and knowledge before entering the field.

(ii) identification of information sources in this context.

(iii) preparation and entry.

(iv) initial 'mapping' activities.

(v) role structuring and definition.

(vi) sequence and timing of research activities.

(vii) incentives for subjects in the research.

(viii) selection of samples and subjects.

(ix) rumours and reactions to researcher.

(x) reporting to the subjects.

(xi) ethical problems.

(xii) human relations within research team and emotional etc. costs to researcher.

In particular, the mutual benefit of the process and the prospective take-over by the subjects were stressed as being central to the whole programme. As Janes observed in his Riverville study, the subjects gradually 'came to the conclusion that the occupational interest of the author.....was both legitimate and perhaps potentially useful'.

Built into this programme has also been a reporting function, and it soon became clear that whether informally or formally, there was a strong desire to 'know what was going on' - if nothing else, as a return for their cooperation. This knowledge, added to the openness of the research role led to the manifestation of 'sponsoring' - a term coined by Whyte to explain the situation in which the subjects give definitions of the researcher's roles to persons not immediately involved in the research. At the same time there is a gradual tendency towards restructuring their own way of looking at the organisational culture such that a problem now became 'a problem relevant to our study' - an early sign of joint ownership of the research.

(iii) Data Collection

Having looked very briefly at participant observation as a general research approach, attention is now directed to the process of data collection.

In this case, the methodology of participant observation was used as the central, linking element: other research methods were used as attachments aimed at confirming hypotheses or clarifying issues unearthed using the main tool.

The philosophy of 'triangulation' was dominant in the research thinking throughout the two years, and as far as possible data was collected from more than one source using more than one method.

Data Collection in Participant Observation

Inevitably, with a broad theoretical approach and a broad methodological one, the data collection for a study of this kind should be based upon a wide variety of techniques and methods. Of particular importance here, since we are dealing with data of a predominantly 'soft' and impressionistic nature, is the concept of triangulation - i.e. of arriving at the same conclusions via differing methods which provide a methodological 'fix' on the studied area.

Most techniques will fall under one of the following headings:- (a detailed discussion of these methods appears in the following section)

(a) direct observation

(b) interviewing

(c) survey methods

(d) document and archive analysis

(e) participation

(f) unobtrusive methods

In every case, one of the most valuable elements in constructing an effective data base will be the cooperation of other observers 'recruited' from within the subject system. By using data from these sources, the problems of history and of simultaneity can be solved: the 'recruit' will know what went on before the researcher arrived and he will be able to 'deputise' for him, so that, in a theoretical sense, the researcher can be in more than one place at the same time. This will, of course, raise problems with the quality and validity of the data, but these are not insoluble.

Equally, another basic consideration is the sample itself - size, typicality, homogeneity, etc. Even if, as was the case with the organisation studied here, the sample remains a 'given' term in the experimental design, it is important to know how it relates to itself and to other potential samples. Once again, the problem is unlikely to be internal validity of results but of external and relational proof.

With regard to the establishment of field relationships which will affect the data collection process it is useful to consider the points made by Dean, Eichhorn, Dean (1967), i.e.:

- field contacts should move from persons in the highest status and authority positions (in both formal and informal structures) down to the actual participants in the field situation. This is partly a legitimating activity and partly making use of leadership, especially informal opinion leaders and gatekeeper figures.

- the field worker needs to have a plausible explanation of the research that makes sense to the people whose cooperation he seeks. He should indicate interest in understanding the legitimate activities of a person or group rather than evaluating them.

- the field worker should try to represent himself, his sponsors and his study as honestly as possible - this relates back to the establishment of role and its allied problems.

- the field worker should have in mind some fairly routine fact-gathering as a first step to provide him with an acceptable reason for being there. Interestingly, in this connection they comment 'Acceptance of the field worker depends more upon the kind of person he is than the perceived value of the research. Informants want to be reassured that the researcher is a 'good guy' and can be trusted with what he uncovers. They are not usually interested in the complete rationale for the study'.

The crucial question in the whole field of participant observation remains that of data validity and quality. It is perhaps best to take a two-step view, accepting with most scientists that the fundamental techniques of observation interview etc. are valid and then attempting to demonstrate that the application of these was comprehensive, systematic and equally valid.

Observational data is most susceptible to threats of the relativistic type, etc.

(a) reactive effects of the observer's presence,

(b) distorting effects due to the observer's perception and interpretation.

(c) limitations to the observer's ability to see all sides of the situation.

In a broad sense, Vidich (1955) comments, 'the social position of the observer determines what he is likely to see'. This position will be arrived at by the response and adoption of the organisation to the researcher and the subsequent identity which they afford him. However, by virtue of his desire to remain at least a partially objective observer, he will occupy a marginal position on those issues likely to polarise opinion.

Again, as Vidich puts it 'he is socially marginal to the extent that he measures his society as a non-involved outsider and avoids committing his loyalties and allegiances to sentiments of it.....his position is always ambivalent and this ambivalence shapes the character of the data he secures and the manner of securing them'.

The consequence of this is that all data must be viewed in the wider context of an understanding of the major social dimensions of the situation in which the data was collected. However, there is a more serious threat posed to observational data in respect of the multiple non-rational determinants of the observer's perceptions. A paper by Schwartz and Schwartz (1955) gives a detailed account of the difficulties which this factor introduces, particularly in the evaluation of the observer as a scientific instrument. They suggest that the act of observation is in fact a sequential process involving registering, interpreting and recording and that this introduces an unavoidable retrospective element to the research. This becomes a little clearer when one considers that the observation of any event will involve too many factors to be simultaneously considered by the observer, e.g. social context, subject's relation to the situation, background factors, effect of observer or/and others etc. On this basis, they argue that what occurs during this retrospective phase is 'a reworking of the representation of the phenomenon as originally registered'. In other words, observation is a continuous process of evaluation.

What is important about this hypothesis is that it brings into sharp relief the possibility of the observer introducing a strong (though possibly unconscious) element of personal interpretation and construction. Questions as to the unconscious significance of the event to the observer, or the way in which his motivation may influence the way he perceives events are then posed.

The key to this issue is found in the definition of the reciprocal relationship in which a participant observer is involved: he is an integral part of the situation he is observing. Because this involves an examination of the observer's effect on the observed, it raises questions discussed earlier about role and identity: the issue here is, however, to what extent the observed data represents the real situation and to what extent it represents an evoked response of some kind. Schwartz and Schwartz suggest that within the role categories already defined there is a second element of "affective participation" in which the emotional responses of both parties are brought into play. This implies the existence of a continuum, parallel to that running from complete participant to complete observer, but with degrees of emotional involvement as the scale. Thus, at one extreme is the case of total involvement with correspondingly high empathy but low experimental validity, whilst at the other is a condition of complete detachment which has low validity because of the lack of empathy.

Measures, or at least indications of the position on this scale might be the application of moral or value judgements or the taking of 'sides' by the observer. What is required here is an optimum, empathic balance which will include an element of emotional interaction with the subjects but will not allow this to block the 'truth' of the situation. It would, however, be a mistake to conclude that these factors are not highly relevant in formal, even stylised situations as well as in relatively informal ones.

Turning now to interview data, it is again possible to isolate three broad categories in which the validity is threatened: these are:-

(a) reactive effects of the interview situation

(b) distortions of information

(c) interview skills lack by subjects

Strauss, in reporting a study, which began much as ours did with a 'cover' title, in this case 'how a hospital works', describes the 'growing up' of methods ranging from the naive, wide-eyed observer to sophisticated interview methods. He also comments on two basic styles of questioning - the 'repertorial', of the who, what, where, why variety - and the 'posing' which put a specific case to a respondent. These could be hypothetical situations, challenges, requests for ideal descriptions etc., but they have in common the basic principle of using the subject's own language, symbols etc. to provide an interpretation. This can be carried a stage further, wherein, as in several reports, a deliberately biased interpretation might be offered in draft form to provoke feedback comment in order to arrive at the correct interpretation. Methods of this kind also have the advantage that they involve the subjects and thus help to promote the rapport or creative interchange role.

Recording data will always pose a problem in participant observation - on the one hand, the wealth of data available in terms of impressions, interviews, conversations, meetings etc. is vast, but on the other it is rarely possible to make use of the more sophisticated techniques and machinery because of their obtrusiveness. A comparison of available methods and an indication of their relative acceptability is given in the following section.

Dean and Whyte (1958) discuss the evaluation of statements made by informants and conclude that the research view must always be that 'the informants statement represents merely the perception of the informant, filtered and modified by his cognitive and emotional reactions and reported through his personal verbal usages'. If we accept this, then interview data will provide us with two separate perceptions - one relating to the individual, in terms of motivation, orientation etc. and the other relating to the situation, at least in terms of the subject's reality. A third factor appears here which is concerned with situation - in a different time and place under different conditions the response may vary. Thus comparison of answers to the same questions posed in different interviews may increase the validity of the data: in addition, the interviewing of the whole sample in this fashion will give rise to a clear statement of the subjective 'reality' of this group - which will be the operating environment into which any change must arrive.

Argyris introduces the final important division to the area of data collection by pointing out the likely defensive reactions which will arise from groups being 'researched upon'. He differentiates between individual defences, such as silence, stalling, protective forgetting' etc., and organisationally-based mechanism such as rumours, overloading with irrelevant information, labelling the researcher as spy, communist, etc., administrative wrangles etc.

It is suggested that, providing initial role definition is correct and providing the flexibility of the observer is sufficient to sensitivity and quickly respond to situational demands, these issues can be resolved, both from the point of view of data validity and also to benefit the subject organisation. The important factor is to be sensitively aware of the existence of these defences.

(iv) Constraints on observational methods

The nature of participant observation requires that prime consideration be given to developing and maintaining the trust and confidence of the members of the organisation under study. Measuring techniques should thus be as unobtrusive as possible, even though this may mean abandoning well-tried and validated structured instruments in favour of simple ad hoc devices.

Design and use of any technique or instrument will need to take into account a number of constraints. These will be discussed briefly here.

(a) Timing

Whilst participant observation permits data to be collected over a sustained period of time, there will be distinct limits on the amount of time which an individual will be prepared or able to give up to the research. Obviously this will vary - in those tasks such as management or production, the orientation is essentially towards a series of problems occurring at short notice and in unpredictable fashion. Research specialists, by contrast will have more time available because their problem horizons are longer and, to some extent, more predictable.

Thus there is a distinct possibility of interruption associated with research activities: making an appointment at the individual's convenience (i.e. when he thinks he is most likely to have the time) may help to minimise this. Nevertheless, techniques should be of short duration and flexible enough to not require a single uninterrupted session for administration.

(b) Access

Another limiting factor is the degree of access to particular individuals, especially senior managers or very busy specialists. Techniques used must reflect the level at which people are prepared to cooperate. 'Sponsoring' by other members of the organisation may not be sufficient to develop trust and confidence, especially if the individual feels threatened by the research.

To cope with this circumstance, a battery of techniques should be available so that it is possible to ask the same question in a number of ways. Novelty in design may make the measure intrinsically interesting despite initial hostility.

(c) Location

It may not be possible to carry out research from within the office. Particularly in the case of production units, the sessions may have to be carried out in a variety of locations - perhaps even on the plant itself. Thus techniques should be present in a robust form which can be taken anywhere.

(d) Threat

Many potential respondents may be unhappy about participating in the research because they perceive it as threatening in some way (an example of this might be the process operator's hostility to work study methods which, in his experience, affect his job). In part this can be coped with by developing relationships, sponsoring etc. but it can also be assisted by using techniques which are novel and fun rather than formal questionnaires etc.

Overall, the emphasis should be on developing flexibility in the research approach; this will pay dividends in that attempts on behalf of the researcher will favourably dispose respondents - 'if he's prepared to go out of his way to accommodate his researching to my problems, then I'm prepared to take an interest and go out of my way to help'.

(v) Feedback

The action research orientation of the project requires that feedback play a central role in the process. This took two forms, formal and informal.

(a) Formal

Under the conditions whereby the project was set up, a formal quarterly report was to be made to senior management. It was decided that this report provided a regular channel for communicating information about the project: as the research expanded, so did the circulation. A side-effect of this was that open discussion of research findings in the report helped in developing a legitimating climate for the research throughout the organisation ('If they're prepared to hang out their dirty washing in public in the interests of constructive change, then I can't very well refuse!).

Other formal feedback sessions included a 'teach-in' for departmental managers (members of the Technical Co-ordination Group).

(b) Informal

Most feedback was given in an informal fashion, in keeping with the research philosophy of making the study as 'normal' a part of the overall organisation's activities as possible.

The guiding principle here was to give feedback as much and as often as possible rather than wait for requests for information. Where possible, individuals were invited to get involved in research activities and this increased the interest in knowing 'how things were coming along'.

Quality of feedback was essentially non-evaluative: in both formal and informal cases, the researcher emphasised his role as an 'organisational mirror'. Where possible, individuals were invited to draw their own conclusions and criticisms: the researcher only gave an opinion when invited to do so.

Of particular interest in this area was the widely-expressed desire for passing the kind of information generated to senior management: the researcher was soon identified, both within departments and in the whole organisation, as a non-evaluative communication channel. Through this medium, information could be passed on to levels apparently inaccessible via normal routes.

(vi) Measuring Techniques

Within the constraints outlined and allied to the general system of participant observation, a number of measuring and observational techniques were employed. Exhibit 5 lists these. Although the research began by making use of imported formal techniques and instruments, the trend towards simplification soon led to the use of ad hoc techniques for the majority of studies. Since the notion of 'objective' truth was largely irrelevant in what was, by its participant nature, a 'subjective' study, questions of validity were ignored. Emphasis was placed instead on developing novel techniques, instruments, games etc. which would illuminate some particular area of interest: these were often little more than crude hypothesis-testing devices. Their value lay in the fact that the results they generated were testable against the reality of the situation under study: in this way a grounded theory was gradually built up.

EXHIBIT 5 : Range of Research Methods (roughly chronological order)

Technique	Applicability	Value
Interviews	General. The major data collection source - different types of interview meant that almost any situation could be regarded as a data-collecting interview. Little apparent limitation on what could and could not be discussed.	High. Levels of disclosure varied and informal interviews were best, but overall this was the most efficient way of collecting information.
Diary Keeping	General.	The single most important activity since these diaries became the major store-house of observations, inferences etc. Non-specific and variable in quality, they provide the background of experience against which the other research elements must be considered.
Observation contact measures	Local to Process Development but could be general.	As before, high in terms of feedback to researcher about depth and range of penetration. Important in directing the research.
Informal invitation measures	General.	High in terms of direct feedback to the researcher about how the relationship was developing. Low research value as such - all it tells us is something about rates of acceptance of observers.

Technique	Applicability	Value
Sociometric survey	Local - only used in Process Development although could be used elsewhere.	Medium - tended to support observed experience. Also not popular because of demands placed on people.
Q-sort style measure	Process Development local - could be applied in the 'imported' form to Research - and there is no reason why a similar devi e couldn't be devised for other specialism styles.	Medium - confirmed observed phenomena but questions were often irrelevant because it was an American questionnaire - something 'home-grown' would be better.
Organisational mapping questionnaire	General - standard format developed from key issues in Process Development but used across whole organisation. Feedback suggests questions were highly relevant in some cases, supporting the design. Built into the instrument were responses to 'local' issues and response to 'total organisation' issues - within and between groups.	High in terms of providing comparative 'large' sample data across the whole organisation. Low in terms of getting an insight into why people answered as they did - too general a device.

Technique	Applicability	Value
Individual factors measure.	Local - only used in Process Development. Far too complex in existing form.	Low. Too complex to administer and going the wrong way about asking the right questions. Luckily, the length of time involved in administration gave rise to much explanation and hence insight into individuals.
Content analysis.	Variable - used on documents of different kinds and in some meeting observation.	Variable - depended on document quality.
Process analysis.	Specific to formal meetings but general in that range of meetings was wide e.g. policy making, project team etc. Of particular value as support to direct observation when observer cannot interact directly, as in a fly-on-the-wall observation.	Variable - depended on meeting
'best and worst transfers'	Local - Production area only, although once again, could be used generally.	High - made use of specific recollections of individuals as to what were 'good' and 'bad' factors.
Peg-board	Local - specific to Production but could be applied to any interfacial situation and any groups/ individuals involved.	Medium - supported interview and observed data. Could be successfully developed as an OD technique for 'bridging' interfaces

Technique	Applicability	Value
Informal assessments	Local to Process Development and the Process Development/ Production interface. Could be extended anywhere - depends only on confidence and trust levels (!).	High both as a trust developing device, an unfreezing agent and also in providing data on norms and beliefs about what makes for effective performance. Needs developing but potentially a useful intervention tool.
Work preference questionnaire	General - questionnaire format, circulated widely to all units and groups studied.	Variable. The nAch scores themselves revealed little but analysis of responses to individual questions showed up differences between groups and dominant beliefs quite well.
Archival data	Variable - depended on access. As trust in the researcher grew so documents of an increasingly confidential nature were made available.	Variable. Some sources, e.g. company newspaper of little more than background significance Others e.g. 'Fate of New Products' document of immense value.
Case histories	Local - confined to Process Development but could be extended. Similar to 'best and worst' transfers but more detailed and supported with minutes etc.	High. Often gave two different 'stories' about the same sequence of events - this data also revealed individual orientations and beliefs.

Technique	Applicability	Value
Creativity Audit	General - involved whole organisation and 'plugged in' to wider national study.	High in terms of catalysis - evoked a strong response and interest. Also very useful in indicating how the organisation performs against 'accepted' theoretical criteria Very effective diagnostic tool when used as part of a wider 'package' - is being developed further.
Video/audio tapes	Highly specific to individuals who attended the Aston course on 'Technical Group Leadership'.	High in terms of insight into specific individuals. Low in terms of overall research, since they were engaged in strange situations off-site. All were connected with the innovation process, however.
Organisational Beliefs Questionnaire (incorporates Business Organisation Climate Index (Payne and Pheysey 1971)	General - limited in format but extensive ($\approx$ 80 items). Large sample size. Attempted to test common beliefs and feedback suggested it was 'on target' in this.	High insofar as sample size and range was extensive. Results disappointing in that wide ranges of belief cancelled out significance in scoring. Suggests a less general approach is required.
Normative mapping	General (to units and groups in the organisation) attempted identification of sub-cultures.	Potentially high but limited in this case since the 'maps' were built up out of various data sources - diaries, interviews, beliefs questionnaire etc. Suggest this area could be very fruitfully developed.

Technique	Applicability	Value
Library circulation survey	General.	Low. Gave an indication of range of input information via journals, and of nominal circulation. Needs a measure of who actually reads (as opposed to names on lists) and what they read.
Activity sampling	Local to Process Development and some Production personnel - could be extended, but was limited by time constraints in this case.	Variable. Useful background data but even intensive studies (which are demanding on resources) don't reveal enough of the 'unstructured' elements - need to stick like a leech over a long period of time to get data of this kind.
Personal Beliefs Questionnaire	General to Paisley site. Potentially applicable elsewhere but access to Wythenshawe limited by time constraints.	Background information - low value in that belief statements too simple and scale too small - could be developed.

Description of research measures and techniques

Interviews

These were held to be the dominant data collection method and attempts were made to try and regard every interaction as a potential information source. Thus interviews could be subdivided, firstly, into formal and informal categories.

(a) Formal interviews: these involved sessions in which respondents were asked specific questions in a relatively structured fashion. This approach was rarely favoured or used for a number of reasons:

(i) people feel ill at ease, often seeing it as a kind of 'interrogation' in which they have to perform well - usually by giving the answer that the interviewer appears to want.

(ii) people feel inhibited about imparting personal opinions or allowing different shades of meaning because the question has been shaped beforehand and asked in a certain, specific fashion.

(iii) the interview situation is artificial, so the replies given may only have validity in this context. In a real situation responses may be totally different to those abstract ones given in interview.

(iv) the kind of information sought in this way should already be available to the observer in his participant role: it is not general knowledge that is sought but individual perceptions, opinions, attitudes etc.

(b) Informal interviews: these involved making use of any interaction as a data-gathering opportunity. Interviews of this kind ranged from a semi-structured operation ('Can I have a chat to you sometime about.....?) to active listening in a lunchtime conversation. As far as possible, the central principle in these encounters was to listen as carefully as possible, to be aware of all incoming stimuli (e.g. non-verbal signals, the relationship between others in a group, reactions to the researcher's presence etc.) and to delay evaluation until the session was over.

Opportunities for this kind of interview grew as the research developed: once people had confidence and trust in the researcher, and saw that it was legitimate and possibly valuable to them to discuss issues of this kind, they seemed eager to participate. Often this meant that they would initiate the contact ('you might be interested in this situation that's come up - the way I see it is.....'): this introduces another principle, which is that the researcher should always be available for interaction of this kind. Whether in the office, on the phone, in the corridor, walking out to the car park or in the pub after work, the opportunity should be taken. Failure to do so may result in a negative reinforcement (he's not really interested, so I won't bother again').

As far as there was any structure to these activities, it was based upon a principle of active listening. Roethlisberger and Dickson (1939) describe the interview techniques which they used in the Hawthorne project and those used in this study used essentially similar approaches. These included:

- relaxed environment. As far as possible, put the other person at ease. Conduct the interview in their office or somewhere where they feel secure. Sit in as informal a fashion as possible - not confronting across a desk.

- take notes as unobtrusively as possible, and particularly don't appear to be scribbling frantically. If possible jot down 'trigger' words or phrases rather than attempt a verbatim transcript.

- as far as possible allow the other person to talk - use questions only in the form of conversational 'signposts' to keep direction in the interview. When there is a silence, make use of it by maintaining it - this will often cause the interviewee to volunteer further information.

- be aware of non-verbal signals - nervous twitches or fidgeting. Particularly these may appear when the issues under discussion are sensitive or have high emotional relevance for the individual.

- provide support and feedback, both verbal and non-verbal. Evidence suggests that eye contact is particularly important in establishing trust ('people who keep looking away are shifty, not to be trusted'). Where there is a common language norm (e.g. the liberal use of expletive adjectives), make use of this as a reassurance to the individual that the interviewer is 'one of us'.

- be non-evaluative. Even when the opinions expressed are distasteful (as, for instance, in a highly prejudiced individual), the interviewer should listen without indicating his own personal reactions.

- allow the interviewee to define the interviewer role. If the subject wishes to adopt a parental lecturing style, as to a young boy - then this can be effectively used. If the interviewer tries to impose a self-definition on the situation, it may not be so productive.

A third kind of interview situation occurred during the administration of measuring and investigating devices. It was discovered early in the research that people preferred card-sorting and other activities to questionnaires. This was apparently because the presence of the researcher afforded the opportunity for an individual to justify or explain his response. Since perceived ambiguity is high in many questionnaire designs, and since construct thoery (Kelly 1955) suggests that individuals perceive issues in different ways, it is argued that the contact approach is valuable.

Of necessity, then, administration of research measures provided another interview opportunity: where the task involved some searching questions, the intimate and confidential content of the interview would often be high and thus of great value.

Observation

The participant observation approach has already been discussed: in practice this was developed into a series of personal strategies aimed at maximising the research opportunity whilst remaining as unobtrusive as possible.

Interviews have already been discussed, in which the researcher was an active participant. There were, however, a number of situations in which he was present as a passive observer which offered important data collection opportunities.

Formal meetings - e.g. strategic planning or departmental co-ordination - were one class: in addition to process and content analysis techniques, direct observation was also employed. This was especially useful when the background orientations, political allegiances etc. of the participants was known since it allowed the researcher to study factors like 'the hidden agenda' at the meeting.

Communicator groups, project teams, informal groups etc. were also studied: throughout these the role of the observer was essentially passive and detached. Where possible, a formally acceptable role (such as secretary) provided the opportunity for study without inhibiting participants: however 'fly-on-the-wall' observation roles did not appear to inhibit participants, particularly during the later stages of the study', when the researcher was well-known and trusted.

Recording data during observation must be unobtrusive. The researcher found it useful to adopt a 'delay system' in note-taking. When a stormy encounter or a significant interchange occurred, it would be distracting and inhibiting if participants were conscious of a reporter busily scribbling away to record this. If, however, the observer presented a detached and passive character, recording information at apparently random intervals bearing little relationship to the emotional tides of the meeting, then the participants felt more secure.

That participants were aware of the observer's presence during difficult interchanges is evidenced by comments like 'Don't take that down!' addressed either jokingly or seriously. Whether he does record the information or not (and, in view of the reasons for studying the group i.e. to observe its dynamics, it may well be that the incident represents important data), he must not be seen to. As far as possible, he should be non-reactive, whatever the content or form of the observed group interaction.

Diary Keeping

This was the most important activity in the early stages of the work. As Mumford (1954) explains, it is rarely possible to directly record impressions and observations, especially when this might prejudice the research relationship. Thus a daily record of impressionistic data will be a necessary component of the research activity carried out at the end of each day.

In the early stages it is important to record as much as possible with little evaluative filtering because the diary may represent the only source of data for this period. Later recordings will fall off in quality as the observer's degree of openness to new stimuli falls with socialisation. The diaries and case notes will be of great value in developing hypotheses.

Measures of observation contact

This was an attempt to monitor the degree of contact the researcher had by plotting contacts per day over a period of time. Two classes of contact were identified - general social and company business encounters, and those encounters whose content referred in some way to the study itself.

The plots of these contacts are reproduced in the appendix.

The principal value of this approach was that it provided the researcher with a means of gauging how far and how deep his research contact extended. In preparing reports, this was of value since it suggested where observer bias might be expected (i.e. in areas of low direct contact). In terms of directing the research it provided information about where to concentrate efforts.

Informal invitation measures

These were simple indicators of the rate and degree of participant observer acceptance. Following Webb (1971) unobtrusive measures of this were looked for: typical examples were

- invitations to the pub to celebrate (birthday, engagements etc.)

- invitations to participate in organised 'night out' functions (departmental social events)

- invitations to join football pools and other syndicates (contribution invited)

- invitations to join informal groups (for coffee, lunch etc.)

- invitations to extra-mural activities (mostly sporting)

Sociometric Survey

This was an experiment carried out within the Process Development group in an attempt to identify communication and interaction patterns. Respondents were asked to select four days at random and to record all the contacts they had during these. Some indication of timing and typical content was also requested.

The purpose of this technique was to try and identify the interaction and communication patterns present within the group (cf Allen 1975). It was also hoped to locate empirically the more 'cosmopolitan' members of the group, the opinion leaders and possibly the technological gatekeepers.

People were not very keen on this measure because it made demands on them to think about their movements over four randomly selected days - this was a source of annoyance in some cases. On the other hand there was some learning reported when people began to realise the significance of their interaction patterns - 'I never realised I spent so much time talking!'

From a research point of view the survey would need to be enlarged in sample size or in the number of days selected: as it stood, it had limited value, principally providing support for observed interaction patterns.

Q-sort style measure

This was a structured instrument based on a factor-analytic identification of different researcher styles. (Gough and Woodworth 1960). A questionnaire with 56 statements about research scientists was circulated and respondents were asked to record the degree of importance they attached to each statement across a five point scale.

The Gough and Woodworth studies, based on responses to this test and correlated amongst a sample population with other psychological data, gave rise to eight dominant stylistic types amongst research scientists. These were:-

- the zealot
- the initiator
- the diagnostician
- the scholar
- the artificer
- the aesthetician
- the methodologist
- the independent

and they suggest that these styles will be predictive of behaviour.

An example of the questionnaire is given the the appendix. Administration of this instrument had a double value in that, in addition to the style measurement it also provoked interest in the project generally and broke the ice surrounding the use of formal measures with a device whose content did not deal with highly sensitive issues.

Organisational mapping questionnaire

This instrument was developed early in the research as a device for identifying areas of concern within groups and within the division as a whole. A series of statements about a number of organisational factors was derived from case notes and respondents were asked to record how far they agreed or disagreed with these on a five-point likert scale. An attempt was also made to measure rate of change in the response to these variables by asking respondents how far the subjects of the statements had changed in the preceding six months.

Issues covered were:
- objectives (local and divisional)
- structural factors (local and divisional)
- communication (local and divisional)
- job satisfaction
- co-ordination (local and divisional)
- barriers to innovation

(An example of the instrument is given in the appendix).

This was little more than a structured way of asking general questions, a blanket attempt to identify focal points of concern. In diagnostic terms it had a dual function: to crudely represent attitudes and, more importantly to stimulate discussion of issues felt to be relevant to the innovation process. Feedback suggested that many of the questions had high relevance for the participants, however. The stability of these issues over time is also deduced from the fact that the questionnaire was not administered simultaneously but was given out as part of a 'package' in research into different areas over the whole study period. Nevertheless, feedback as to the relevance of the statements was regularly received over this time: this suggests that the issues were central and longstanding rather than simple, peripheral symptoms.

Individual factors measure

This was an attempt to investigate the role and motivational characteristics of individuals along the lines of Pelz and Andrews (1965) studies which provided insight into productive climates for research scientists.

A number of statement cards were required to be sorted into categories by the respondent. This technique suffered from being:

(i) too complex - the scales for each question varied and the statements were often ambiguous.

(ii) too time consuming - a function of (i), the measure took too long to administer and this made it generally impractical to use.

Nevertheless, it did provide a great deal of information by way of explanation, which added to insights about given individuals.

Content Analysis

A number of documents and transcriptions of meetings etc. were subjected to content analysis to identify relevant issues and foci of interest. 'Live' analyses were also attempted during meeting observations, where key phrases and words were 'scored' over time.

Process analysis

Based on the early studies of Bales (1951) and others on group processes, this was an attempt to observe performance of groups in a variety of situations e.g. co-ordination meetings, planning meetings, problem-solving sessions etc.

A number of observation categories were used, depending upon the situation: typically these included:-

information seeking and giving
opinion " " "
chairman/process interventions
tension releasing and generation
support seeking and giving

In addition, an attempt was made to ascribe functional role labels to various group members (cf Benne and Sheats 1948).

'Best and Worst Transfers'

This was an attempt to assemble some critical incident data regarding transfers of technology between Research and Development and Production. Respondents were asked to identify the best and worst examples of specific transfers and to try and indicate what the determining variables (in their judgement) were - i.e. what factors influenced success or failure.

Some examples of this data appear in a later section on studies in the Production area.

Peg-Board Assessments

This was another simple device aimed at identifying relevant dimensions of performance at the Production/Research and Development interface. Administered to members of the Production units, it was an attempt to focus thinking about what 'behavioural' elements made for smooth and efficient transfer of technology from Research and Development into Production.

The time constraints already discussed meant that any measuring device used in the production environment had to be simple, easy to administer and preferably novel. In this case, respondents were given a simple boards scaled in five dimensions (see appendix i). By using different coloured drawing pins, they were asked to perform three operations.

(i) with the first colour to indicate on the scales the level of performance they associated with named individuals and with the department as a whole.

(ii) with the second colour, to indicate how they would allocate five 'improvement points' along the scale (i.e. they could improve one factor by five points or five factors by one point).

(iii) with the third colour, to indicate how they would allocate ten 'improvement points'.

The purpose of the 'improvement points' idea was to try and ascertain some crude order of priorities for improving activities involved in transfer. Categories for assessment were derived from discussion and included:-

- communication
- task skills
- understanding of production problems
- flexibility
- involvement, ability to motivate and interest others - 'selling'
- follow-up and consultation

Informal assessments

This was an experiment carried out within the Process Development group and later extended across the interface with Production units. It grew out of general discussion of performance of people within the group: what were the factors that made for an effective contribution? Since the company already operated a performance appraisal system based on the Hay-MSL approach, it appeared good practice to make this informal appraisal similar in format, though not in content.

In general, the Hay-MSL system involves appraisal by immediate superiors, based on an analysis of how far the subject has discharged the responsibilities outlined in his formal job description.

The evaluation takes into account significant elements in the job such as the degree of human relations involved: nevertheless it is limited to specific task-related activities. Exhibit 6 indicates the performance categories against which accountabilities are assessed.

Some dissatisfaction with the limitations of this approach led to discussions of informal assessments based on relevant aspects of interpersonal behaviour and competence. A variety of trial runs were made before the operational list of categories was developed.

Respondents were given a deck of cards with the names of all members of the department on them. They were asked to select those they felt competent to make judgements about and to sort them on a scale (related to Hay-MSL categories). This operation was carried out for each of the following categories.

- communication
- self-motivation
- motivating others
- decisiveness
- innovativeness
- leadership
- informal contribution
- co-operation
- interpersonal skills
- delegation
- task skills

The measure is an attempt to stimulate interest in and aspiration towards those characteristics which are generally believed to contribute to good performance.

At the same time, it is argued that a technique of this kind, involving the researcher in the process of recording confidential information will also provide a useful measure of the level of confidence and trust placed in him.

EXHIBIT 6 : Definitions of Performance Levels

Performance Level	General Definition	Rating Symbol
Outstanding	Peformance is of such a distinguished character that it is clear to all. All principal accountabilities are achieved. The job holder regularly suggests and implements improvements of an original and effective kind in his own worn and in the work of the unit or department. He succeeds in almost everything undertaken.	O+ O-
Superior	Performance is characterised by such an authoritative and consistently reliable level of achievement that it is noticeably better than fully acceptable. All principal accountabilities are achieved. The job holder makes frequent well thought out and effective suggestions and improvements in his own work and less frequently in the work of the unit of department. He succeeds in the major part of everything undertaken.	S+ S-
Fully Acceptable	Performance is characterised by complete achievement of all the most important principal accountabilities, so that there is no doubt that the job requirements are being fully met. Performance in the job makes in full the designed contribution to the department's aims. The job holder suggests and introduces from time to time, of his own initiative, competent and useful improvements in his work and occasionally in the work of the department. He succeeds in nearly all the tasks undertaken which are critical to fulfilling job requirements.	FA+ FA-
Incomplete	Performance is characterised by being close to fully acceptable in some respects, but leaves no doubt that in some key areas there is a recognisable need for further development. The job holder achieves an acceptable minimum of principal accountabilities.	I+ I-

Performance Level	General Definition	Rating Symbol
Marginal	Performance is generally characterised by clear evidence that key job requirements are not being met, or alternatively are only just being met with considerable additional assistance. Principal accountabilities are not achieved or are only achieved irregularly.	M+ M-

Work-preference questionnaire

This was an attempt to make use of a formally structured instrument to measure need for achievement based on Fineman (1975). Need for achievement (nAch) has been defined by Murray (1938) as 'the desire or tendency to do things as rapidly and/or as well as possible..... to excel oneself. To rival and surpass others. To increase self-regard by the successful exercise of talent'. Writers such as McClelland (1961) indicate that it can be related to the 'innovative impulse'.

Most operationalisations of nAch have relied on projective measures (e.g. the Thematic Apperception Test (McClelland 1953) which would have been difficult to use in the research situation. Fineman has reviewed the construct and its operationalisation extensively (1975, 1977) and developed the Work Preference Questionnaire to meet the following criteria; of acceptability:

- standardisation on populations
- industrial acceptability
- control for social desirability and faking responses
- psychometric adequacy

It consists of 24 pairs of statements about ideal boss and work organisations: respondents are forced to choose one out of each pair.

An example of the questionnaire is given in the appendix. Once again, this questionnaire was used as part of a general research package over the whole two years in different areas.

Archival data

A number of data sources were made available to the researcher, particularly during the later stages of the study. These included:

- minutes of strategic planning and policy interpreting meetings

- " " co-ordinating meetings

- special report on 'why new products failed'

- items of confidential correspondence

- company publications, journals etc.

Case Histories

This was a more detailed attempt at collecting critical incident data about specific innovations. Individuals were asked to give a free account of their recollections of the major projects with which they had been associated. As far as possible, they were encouraged to tell 'their side of the story' and give their own opinions as to why decisions were taken and whether they were 'correct' or not.

Because they were recalling projects rather than single innovations, data collected in this fashion better represented incremental as well as radical, product and process innovations. Combining the perspectives of many individuals who had worked on the project gives a clearer insight into the mechanics and problems involved.

In addition to personal recollections, many case histories could be added to by referring to existing formal reports: individuals also used their own files to jog their memories and this helped to fill in details of time etc.

Creativity Audit

This was a structured instrument developed at the Innovation through Creative Analysis (INCA) unit at Manchester Business School. Since Dr. Rickards of INCA was engaged in a research consultancy operation within the same organisation as that being studied in this project, it was decided to collaborate on developing this measure.

The measure grew out of attempts to devise a check-list of factors which would be specific to each organisation studied and which could differentiate between capacities for innovation and creative change.

In essence it is concerned with attitudinal factors which are associated with the individual and with the organisation with respect to some of the key findings in the field of innovation. Examples are given in Exhibit 7. The final audit is reproduced in the appendix.

The value of this instrument was that it was well-validated across a large sample of British industry, public and private sector. It was possible to use this comparison in reporting to give immediacy to some of the organisational problems.

However, continuing work on the development of the audit raises some doubts as to its value when used to identify organisational capacity for innovation, since it does not take into account sufficient contingency factors. Despite these drawbacks, it has demonstrable value as both a training aid and also a hypothesis generating instrument, particularly when used as part of a larger, participant-orientated study.

Factor analysis on the largest possible data set has identified a number of factors whose presence accounts for a high proportion of the variance. A number of working papers covering the development and statistical treatment of the audit are available (Rickards et al 1977, 1978). The instrument is being developed further.

EXHIBIT 7 : Key factors in the 'creativity audit' (Rickards et al 1977)

- track record	- good track record is particularly favoured by financiers evaluating proposals for funds.
- managerial attitudes towards market	- SAPPHO, Langrish et al. Successful innovators have better grasp of market needs than less successful innovators.
- managerial attitudes towards ideas and creativity	- the creative organisation is open to change and new ideas (Steiner)
- organisational structure	- structure will reflect environment (e.g. Burns and Stalker). Ability to change to cope with external changes should be important.
- management style	- an excessively bureaucratic style is likely to be slow to anticipate change opportunities.
- communications	- discontent may be reflected in attitude to communications. Does the organisation use outside sources?
- human resources	- has the organisation 'product champions' (Schon), 'technological gatekeepers' (Allen) etc.
- reward systems	- carrot and stick? hygiene OK? (Herzberg)
- planning and control systems	- what sort of control is necessary to avoid chaos but organise while permitting freedom
- managerial environment	- wider issues possibly influencing the organisation (Lawrence and Lorsch).

Video and Audio Tapes

During the second year of the study, some members of the organisation attended a course on Technical Group Leadership at Aston University. Audio recordings of all sessions of this course and video recordings of some activities were made.

Organisational beliefs questionnaire

This was one of the final instruments to be administered. By this time (18 months), it was assumed that the participant status of the observer was well-developed and an attempt was made to try and identify elements of the organisational 'ethos' expressed in the form of commonly-held beliefs. The assembled list was tried out on several members of the organisation and modified accordingly: it was then codified into questionnaire form and card deck.

Administration depended upon research opportunity. As has already been explained, where possible interviews with card-sorting activity were preferred but this was not always possible, in which case questionnaires were sent to or left with respondents. In both cases, respondents were asked to indicate their degree of agreement with the statements on a likert scale of five points.

Incorporated in the questionnaire were statements pertaining to the Business Organisational Climate Index (Payne and Pheysey 1971): the object of this was to identify the organisation's score on the index.

The questionnaire appears in the appendix.

Normative mapping

This was an attempt to identify the various norms of the groups under study. Based on studies like that of Dale and Spencer (1976) and on practical approaches like Pilnick and Allen (1972), it involved collecting a number of statements which, by a process of feedback and testing gave rise to a number of 'norm' clusters. As Dale (1974) points out, there are many norms and beliefs acting at the same time, and some attempt was made to structure the data to conform to his classification. In particular it is important to note that people do not contribute in equal proportions to the development, maintenance and change of norms: as Blumer (1946) points out, public opinion is not mass opinion or a simple aggregate of individual opinions.

Many of the normative statements were used in the design pf the organisational beliefs instrument. Typical areas of clustering were:

- organisational and personal pride
- performance and excellence
- teamwork and communication
- leadership and supervision
- concern for profitability and effectiveness
- relationships with others
- relationships with market-place
- training and development
- innovation, adaptation and change

Library circulation survey

This was an attempt to observe the circulation patterns of various journals received and disseminated by the company information service. By studying the circulation lists it would be possible to identify which journals were received in which area. (Whether they were read, and if so by more people than the single name appearing on the list were factors impossible to discern by this method).

Activity sampling

The idea of specialists and managers followng an activity outline made up of strategies and heuristics was suggested during the later part of the research (Gregory 1978). Since there appeared to be little empirical evidence for the nature of these activities, attempts were made to obtain some blow-by-blow information as to what specialists actually did.

The practical difficulties involved with this meant that much of the observation was based on activity sampling approaches, where an individual was asked at random intervals and over a long period of time what he was doing. Attempts were made to chart a 'typical day profile' for a number of individuals: this information was compared with an individuals own assessment of how he typically spent his day. The method appeared more effective for uncovering the routine and programmed elements than for providing insight into the range of non-programmed activities. It is suggested that a longer study might usefully be carried out along similar lines.

Personal beliefs measure

This was an attempt to identify dominant belief systems about work in general, irrespective of the actual job in which a respondent was involved. The approach was based on Dickson (1977) and involved the sorting of statement cards into categories of agreement/disagreement.

Five dominant belief systems were suggested:

(i) the work ethic:- 'work is good in itself and bestows dignity on a person. Everyone should work and those who do not are not useful members of society.

By working hard a person can overcome every obstacle that life presents and make his own way in the world. Success is thus directly linked to one's own efforts and the material wealth a person accumulates is a measure of how much effort he has expended. Wealth should be wisely invested to earn still greater returns and not foolishly spent on personal consumption. Thus thrift and frugality are virtues to be practised in the use of one's material possessions!'

(ii) the organisational belief system:- 'work takes on meaning only as it affects the group or the organisation for which one works and as it contributes to one's status and rise in the organisational hierarchy. Work is not so much an end in itself, but is more of a means valued only for how it services group interests and contributes to one's success in the organisation. But this success is more dependent on one's ability to conform and adapt to group norms than it is the result of individual effort and accomplishment. In other words, success in the organisation is more dependent on the ability to get along and 'play the game' than it is on individual productivity.

(iii) Marxist-related beliefs:- 'productive activity or work is basic to human fulfilment. Without work man cannot provide for his physical needs, nor can he maintain contact with the deepest part of himself. Through work man creates the world and himself and keeps in touch with his fellow human beings. As presently organised, however, work in this country does not allow man to fulfil himself as a creative and social individual'.

(iv) humanistic belief system:- 'work is to be taken seriously as the way in which man discovers himself and finds fulfilment as a human being. Thus individual growth and development on the job is more important than the output of the work process. What happens to people in the workplace is more important than productivity. Work must be redesigned to allow man to become fully human and reach higher stages of development than fulfilment of material or lower order needs and wants. Work is an indispensable human activity than cannot be eliminated. Thus work must be made meaningful and fulfilling for individuals.

(v) leisure ethic:- 'work has no meaning in itself but only finds meaning in leisure. Jobs cannot be made meaningful or fulfilling but work is a human necessity to produce goods and services and enable one to earn the money to buy them. Human fulfilment is found in leisure activities where one has a choice regarding the use of one's time and can find pleasure in pursuing activities of personal interest. This is where a person can be creative and involved'.

(vii) Critical Review of Research Methods

In general the major defect in this research study was the pioneering nature of many of the instruments. Many devices were crude ad hoc attempts to measure processes which might or might not have been relevant. Given more time, better techniques might have been developed: certainly the experience gained during the two years of research could be used to develop more effective instruments for future studies.

Structured instruments were very useful in that they offered the chance of circulating a standard instrument across a wide sample: the internal mail system could be utilised so that administration time was kept to a minimum. On the other hand, the design of most structured instruments (particularly those borrowed from other writers) was criticised for being too simple and for failing to represent all the contingencies of the real situation.

For this reason, attempts were made to develop instruments on a much more interactive basis, using potential respondents to direct their design. Questions like, 'how would you go about measuring this' or 'do you think this is worth measuring' would often lead to discussions as to general research approaches. Over time it became apparent that the most fruitful research information came via informal interviews - relatively unstructured but involving a high level of disclosure.

Instruments which acted as 'triggers' to disclosure in new areas were the most successful: i.e. the actual data collected by the instrument was less important than the 'incidental' information picked up from explanation and other general conversation around the subject of the research instrument. Since there was little chance of validating the instruments used anyway (for reasons of small sample size etc.) this approach was adopted for most of the later studies.

Overall two approaches dominated research strategy: the personal and the impersonal. In the latter case, an introduction to a new area would be sought (hopefully with an informal recommendation by a Process Development 'sponsor' to precede it). Once in the new situation, the interview would be brief, fairly well-structured and raising few sensitive issues (unless the respondent indicated that he would like to) and would conclude with the leaving of a 'package' of structured instruments. The follow-up session would be much less structured, often using a 'game' type measure (e.g. the pegboard) whose novelty made it easier to discuss sensitive issues. If this relationship developed further, the approaches could become more and more personal and the instruments less and less structured: in the end it was possible to make extensive demands on some respondents with whom a strong research relationship had been built up.

In conducting future research, attention should be paid to the following factors.

(a) only use structured instruments where the relationship is impersonal and where the data collected is of low value: use this as feedback to develop interest. Structured instruments cannot differentiate adequately for most of the contingencies to be studied.

(b) use 'home-grown' structured instruments since these will have more direct relevance: if possible phrase statements, questions etc. in terms of quotes from members of the organisation (recorded in interview notes etc.)

(c) Where possible use instruments which will trigger comment, explanation, conversation etc. This will require high levels of novelty in design of instruments.

(d) Develop interactive design strategies so that the respondents have an input to the process of deciding how and what to measure. Repeat measures, refining them over time on the basis of interactive feedback.

Overall the major problem, acknowledged in reviewing the research methodology, was probably the attempt to use 'acceptable' (i.e. structured and validated) techniques in a situation to which these were inapplicable. By virtue of both the research subject (cf Payne 1975) and the research approach, the use of 'subjective' techniques coupled with interactive strategies aimed at testing the reality of any perceptions should have been more prominent from the outset.

CHAPTER 6 : The Research Study

This chapter introduces the subject organisation of the research study. Descriptions of history, economic position, structure, culture etc. are given, together with a more detailed review of the innovation process. The intention is to provide a basic contextual framework in which events took place; finer details will be discussed later.

The contents of this chapter are as follows:

(i) General Introduction

(ii) History

(iii) Technology

(iv) Economic Position

(v) Innovation History

(vi) Innovation Patterns

(vii) Innovation Strategy

(viii) Innovation process

(ix) Organisational Information

(x) Organisational Culture

(i) Introduction

The company studied was a medium-sized subsidiary of a Swiss multi-national chemical firm. The parent firm was fromed in 1971 by a merger of CIBA and Geigy: both had operated in the U.K. for over 50 years. During the course of the project further reorganisation took place and the organisation studied now exists as a division of the Plastics and Additives company in the U.K. The company studied was concerned with the manufacture of organic pigments; it has a high level of autonomy with its own production, research and marketing facilities.

Operations are based on two sites. The first, at Wythenshawe, Manchester is concerned with testing, marketing and technical service and also houses senior management and product management functions. The other, at which the research was largely carried out, is at Paisley in Scotland and houses research, development, production and other manufacturing-related functions.

In total, the division employs some 1,100 people, approximately 1,000 at Paisley and 100 at Wythenshawe.

The division's products are used for colouring paints, plastics, paper, printing inks and man-made fibres. In 1974 they received the Queen's Award to Industry for export achievement: some 50% of pigment produced at Paisley is for export.

Despite divisional autonomy, the Swiss parent company is still extensively involved. The product range is large and is roughly split into high-value pigments (made in Switzerland by the parent Pigments division) and high-volume pigments (made in Paisley). Marketing activities within the U.K. are handled from Wythenshawe but the parent division manages European and world-wide export marketing. Research is carried out at Paisley but is also related to the parent company's Central Research Group in Switzerland.

Exhibit 1 indicates the structure of the Plastics and Additives Company, and Exhibit 2 the relationship of Pigments Division to the overall organisation.

EXHIBIT 1 : Organisation of Plastics and Additives Company

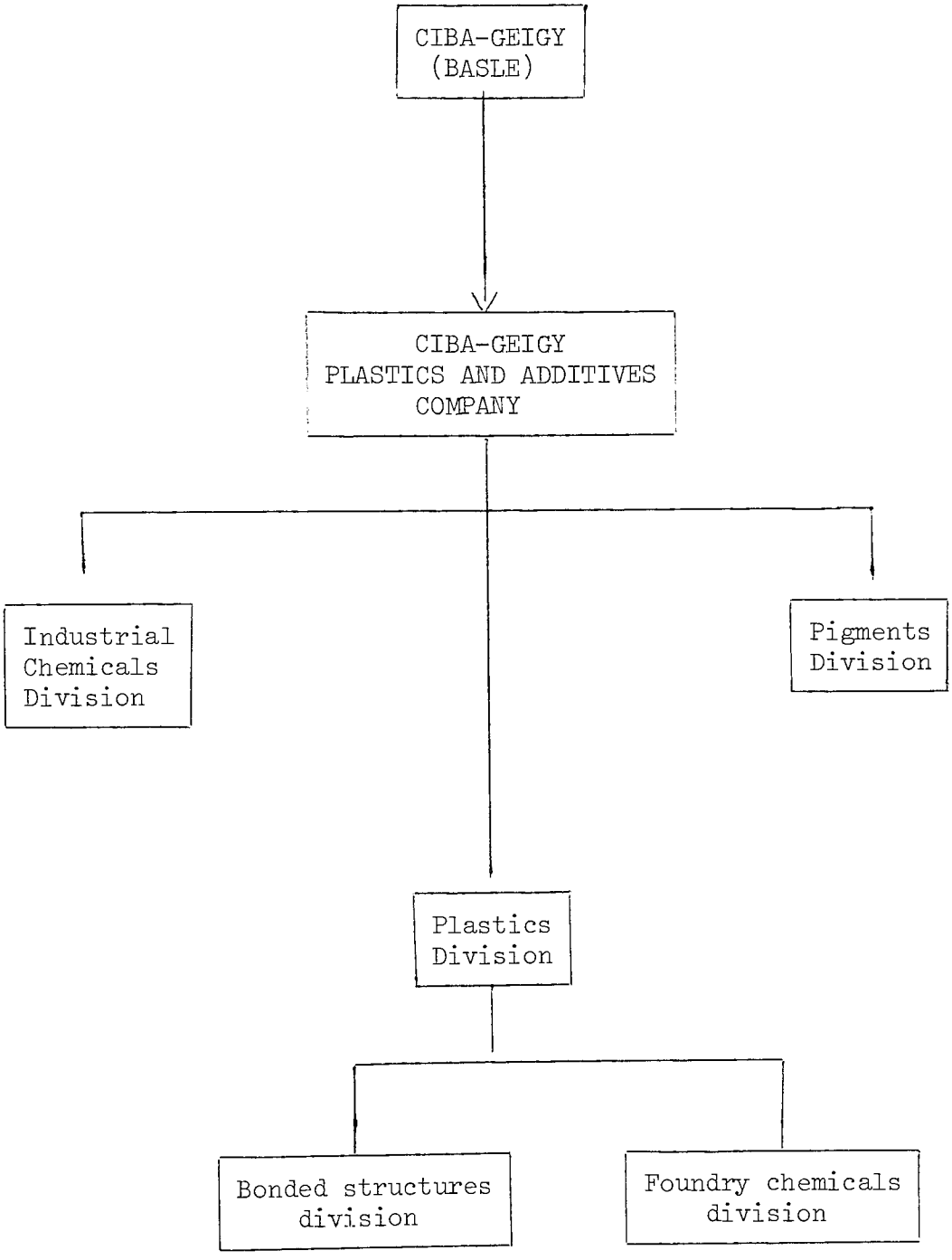
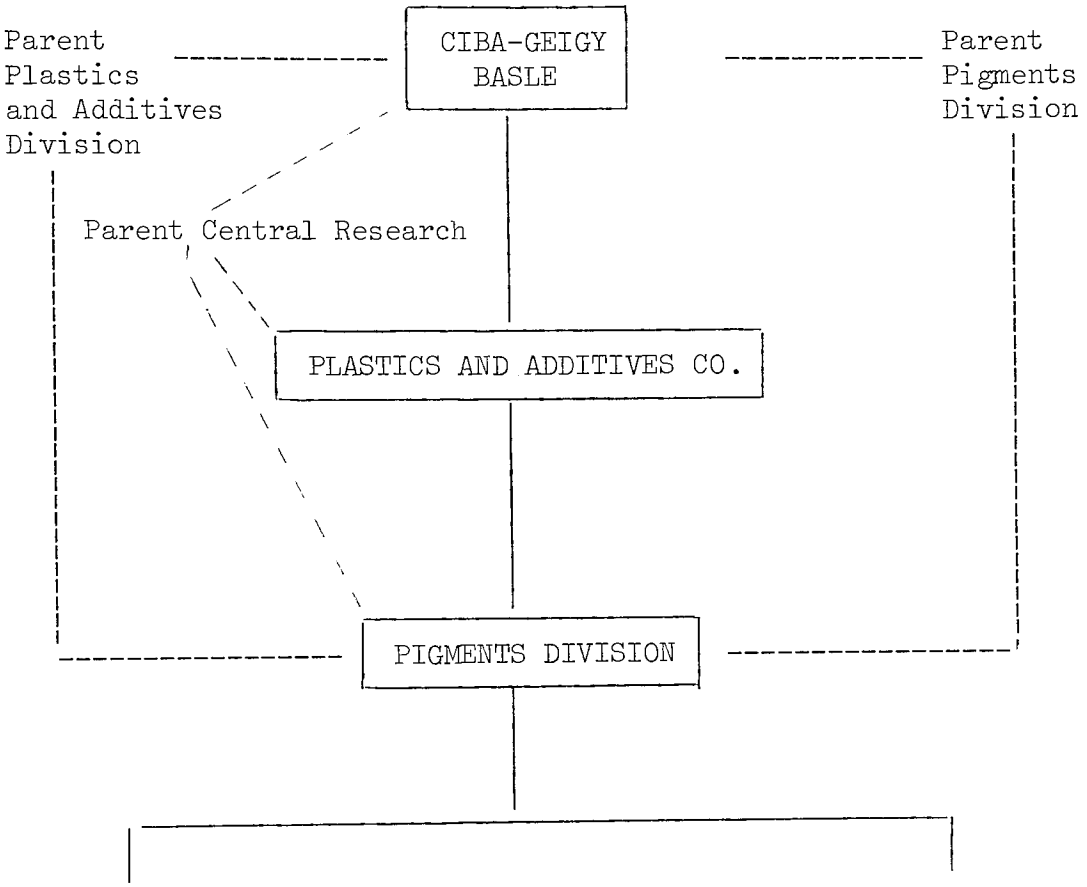


EXHIBIT 2 : Relationship of Pigments Division to Overall Company



Wythenshawe Site

- marketing (U.K.)
- applications and technical service
- senior management (managing, technical, marketing directors)
- product management

Paisley Site

- research
- process development
- production
- engineering
- support groups e.g. accounts, maintenance, computer, personnel.
- logistics

(ii) History

Colour manufacture in Scotland dates back to 1930 when the Geigy Colour Company worked in co-operation with James Morrice (James Anderson and Company) Ltd. Inorganic pigments and lakes were made in a small factory in Glasgow. Emphasis shifted to organic pigments and by 1933 output was 20-30 tons/year. In 1938 Geigy acquired a part of James Morrice and formed a new company, James Anderson and Company (Colours) Ltd.: production was around 50 tons/year mostly going to the paint and printing ink industries.

After the war, the operations were moved to the Paisley site and the first batches of colour were produced there in 1949. Azo pigments and dye complexes were the output of the original two units. (a third was added in 1964). Phthalocyanine blues were introduced in 1957, shortly followed by greens: a second unit was built in 1965 and a third in 1967.

Other production facilities included a new dry grinding unit and raw materials warehouse (1958): new laboratories (1960): tank farm and silo storage for raw materials (1966): finished products warehouse (1967) extended (1969): pigment dispersions unit (1970): new research laboratory and effluent treatment plant (1974): pilot plant (1976).

Investment is also being made in extensions to both major azo and phthalocyanine units.

(iii) Technology

Manufacturing operations at Paisley can be grouped under four categories:-

(a) azo and basic dye complex pigments:- three azo units produce almost a hundred different pigments. In addition a special plant in one unit makes high performance metal complex pigments.

Azo pigments are made by reacting diazotised amines with a variety of coupling components. This process is very dependent on control and has evolved as a skilled batch operation: some attempts at automation have been made but manufacture remains skilled labour intensive.

(b) phthalocyanine pigments:- three units produce about 30 different pigment with varying properties.

The phthalocyanine process involves synthesis of crude phthalocyanine followed by conversion to pigment, either by acid pasting or, more commonly, by grinding. Attempts at automation have been more successful in this area.

(c) dry grinding:- pigment produced by either of the above groups is filtered, then dried and ground. Blending is carried out to give uniform colour and strength; previous off-standard batches can thus be 'blended off' with good batches to minimise losses.

(d) pigment dispersions:- although most pigment made will be used in powder form, some filter presscake is further 'elaborated' into aqueous paste dispersions. A variety of milling techniques enable the manufacture of around 130 elaborations.

The development of elaborations is an attempt to meet as closely as possible the demand for a pigment which can be incorporated into the user's product - paint, ink or whatever - with a minimum of effort.

These operations comprise the production activities on the Paisley site. In addition there are a number of other relevant activities:-

- Process Development:- this group have two principal functions. The first is concerned with bringing new products from the research laboratory to a stage of economic production, having solved all chemical and mechanical problems on the way.

The second is the progression of processing from mainly batch operation to full instrumented systems - where this is practicable.

- Quality Control:- this group has the responsibility for testing pigment samples prepared in the production control laboratories: for assessing the pigment batches produced in the plant, and for controlling the subsequent blending and grinding operations.

- Engineering:- there are two major engineering groups, Works engineering and Capital and Chemical engineering. The former has the twofold responsibility of maintaining the plant, buildings and site to provide a satisfactory working environment and to prevent any breakdown of the manufacturing programme - and of ensuring the smooth running of all essential services.

  Capital and Chemical Engineering are concerned with major projects: their activities extend from appraisal of alternatives, preparation of flowsheets, specification and procurement of equipment through to design, location, building and commissioning of new facilities.

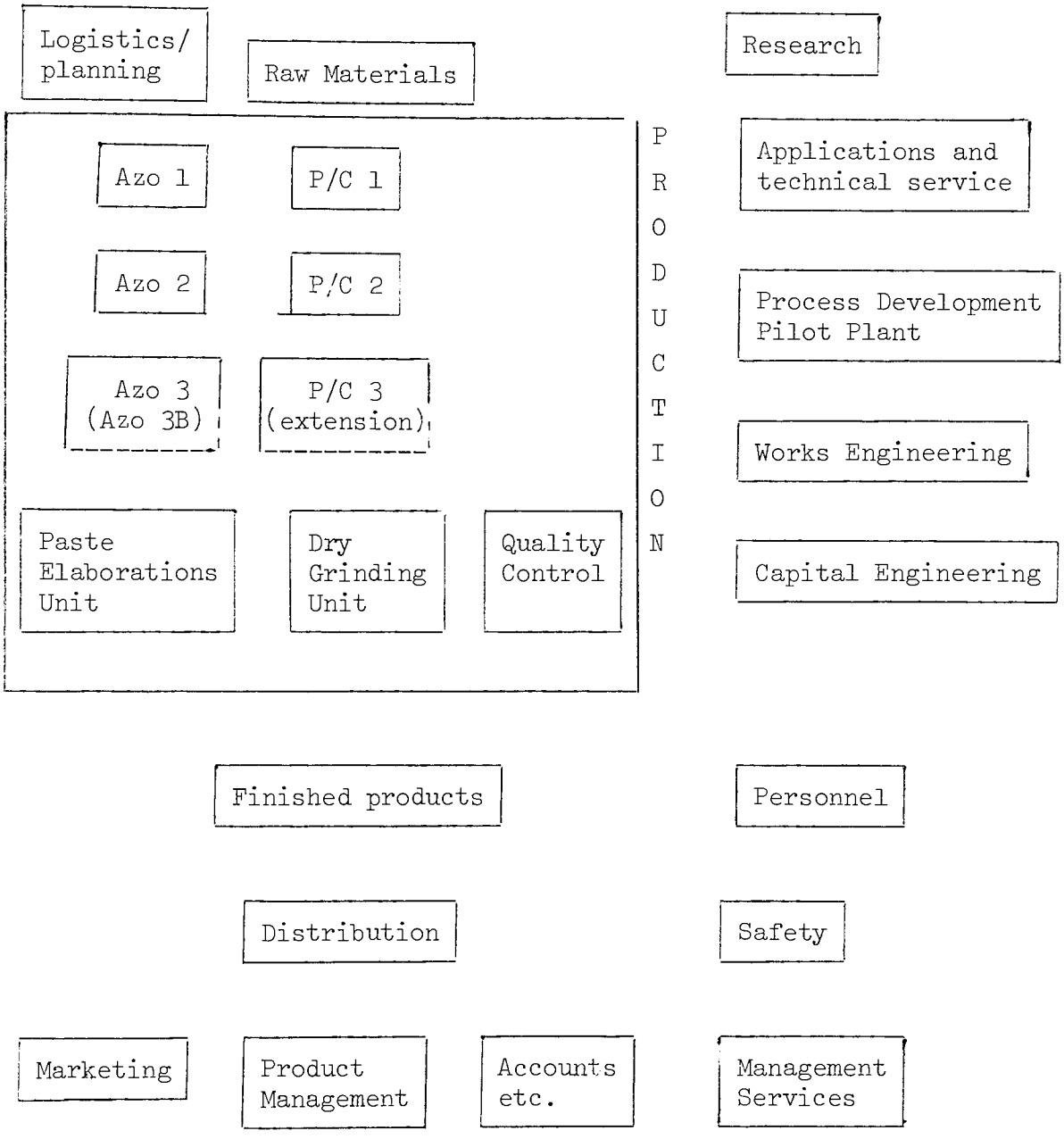
- Logistics and Distribution:- these groups are concerned with production planning and scheduling according to customer needs, and with packaging and making available the finished product.

- Research:- this large group is concerned with integrated development of new products to meet the future needs of the company. Some work on fundamental mechanism, physical chemistry and radical new chemical approaches supports the major programme with a growing background knowledge.

  Extensive laboratory facilities are available at Paisley: in addition the work is integrated with the Central Research Group in Basle.

- Applicational Research and Technical Service:- this is a separate department but falls under the general arm of Research. Three laboratories in Wythenshawe deal with problems of the individual customer, with applicational research projects, and with the screening of research products originating from Paisley.

Schematic Diagram indicating operations within Pigments Division



(iv) Economic Position

Recent variations in the economic position of the company reflect both external changes and internal problems. In the period prior to 1974 growth had been extensive and sustained: evidence for this can be seen in the investment programme at that time. June 1974 saw the opening of a new £1.4m laboratory complex and a £550,000 effluent treatment plant: these were seen as the first stages in a proposed £13m investment plan.

However, subsequent capital investment (new pilot plant (£800,000), second effluent plant (£70,000) and safety centre (£180,000) totals just over £1m. Plans are now well advanced for a new phthalocyanine plant (circa £2m) and an extension of the newest azo plant (≏ £3m) but even taking these into account, it is apparent that growth of the company has been significantly retarded.

In general, this is a consequence of variation in market demand. Prior to 1972 the demand for organic pigments showed a steady progression: in 1973 there was a surge which coincided with a number of shortages in the chemical industry, notably of those intermediates used in pigment/ dyestuff manufacture. Despite the shortage of pigments, supply did not fall far behind the high demand.

1974/5 was a very bad period for the pigment industry and 1976 only improved to volume demand levels below those of 1974. 1977 demand was similar to that level experienced in 1972.

Effectively, on averaging out the fluctuations in demand, the picture is one of a zero-growth rate over the preceding five-year period.

A realistic appreciation of this market situation plus difficulties in obtaining necessary price rises due to statutory constraints led to a 'mothballing' of major investment proposals. More recently, the position has improved and some price increases have been permitted (improving potential returns on investment): thus the restarting of production unit construction.

However the rate at which expansion proceeds will be more cautious and projects will not necessarily result in additional volume capacity. As with most chemical plant, operation must be kept at levels near to design capacity: under-utilisation is very expensive.

Where growth appears likely to take place is in the export sector: most opinion suggests that there will be little development of the U.K. market.

Costs in the Pigments Division absorb much of the potential profit: capital and depreciation charges, raw materials (estimated to have increased by 30% over 1977), energy (estimated double over 1977) etc. are all major contributors. However, areas like Research and Development are most susceptible to criticism and cutback under adverse conditions; the overall role of technological innovation and the forms which it should take have been a central issue for debate.

(v) Innovation History - The Role of Research and Development in Pigments Division

In the 1930's, the company began to make use of Research and Development as a specialist function. A policy of recruiting colour chemists from Leeds University engaged to put Research and Development on a graduate basis was begun. Initially emphasis was on the analysis of competition products but after the war the BIOS reports on German industry became available. A technical agreement with DCC of Canada brought American pigments into consideration.

During the 1940's and early 1950's the emphasis remained largely on the analysis and matching of competition samples, and on technical service to customers in the form of slightly modified pigments, special mixtures and rapid delivery.

In the 1950's I.C.I. were the market leaders in the U.K. and the efforts of James Anderson and later, Geigy were largely aimed at taking business from an unwieldy giant on the basis of better service and a quicker response to customer needs. This approach persisted through to the McKinsey reorganisation in 1965/6 - many successful products being invented or developed from ideas originating in Geigy research in Switzerland.

1957 also saw the introduction from Switzerland of the first phthalocyanine pigments, probably the first β-form blue pigment on the market in Europe, if not the world. All blue production and the responsibility for its continued development was later transferred to Paisley.

Up to the time of reorganisation, there had been three more or less distinct groups involved in Research and Development interests. A Central Research group for the whole company and a Research Department and a Technical Department within James Anderson who shared responsibility for product development. The 'technical' department was responsible for chemical process improvement and was 'technically' in charge of production.

When the first Research building was constructed, this clearly identified a separate Research group (although it was largely concerned with development) and Central Research remained another district entity). The exception to this was phthalocyanine development which remained in a laboratory above one of the production units. However, any confusion of objectives was hidden by the fact that there was very large growth during this period and plenty of work to occupy all concerned.

In 1966, McKinsey drew up the first Management Plan which set formal Research and Development objectives with target dates and potential contributions: however this did not involve any structural change in the Research and Development organisation.

In 1969 it was recognised that a process development group with a chemical engineering basis, was required in order to study pigment-making processes and to be responsible for their improvement and the introduction of new products to the plant. A small group was formed, and in 1971, the Pilot Plant and two small groups to handle azo chemical process development and elaborations development were transferred from Research. When the new Research laboratories were occupied in 1974, the phthalocyanine chemical process development group was formed in the same way.

Process Development remained under the control of the 'technical' group, whilst Central Research was absorbed into the Research group. Planning was carried out independently by these two units but in 1976 and 1977 planning was carried out as a unified process.

The expansion of Process Development and Research was planned on the assumption that business would continue to grow at a rate which would saturate the Paisley site by 1985. Subsequent changes in the affairs of the company have called for a thorough re-assessment of the role and size of its Research and Development activity.

(vi) Innovation Patterns

New types of pigment, in the chemical sense, emerge infrequently (5-10 years) in the industry. Thus the major innovation commitment in strategic terms is to range maintenance, i.e. the continuing development of products that are better than existing products. Normally these are not substantially different in chemical terms and are developed for specific market requirements: the skill thus lies in the accurate determination and speedy satisfaction of these needs.

The range itself is a determining step - too large and extensive a range would raise stockholding problems whilst too small and specialised a range for few customers would fail to justify Research and Development expenditure. Consequently the trend is towards rationalising and specialising ranges and towards 'tailoring' products (and product forms - e.g. dispersions, powders etc.) to customer needs.

Whilst need-pull innovation dominates the company there is also knowledge-push activity. In the process development area, principal aims are to reduce costs and improve efficiency: these are carried out by applying new knowledge about processing technology to existing plant. In the research sector, efforts are made to balance the essentially short/medium term approaches involved in market-pull operations with long term knowledge-push approaches based on improving fundamental understanding. Work is also carried out in speculative attempts to synthesise new chemical structures with pigmentary properties.

Inevitably the balance between long/short term approaches, between product/process innovation and between incremental/ radical innovation will be a matter for informed strategic choice. There will be arguments for both sides and the validity of these will change with the general dynamics of the company: the importance of this split as an issue will be seen later.

(vii) Innovation Strategy

As has already been indicated, up to 1966 the bulk of growth could be attributed to very effective copying of major competitors and the studied introduction of incremental improvements. These approaches, combined with an excellent customer service of all types contributed to establishing a strong position in the U.K. market and a firm foothold overseas, especially in Germany.

However, there was a growing feeling that it was becoming increasingly difficult to make further incremental improvements, and that in order to expand their market position the company had to make significant additions. A formal Research and Development strategy aimed at this was formulated during the period of the McKinsey reorganisation.

As far as the Research strategy was concerned (as distinct from the Process Development one) the principal aims were twofold.

- to enlarge the information base available to the company: development of knowledge about products, markets etc. which could be used as the basis for future innovation and growth. A particular element of this was felt to be the need for improved understanding of the physical chemistry of organic pigments. A Physical Chemistry group was set up, including links with university departments where advanced appropriate techniques were being developed.

- the generation of new ideas: this was done in three ways:-

  (a) by maintaining a highly competent synthetic chemistry group.

  (b) by bringing new and highly trained minds to bear on existing products and traditional problems.

  (c) by generating new physical forms.

  Inevitably, this represented a major shift in direction and was heavily criticised in the manner of all long-term research - for being non-productive, resource intensive etc. Argument for both sides continues, with the proponents of long-term work pointing out that what is now 'common knowledge' has been contributed by largely by fundamental 'background' research.

  The basic aim of this, and any Research and Development strategy is to balance short-term incremental improvement work against mid-term development of previous ideas and new long-term projects. Market dynamics have led to conditions of escalating uncertainty and an overriding emphasis on short-term 'defensive' activities.

This has particular implications in that the overall business strategy, in order to be flexible, will alter in the direction of shortening time-scale to better match the market variety. In view of the long time it takes to develop background information, generate new products and bring them to a production level, it is clear that it will become increasingly difficult to be successful when the time scale of changes in the overall business strategy is less than that for the development of a new idea. There is bound to be an increasing amount of mis-fit.

(viii) Innovation process

(a) Strategic Planning Process

Overall strategy is developed at the management committee of the division, at meetings of the Plastics and Additives Company as a whole and in consultation with the parent organisation in Switzerland.

In practical terms, the managing director, in consultation with various staff members and especially Product Management develops long-term plans which are then presented to the management committee for discussion and ratification. During the period of the research project, formal strategies for azo and phthalocyanine product ranges were developed and introduced for the first time: prior to this, strategy was more short-term, orientated towards market conditions.

The hope expressed was that the use of formal strategies would better enable the company to decide where it wanted to be in the 1980's instead of being 'led' to a position by the market. Components of these strategies included extensive rationalisation of product ranges, and this caused some problems in the short-term, since it gave the appearance of arbitrary axing 'perfectly profitable' products. In addition, policy decisions taken before the development of these strategies had, in some cases, to be reversed: again this was disturbing to people working at operational levels.

Policy interpretation for product innovation is carried out at Meeting 3: this is a monthly meeting held with the Technical, Marketing and Manufacturing directors and Product Management. Essentially it reviews the status and progress of new products and provides policy guidelines for departmental managers to implement.

In turn, departmental managers co-ordinate their activities to provide ways and means of implementation via the Technical Co-ordination Group, which again meets on a monthly basis.

(b) Present Innovation Process within Pigments Division

In general, the innovation process continues to generate new products aimed at specific needs in the market place. Most of these represent modifications: there is little that is truly radical in the product innovation field. (There is a strong argument which suggests that the industries, technology and market have matured to such an extent that only incremental change is possible).

Consequent on this and in keeping with increasing pressure on unit cost reduction and other economies, there has been growing emphasis on process innovation. Whereas this used to be an operation concerned solely with the solving of problems associated with new products, process innovation now contributes significantly to the technological development of the division.

There is a formally-defined model for the process of product innovation within the division: whilst it is not always strictly followed, it provides a useful background to our study of innovation.

Based on the parent company system, the Produkte-Werdegang is a five-phase sequence for the introduction of new products.

Phase One: a new product is identified, usually in terms of market needs but often arising out of an interaction between the Research group with a range of potential products/properties and an awareness of needs. The Applications group, working in conjunction with Product Management identify a formal specification for this product.

Applications then have the task of developing test methods for evaluating the performance of this product relative to criteria laid down in the specification. Research have to synthesise the product itself.

Phase Two: involves the laboratory development of this product and the identification of a formal process route (or routes) for its manufacture.

Phase Three: is concerned with the systematic development of the product at laboratory scale. Much of phases one and two work is done over a relatively short time since invention is the major activity. By phase three, the Applications criteria become of central importance and much work has to be carried out in modifying product and process to meet the specification. This may commit considerable resources and take a long time (e.g. weathering tests take 12 months in some cases) in the dialogue between development and testing.

Eventually the product will be given a 'phase three standard' which means it is a developed laboratory product and process meeting all the relevant specified criteria.

Phases one, two and three are usually carried out in Research: transfer between phases can only take place on receipt of official Applications certification. This process involves Applications in identifying a 'standard' for the product (either based on a previous product or on an actual tested sample of the new one) which provides a yardstick against which the properties of the new product can be assessed. Standards are used to assess not only innovations but also production samples in quality control.

Phase Four: on receipt of relevant transfer documents, Process Development normally take over product innovations at the phase three level. It then becomes their responsibility to develop them through the various scale-up problems (including safety, ecology, toxicology etc.) to production level. Once again this activity takes place in conjunction with the Applications group: a phase four standard is normally associated with pilot plant trials or early production trials.

Phase Five: is the final stage and involves the actual transfer of the new product and process into production. When it has been adequately demonstrated that production can make the new product consistently to the standard required, formal handover takes place and the product is ready for manufacture. Diagrammatically, this is:

Market input Strategy input Research input	Identification of specification and standard.	Phase One Research and Applications
	Laboratory-scale production of testing.	Phase Two Research and Applications
	Development of product and process. Ironing out of problems etc.	Phase Three Research and Applications
	Scale-up development of process to pilot-plant/ production.	Phase Four Process Development Applications Production
	Trial production	Phase Five Process Development Production Applications
	Full-scale production	

In addition to this essentially incremental product innovation system related strongly to market 'need pull', there are provisions for process innovation. The balance has begun to move quite strongly in favour of innovation aimed at reducing unit costs of production, which has meant a large number of process innovation projects associated with introducing new and more effective technology. In addition there are those innovative projects connected with safety, ecology etc. which form a growing element in technological change throughout the chemical industry.

(ix) General Organisational Information

Many of the factors concerned with size, degree of specialisation, levels and spans of control etc. which characterise the organisation can be usefully described by the Aston index. This schedule of information was developed by the Industrial Administration Research Unit at Aston (Pugh et al 1963) and is reproduced (with data for this organisation) in the appendix.

The value of this information presented in this form is that it offers the opportunity for direct comparison of organisations with similar characteristics.

(x) Organisational Climate/Culture

One other contextual factor remains to be discussed: the social setting of the organisation, Jaques (1951) lists these factors as important in this area: the general morale situation, the reward system, the structure and nature of working groups, the quality of supervision, the larger social forces emanating from the general economic situation, the competitive position of the company and the characteristics of the local community. In addition, the organisational ethos - the complex social order of beliefs, sentiments, values, norms etc. - will also be relevant.

At the start of the project, little of this data was directly available. As time went on it became apparent that the culture and climate of the organisation were very significant elements in determining what went on: attempts to measure aspects of this were accordingly made. However the general quality of this environment was determined at the outset largely by observation. The following factors were noted:

(a) geographical location: the Paisley site drew a large proportion of its workforce from the West of Scotland. Whilst the more skilled specialist jobs inevitably attracted a cosmopolitan selection of personnel, it is suggested that the dominant culture remained that of the locality.

In terms of very broad generalisations, this culture was strongly working-class 'puritanical' in its values. Emphasis was placed on hygiene factors (e.g. timekeeping), on respect for experience, age, 'serving one's apprenticeship', on the traditional ('we've always done it this way) methods. Even at management levels, the dominant leisure activities appeared to be sport (mostly football, golf and fishing) television and drinking. The most popular newspaper was the 'Daily Record' (Scottish edition of the 'Daily Mirror'). The most commonly reported idea of a 'good time' was the 'night out' with a group of friends (often excluding women) in a local pub. Tall stories of drinking exploits, especially over the New Year period, had a high incidence in conversation. The activities of the social club (formed during the research period) reflect this. With the exception of a winemaking group, and a gardening group, the other activities were all sporting - football, golf, fishing etc.

(b) historical tradition:- the manufacture of pigments has always been a delicate and skilled operation requiring judgement and experience. Consequently the ability to make pigments was a major indicator of an individual's value in the organisation - 'outsiders' were regarded with suspicion until they could prove that they had 'served their apprenticeship'.

In addition the company had been a small unit for a considerable time and the old nucleus of Geigy employees tended to stick together in a clique. Indeed, a very strong belief on site was in the existence of a 'production elite' who were promoted through the same kind of 'informal academy' and bred into the same philosophy, values etc. It was felt to be almost impossible for Research and Development personnel to break into production jobs - and those who did often failed to integrate well and subsequently left.

The atmosphere on the Paisley site was strongly dominated by the production philosophy: by contrast the Wythenshawe site was more business orientated: if anything, a marketing spirit (or at least a strong awareness of the market-place) could be said to predominate.

(c) attitudes to work:- accepting Fox's (1974) view of these attitudes as being socially and culturally moulded, these were essentially related to intrinsic motivations similar to Mill's (1956) 'craft ethic'. Only amongst the shop floor workers was there any suggestion of a purely instrumental culture, i.e. one in which work ' is seen largely as a means to a steadily-rising material standard of life and the pursuit of leisure activities'.

Amongst the technical specialists, attitudes appeared 'professional' - 'for all of them the conditions for performing the task effectively are also conditions which provide scope for meeting challenges, carrying responsibility, exercising independence, enlarging knowledge, and enjoying opportunities for achievement and recognition'. (Miller and Rice 1967).

Set against this was the overall economic climate which was restrictive in terms of salary increases and falling living standards. There was a high preoccupation with salary levels and dissatisfaction was reflected in the support for trade union activity, even amongst professional staff.

CHAPTER 7 : The Research Study

This chapter presents the bulk of the observations and results of two years detailed study of the organisation. It is split into the following sections:

1. Process Development studies.

2. Case histories for specific innovations.

3. Case history of a major radical innovation.

4. Studies of senior management.

5. Production studies.

6. Research studies.

7. Applications studies.

8. Organisation-wide studies.

9. Summary.

The Research Study

On-site research began in January 1976. The terms of the arrangement were set out in a letter of intent, part of which is reproduced in Exhibit 1.

The researcher was initially attached to the Process Development department, responsible to the departmental manager as external supervisor. Studies of this department were made during the whole two year period and the researcher remained based there throughout that time. However, the research focus shifted several times: Exhibit 2 indicates the range covered.

Contact with academic supervision was maintained via telephone, visits to the University and by keeping a diary of activities in duplicate, one copy of which was sent to the internal (University) supervisor. In addition a regular meeting of supervisors was held on a monthly basis at Paisley. The purpose of this meeting was to review progress and plan future work: where necessary, other involved people were invited to attend.

The study will be reported here in approximate chronological order.

EXHIBIT 1 : Paisley Research Project

Further to the discussions at Paisley on Friday, February 21st and Friday, May 15th this year and associated correspondence, we are prepared to proceed with a research investigation which involves work on our Paisley site by a researcher under your direction. It is envisaged that work will begin on October 1st, 1975, or some other agreed date and last for an initial period of two years.

1. Objective

The general objective of the research is to monitor activities connected with the development and introduction of specified new technology, to carry out relevant observations and surveys, to study and propose alternative courses of action, to assist the members of management so involved, and, ultimately to report on the utility or otherwise of available knowledge, techniques and models. The investigation will particularly emphasise the personnel and human problems arising as a result of new technology. It is hoped that significant phenomena, new theoretical and practical methods and approaches will be identified.

2. Position of the Researcher, Costs

The Researcher will remain an employee of the University.

He will be attached to a working group which has a relationship to the development and introduction of new technology so that he may be able to operate at least as a 'participant observer'. For this purpose he will be treated in his relations with the management and the employees of our Company as if he were a member of our staff. He will as a condition of working on site be expected to conform to Company rules and procedures and to respect all confiential matters. We should require that initially he is acceptable within the works and that he maintains acceptability.

The University as the Researcher's employer will be responsible for his salary and for his expenses in the execution of the research work such as for instance travelling off the site (it is accepted that the University will be funded by the Science Research Council).

3. Working Methods

It is expected that you or your nominee will visit the site for discussion with the Researcher and with members of Company management at approximately monthly intervals. Further, it is understood that, as deemed necessary and approved by you, the Researcher will visit the University or other working locations in connection with the Paisley project. Our management liaison with you will be through Mr. H.V. Miller.

4. Results of the Study

Our Company will receive full information about the results and conclusions of the investigation and be free to take advantage of such results and conclusions in view of any possible application in our Company or in any affiliated Company.

The University will be free to use the results and the conclusions of the study for any scientific purpose, publication or otherwise subject to the conditions of Paragraph 5 below.

5. Confidentiality

In order to guarantee confidentiality with respect to sensitive commercial technical or other matters and to avoid any misunderstanding in the interpretation of the facts investigated by the Researcher we should require that:-

- No confidential information be disclosed either by the University or by the Researcher. We understand by 'confidential information' any information which is not available to the public and disclosure of which with or without explicit reference to our Company would in the opinion of the Company be likely to cause any financial, commercial or other prejudice to our Company.

- No reference be made to our Company without our previous approval.

- Any information written or oral relating to our Company's activities proposed to be disclosed by the University or the Researcher be submitted to our Company for prior approval.

It is understood that our Company will not unreasonably withhold its approval and that our Company is aware of the University's general objectives of academic publication of any kind or of reports to the Scientific Research Council, the University being responsible to use its best endeavours to protect the Company and apply such security procedures as the University and professional academic practice permits.

6. The Research project may be terminated at any time by mutual agreement or by either party if the other party should not conform with the conditions set out in this letter. Such termination shall not affect the obligation of confidentiality.

The project may also be extended beyond the initial period of two years by mutual agreement.

EXHIBIT 2 : Range of Research Activities (approximate chronological order)

1.	Studies of Process Development:	Throughout two year research period, using all available methodology.
2.	Project Team Studies:	During 1976 for some six months. Involvement with early project teams working on the introduction of continuous technology. Observation, Participant as secretary or observer.
3.	Studies of Senior Management:	From October 1976 to end of project. Observation of Meeting 3, T.C.G. and other groups. Discussions and other measures with individuals.
4.	Teach-In:	Held in February 1977 to members of the T.C.G. Aimed at giving an indication of plans and progress prior to extending the research into new functional areas.
5.	Studies of Production:	From January 1977 to end of project. Most work during 2nd quarter, reported in 6th quarterly report. Interviews, observation and other methods used. Non-participant.
6.	Studies of Research:	From July 1977 to end of project. Subject of 8th quarterly report. Interviews and other methods - little direct observation. Non-participant.

7.	Studies of Applications:	During November 1977. Subject of 8th quarterly report. Non-participant, data mostly from interviews and instruments. Little observation opportunity.
8.	Studies of Product Management Marketing, Etc.:	During latter part of research period. Isolated interviews and measures no observation or participation opportunity.
9.	Short Course Studies:	April 1977 - intensive one-week course in group processes. Involved several company managers. Observation and other methods used.
10.	Organisation-wide Studies:	Throughout second year of project. Specific instruments (e.g. creativity audit) integrated with existing research findings. Subject of 7th quarterly report.

(i) Process Development Studies

General Introduction

This was one of the youngest groups on the site having been formed largely to accommodate the growing need for chemical engineering and allied skills in the development of product and process technology. It involved the original azo and phthalocyanine product development groups (which had a history of close working relationships with production units, having shared the same buildings etc.) and also included a process engineering group, an elaborations development group and the pilot plant facilities.

Exhibit 3 indicates typical examples of the range of innovative activities associated with this group.

On arrival on site in January 1976, the researcher was attached to the Process Development group. There was little planned activity during this early phase of the work: it was very much a case of establishing and gaining acceptance for the research.

EXHIBIT 3 : Range of Innovative Activities Associated with Process Development

(a) process innovation

increasing in radicalness ↓

- better use of existing equipment.
- new equipment reducing manufacturing costs e.g. continuous band filter, new mill types.
- process modification which reduces manufacturing costs e.g. salt-free milling, improved crude-blue synthesis.
- new process which reduces manufacturing cost or improves the consistency of production quality e.g. emulsion treatment, continuous azo manufacture.

(b) product innovation

increasing in radicalness ↓

- adapting 'known' principles to meet market needs e.g. elaborations.
- new equipment which produces special product properties e.g. Calmic dryer.
- modified composition to improve product.
- new process which produces special properties.
- new chemical structure e.g. metal complex (usually Research initiate, Process Development develop).

(c) Capital projects/additional production capacity

- testing instruments and equipment on pilot scale.
- checking materials of construction on pilot scale.
- devising ways of handling and conveying 'difficult' materials.
- commissioning new plant - e.g. belt feeder.
- contribution to large-scale project teams.

(d) Safety and Ecology

- screening new products, processes and equipment.
- recovery of solvents, heavy metals etc.
- avoidance of objectionable effluents.
- development of alternative raw materials.

The initial problem in participant observation is establishing confidence and trust: until the research relationship is developed to this level there will be little productive interchange with the subjects. Early attempts to establish this are described in Exhibit 4.

Observation was limited to trying to build up an accurate picture or 'map' of the organisation as seen through participant's eyes. Key issues and problem areas were also identified: the general strategy was to ask each interviewee to describe the organisation for the benefit of a newcomer. This appeared to be successful, insofar as the proposed long-term participant status of the researcher meant that the group operated its standard socialisation patterns in indicating beliefs, values norms etc. expected of the new member.

The researcher was formally attached to the azo chemistry section after two weeks: some time was spent in the laboratory making simple pigment preparations. This had a dual value, in that it provided an insight into the 'alchemy' of pigment chemistry whilst also involving activities which brought frequent contact (contributing to development of relationships).

EXHIBIT 4 : Early Attempts to Develop Research Relationship

- by virtue of a chemical engineering background, it was possible to stress the essential similarity between researcher and subjects. This extended for example to the language used - it was, apparently, reassuring to subjects to be able to discuss technical matters with someone who understood - this reinforced the 'one of us' aspect of the researcher status.

- early role definitions of the researcher by the subjects were encouraged ('student' in some form being the most common) whilst self-definition was deliberately ambiguous. It was particularly important, however, to stress the innocuous nature of the research since a previous observer of the organisation had been a manpower planning consultant whose recommendations were thought to have engendered a number of redundancies and a generally insecure employment climate. The label of 'company spy' had to be refuted early in the research.

- informal situations were exploited as extensively as possible. Where possible the researcher used opportunities to talk with as wide a range of people as possible over lunch or coffee or casually in the corridor etc. Where a contribution could be made - for example, offering lifts home, the gesture of offering rather than waiting to be asked was important.

It also reassured people throughout the department of the role and status of the researcher: this was generally held to be along the lines of 'a technologically-orientated (but not necessarily experienced) student' - and thus perceived as offering no real threat.

At the same time, the researcher was a member of one of the strong informal groups, sharing coffee and lunch-breaks. The members of this group were associated with the old elaborations group: whilst the group had formally changed, the social unit remained.

With membership of these two groups, a large part of the department was available to the researcher: as relationships developed, it become easier to identify the key problem issues in the department.

Exhibit 5 lists some early indicators of informal acceptance of the researcher. During this early period, extensive observations were made of various groupings in the informal structure: crude sociograms were attempted which revealed opinion leaders and isolates. Exhibit 6 lists some of the range of informal groups, and indicates the basic sociometric distribution.

EXHIBIT 5 : Some informal acceptance measures

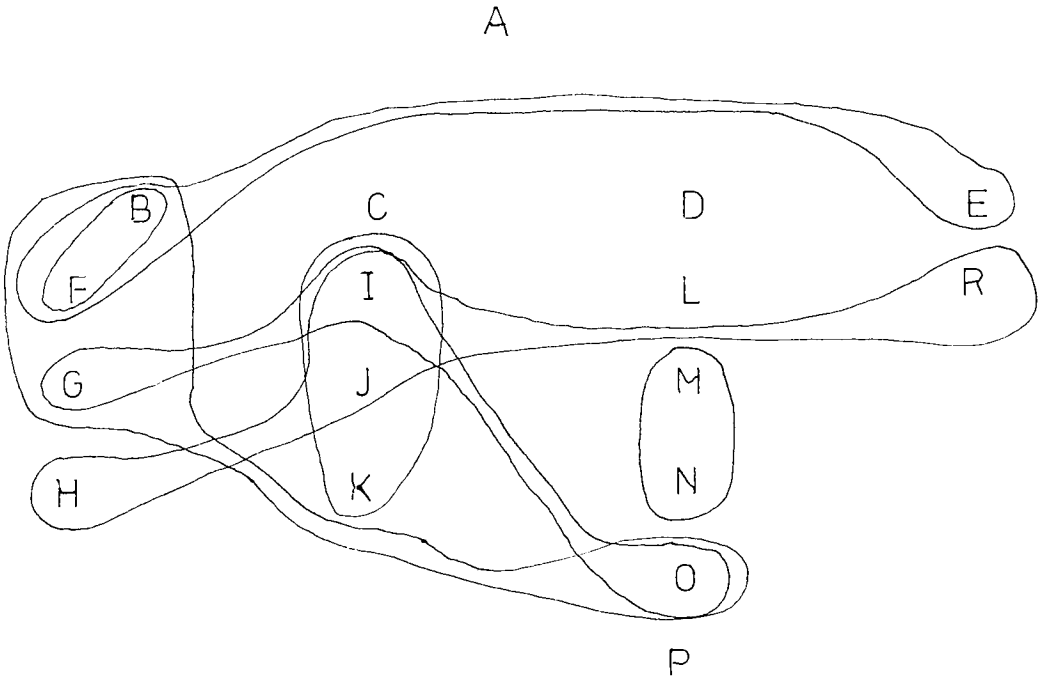
- invitations to participate in off site activities e.g. lunchtime drink to celebrate birthdays, engagements etc.
- offers of help - e.g. with finding accommodation, repairing the car etc.
- invitations to join a regular group for coffee or lunch.
- invitations to join 'syndicates' - e.g. football pools.
- being plugged into the grapevine and told of rumours etc.
- invitations to join sporting activities.
- expressions of interest and concern about the researcher's welfare.

EXHIBIT 6 : Typical Informal Groupings

- lunch groups.
- coffee groups.
- 'bridge players' group.
- staff association/union group.
- ex elaborations group.
- car pool groups.
- sports and other outside activities in common.
- football pools syndicates.

Basic Sociometric Distribution

Letters denote individuals, arranged in formal organisational position



The progress of the research up to this stage was reviewed at a joint meeting, held in February, involving university and industrial supervisors and departmental section leaders. Many emerging problem issues were discussed and analysed from a variety of perspectives.

In many ways this meeting represented a major turning point for the research since it brought out intervention possibilities implicit in the project. A number of objectives were developed from discussion of the problem issues; principally these were:

- to improve self-awareness (of individuals and of the group as a whole)

- to improve awareness (of others and of relationships with others)

- to improve individual/group contribution (towards achieving common goals)

- to increase self-confidence (of individuals and of the department as a whole)

In practice this would involve improving integration at all levels and bringing about a management style better adapted to the contingencies in which the department operated.

Having established an introductory role, the researcher worked on a specific project, again in the azo chemistry area. This involved the development of control techniques for proposed continuous manufacturing technology. (A case study of some aspects of this project is reproduced elsewhere). In early stages of the study, this was useful as a means of being seen to work productively for the group.

By the time of the third monthly meeting, there was a high degree of interest if not involvement. Initial suspicion had been overcome in most cases and, at least at section leader level, there was concern as to the direction the project should take. Various inputs were made at the meeting in question.

Publication of the first quarterly report (circulated to most members of the department as well as key members of the divisional management committee) generated more definitive feedback as to the direction of the study. The emergent view was that the goals expressed in the report (discussed earlier) were important; any action, by the researcher as catalyst or by management as direct intervention, would be of value.

The mood was essentially one of 'cautious optimism' - the researcher was, by this time, largely accepted but the purposes of the project were still vague in most people's minds. (This period of 2-3 months for acceptance compares well with published accounts of participant observation, e.g. Pettigrew 1974, Olesen and Whittaker 1972).

In addition to observation and interviewing, it became possible to use more structured instruments. Since individuals had formed the basis of much of the early study, and extensive notes on various aspects of behaviour - sociometry, communication, skills, problem-solving ability etc. had been made, an instrument to identify individual style was used.

Defining style as a pattern of behaviour, this instrument attempted to group individuals according to the style they adopted in terms of their Research and Development work. (It was based on Gough and Woodworth, 1964) discussed in the methodology section). Exhibit 7 summarises the results.

EXHIBIT 7 : Researcher Style Q-Sort

The results of this survey were plotted out firstly on an individual basis to try and determine stylistic types against the Gough and Woodworth archetypes described in the methodology section. Unfortunately there were no clear correlations emerging from this plot.

A second analysis of the data in statistical form is of more value since it reveals departmental mean scores on the relevance of a number of statements about research style. Once again, limitations arise from the small sample size.

However, a number of interesting points emerge. In the first place there are very few statements which were felt to be irrelevant or unimportant. These included factors associated with high specialisation (5) and perfectionism (39). By contrast, a large number of statements were felt to be of particular importance. Notable amongst these were pragmatism (13), diagnostic skills (24), consultation (26, 31), catalytic activity (47), curiosity (50) and flexibility (51). This emphasis on flexibility and some measure of generalist skills is significant since it may help to define the 'technical specialist professional' - a character who emerges strongly in later studies.

Q-sort Profiles

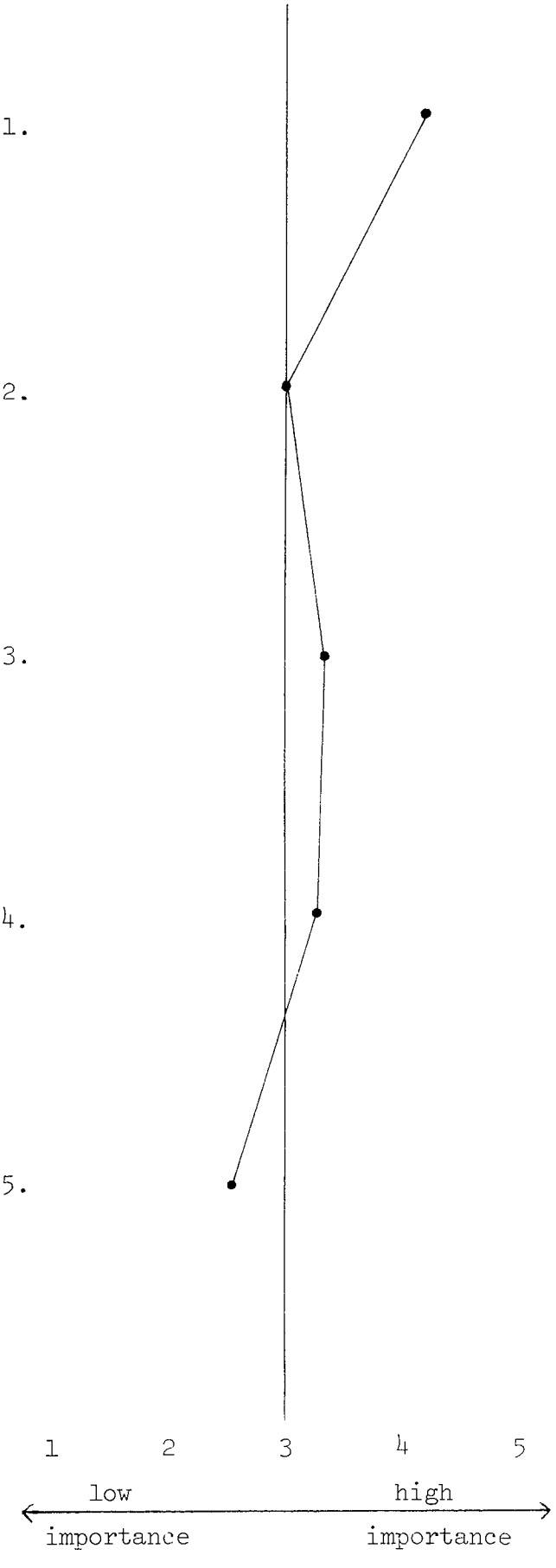
Reacts quickly to research problems: immediately generates a great number of ideas. 1.

Is somewhat deficient in his command of basic sources and technical literature in the field. 2.

Pursues details and ramifications of research problems with great thoroughness. 3.

His research interests lie within a narrow range. 4.

Has exceptional facility in mathematical analysis. 5.



Easily discouraged; needs help and encouragement to do his best work. 6.

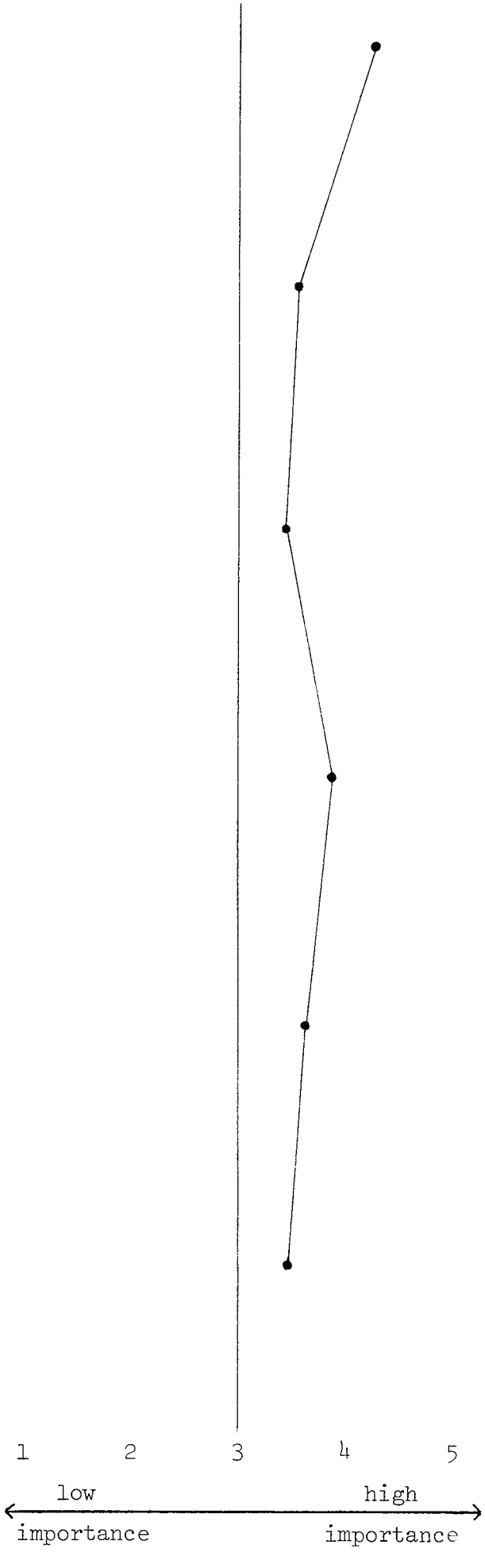
Is keenly interested in methodological aspects of research. 7.

Prefers to work on problems which lend themselves to elegant and exact solutions. 8.

Tends to slight the contribution of others; takes undue credit for himself. 9.

Likes to play his hunches in research; is guided by his subjective impressions. 10.

Is neat and orderly in his habits and manner of work. 11.



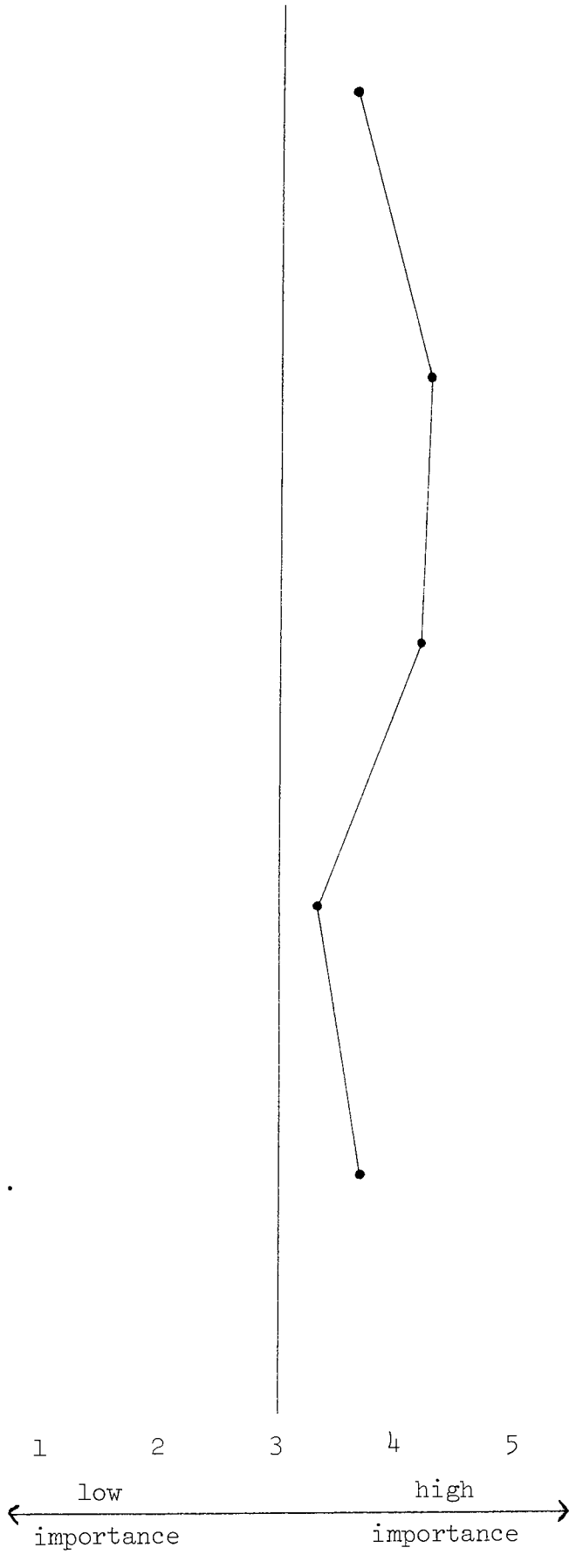
Dislikes and avoids administrative details connected with research projects. 12.

Is good at developing short-cuts and approximation techniques. 13.

Frequently makes errors; his work needs to be checked for accuracy. 14.

Prefers to work alone; is not a 'team' research man. 15.

Is erratic in his research output; varies from work of excellent quality to work of marginal or even inferior worth. 16.



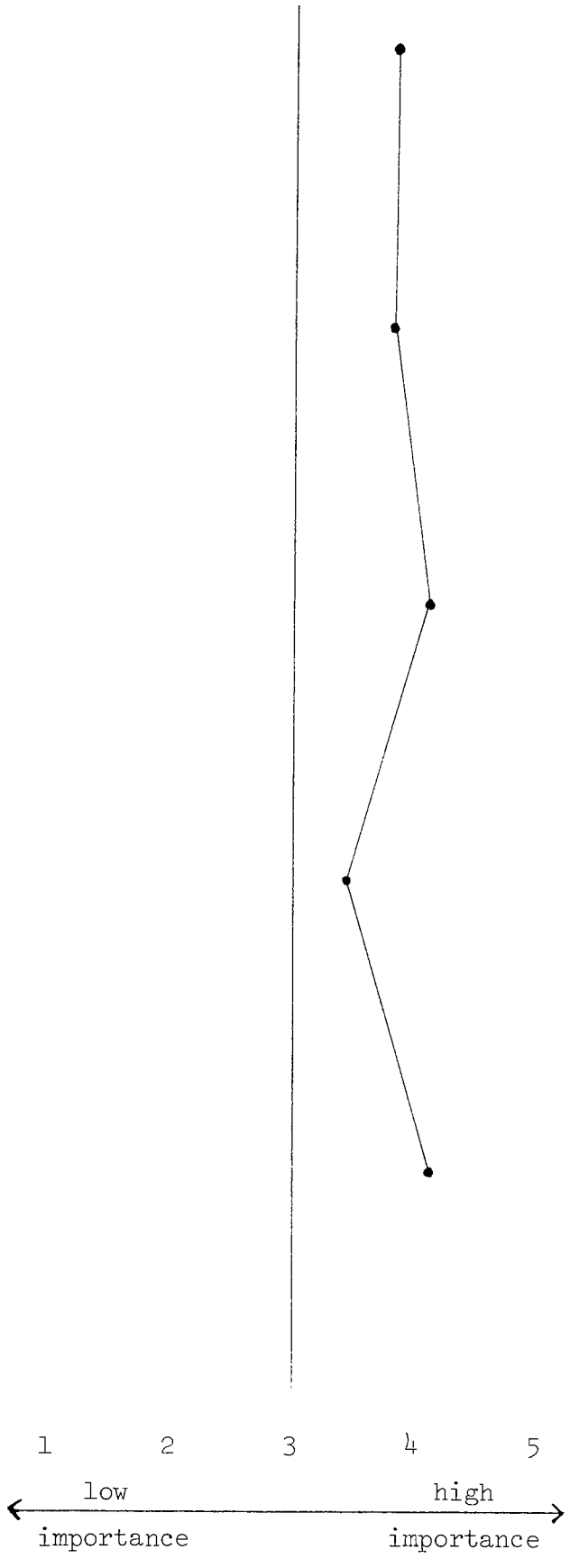
Indifferent to the practical implications of his own research. 17.

Seldom comes up with a really new idea or suggestion. 18.

Has exceptionally high standards of research performance for himself as well as for others. 19.

Has a special talent for solving instrumentation problems. 20.

Is thorough and patient in his approach to research issues; does not get upset if progress is slow. 21.



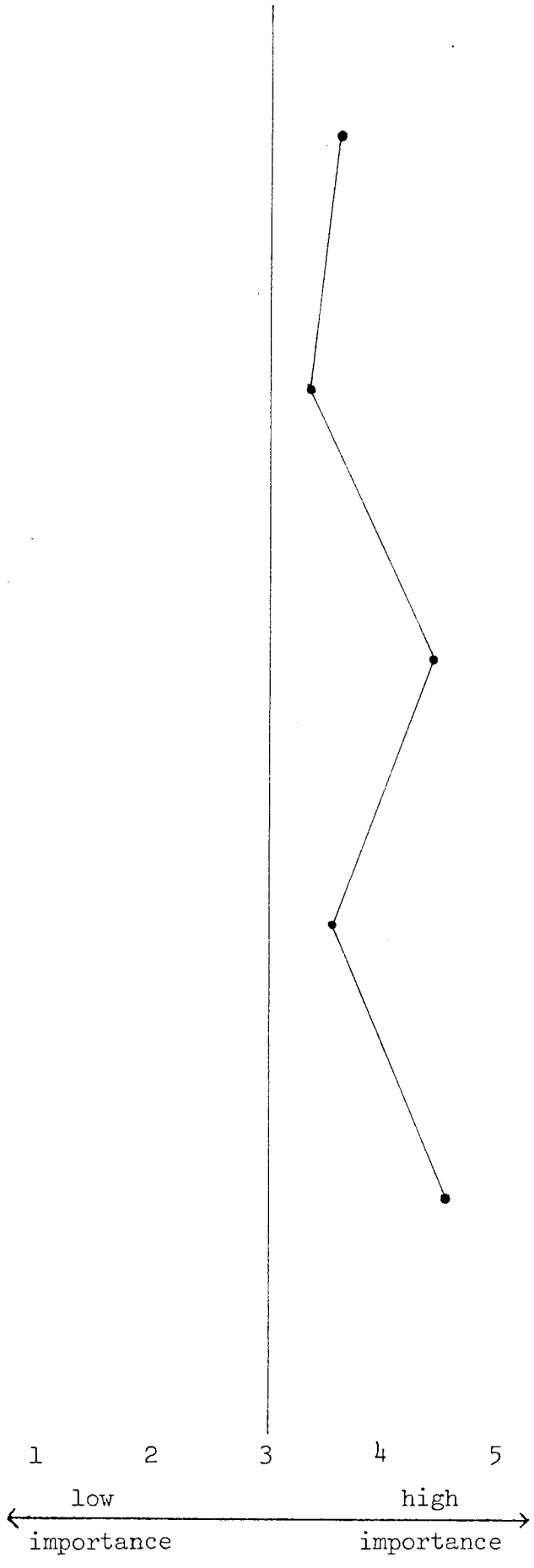
Is a driving, infatigable research man; cannot stop working on a problem until is is solved. 22.

Is relatively uninformed on most subjects other than his research speciality. 23.

Good at evaluating research; able to diagnose strong and weak points in a program quickly and accurately. 24.

Is fiercely competitive; wants to be the best man in every research task that he undertakes. 25.

Seeks out the help and advice of other people when he hits a trouble spot in his own research. 26.



Makes a serious effort to read current publications and to 'keep up' on the literature in his field. 27.

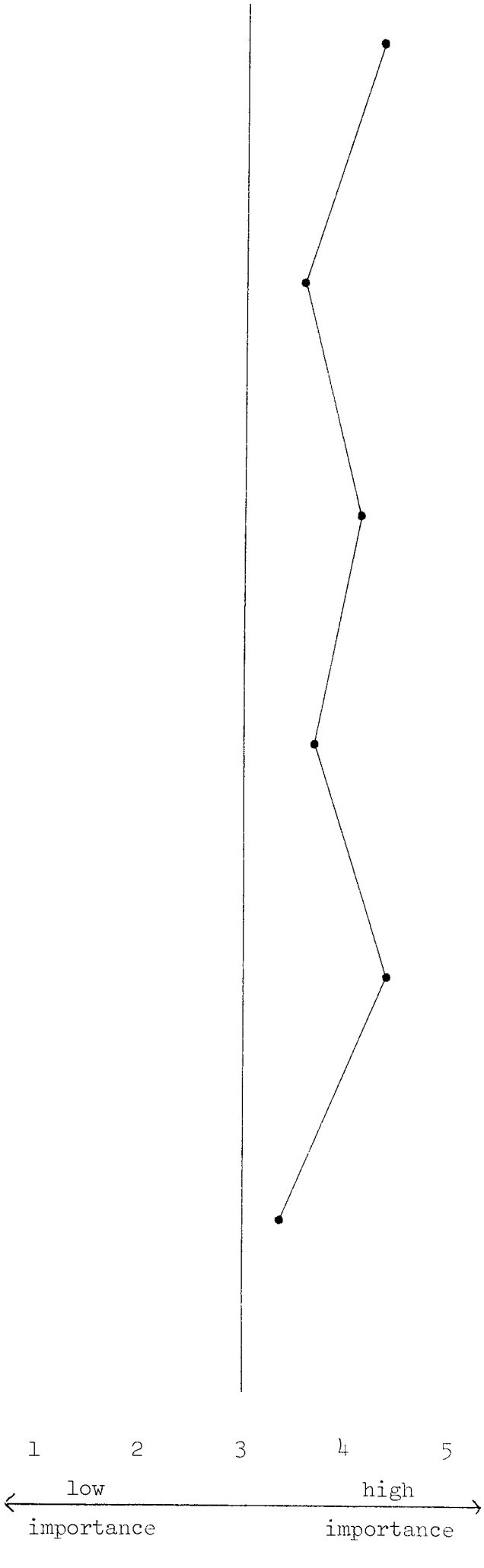
Is creative in anything he tries, whether in science or not. 28.

Has an orderly, well-organised approach to research, plans his projects and activities with great care and precision. 29.

Gives freely of his own time and ideas to other research endeavours without asking for special credit or recognition. 30.

Likes to talk out his research ideas and get other people's reactions. 31.

Many of his ideas turn out to be impractical. 32.



He is aware of his own professional limitations; does not attempt what he cannot do. 33.

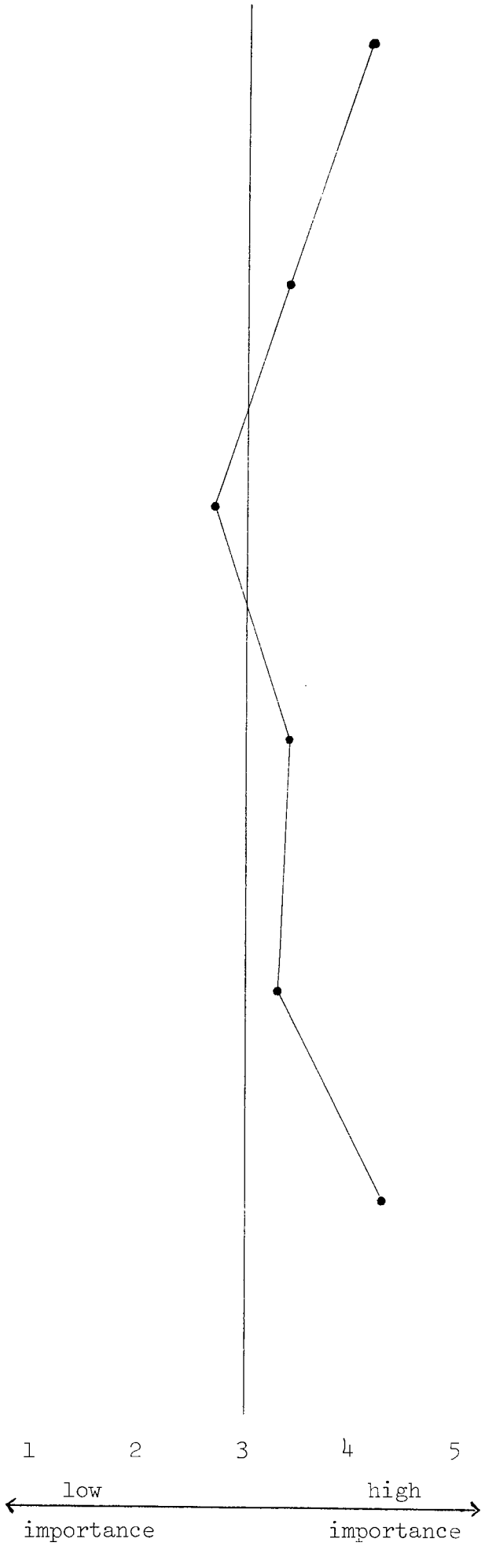
Has a quick tempo of thought and speech. 34.

Prefers to think in analytical and mathematical ways, rather than in terms of physical and structural models. 35.

Is never too busy to 'talk shop' with other researchers. 36.

Has an exceptionally good memory. 37.

Has a knack for improvising quick solutions in research trouble spots. 38.



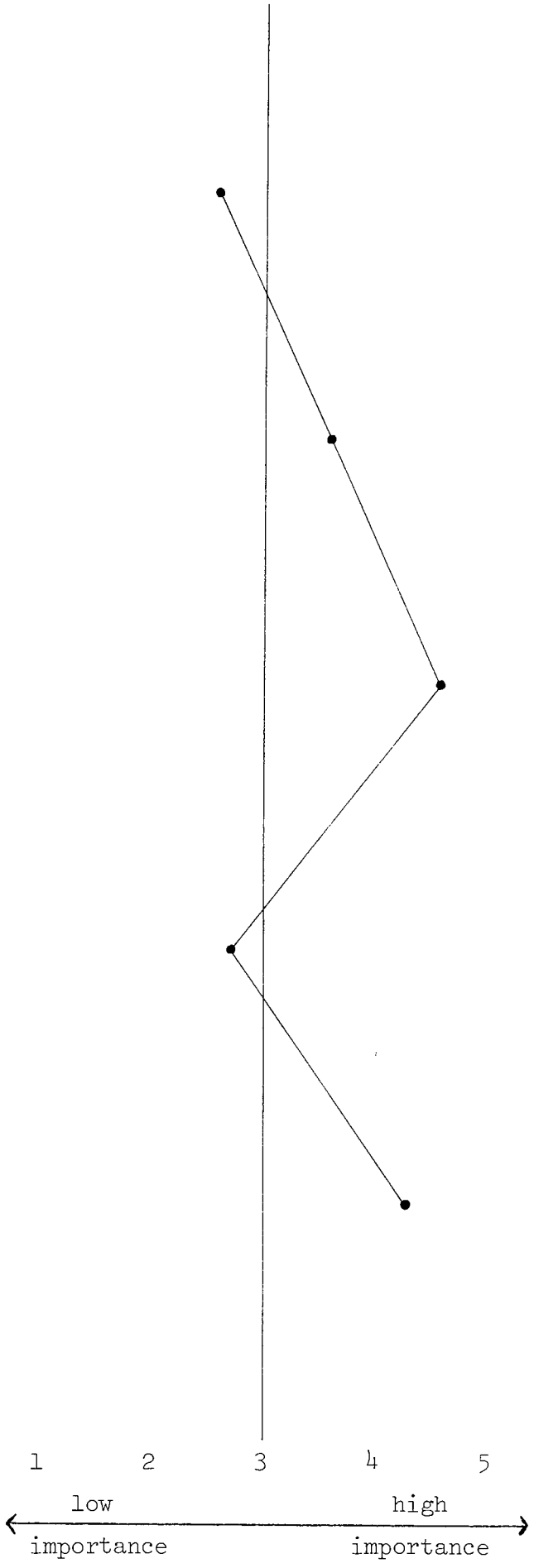
Is a research perfectionist; devotes endless attention to matters of design, apparatus, procedure etc. 39.

Plays his cards 'close to the vest'; prefers not to tell anyone about his research plans until his work is finished. 40.

Is a creative and inventive researcher. 41.

Is tolerant of metaphysical issues. 42.

Is a talented 're-write' man; can take other people's ideas and hunches and fashion them into practical research designs and programs. 43.



Has strong research biases; is vehement in his disapproval of certain methods and procedures. 44.

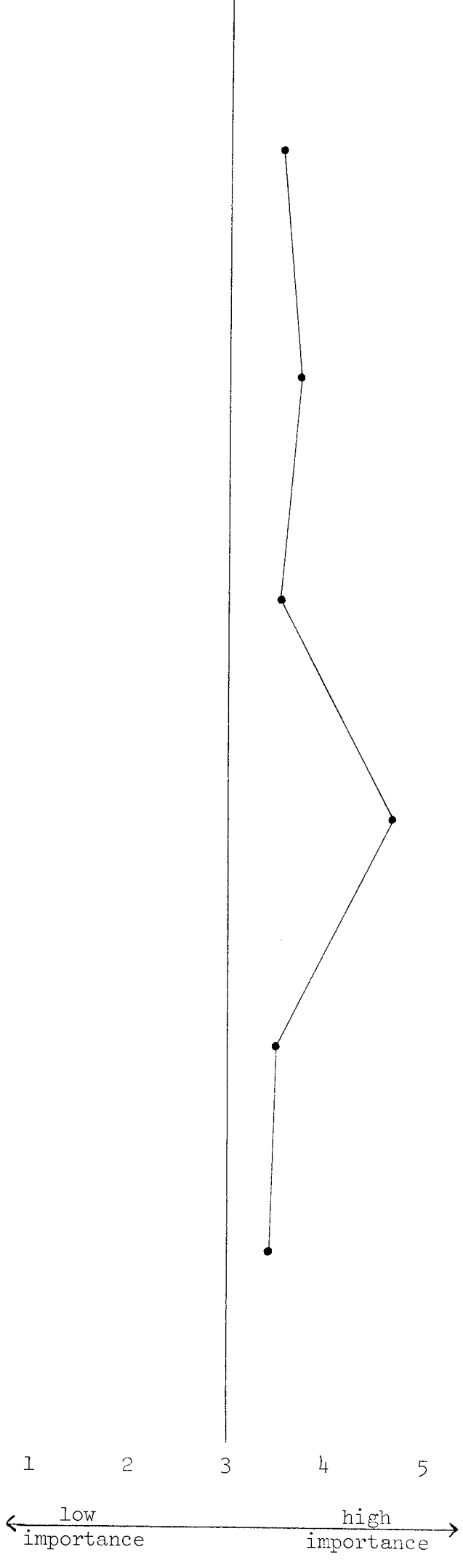
Primarily an 'idea man'; prefers to turn his hunches and hypotheses over to someone else for systematic experimentation and analysis. 45.

Somewhat given to bluffing; claims to know more than he does. 46.

Stimulating to other people; seems to catalyse others into more original and productive endeavour than they would otherwise achieve. 47.

Tends to be sarcastic and disparaging in describing the work of other researchers. 48.

He is intellectually gifted. 49.



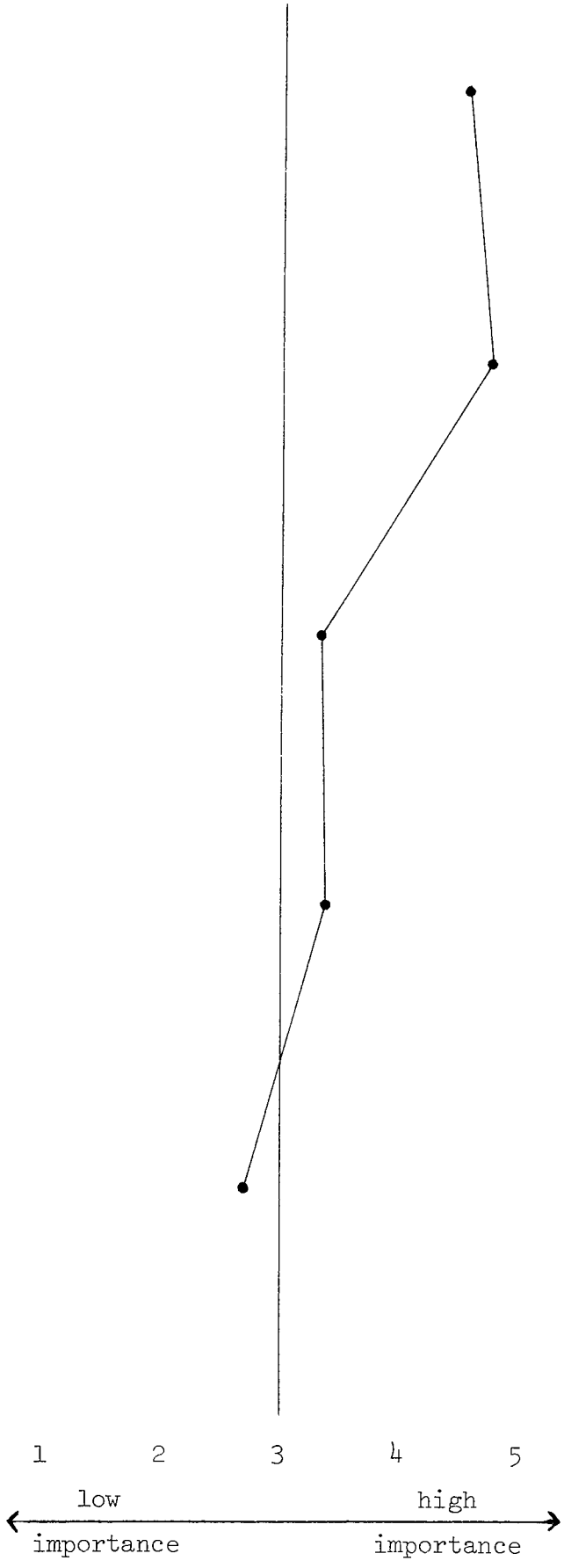
Has a lively sense of intellectual curiosity and inquiringness, a desire to know and to understand. 50.

Is flexible and adaptable in his thinking; able to shift and to restructure easily. 51.

Takes an esthetic view; is sensitive to matters of form and elegance in research problems. 52.

Has a 'sense of destiny' with respect to his own research career, an inner conviction of the worth and validity of his own efforts. 53.

Enjoys philosophical speculation 54.

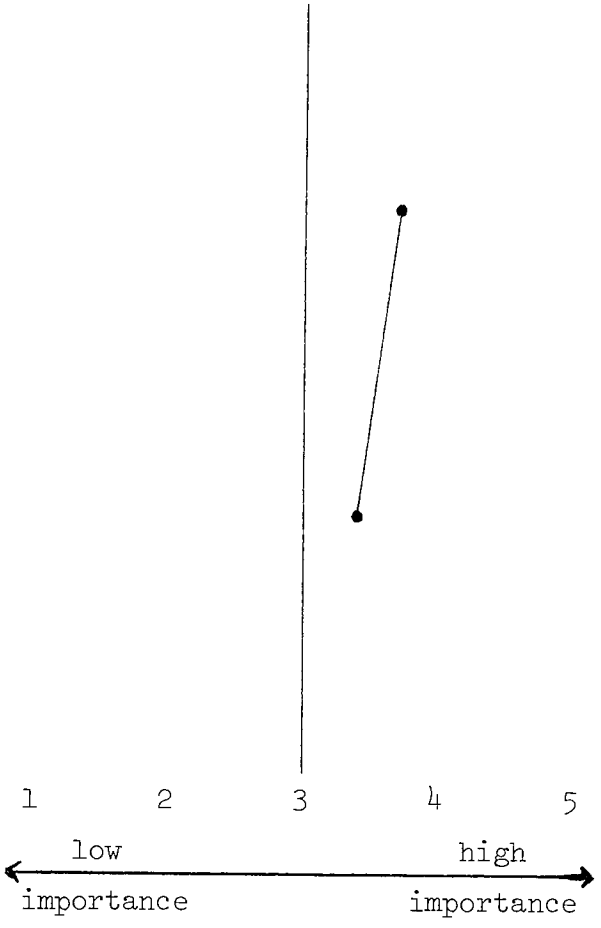


Lacks confidence, is afraid to strike out in new direction.

55.

Subordinates everything to his research and scientific goals; puts scientific values above all others.

56.



Development of the project during the next months was encouraging more people became actively involved. This took several forms, the most common being to approach the researcher whenever anything significant arose, and to initiate discussion rather than wait to be approached. Comments indicated that acceptance was well-established and that changes in the climate and behaviour of the department had been noticed. Whether these were directly attributable to the project was not of importance; the belief was that 'things are getting better'. An example of this was a series of references to observed changes in the management style of the departmental manager (a major area of perceived problems).

During May, a second study of innovation within the company began, this time operating from outside and involving a cross-sectional comparison between a large number of companies belonging to the Centre for Business Research. Contact with Dr. Rickards of Manchester Business School (in charge of the project) was made and a co-operative strategy arranged. His early study involved the collection of opinions on major blocks and barriers to innovation: Exhibit 8 summarises the responses for the Process Development department.

A number of personnel changes included the departure of two key pilot plant people. Several prominent and experienced staff left the company around this time, attracted by overseas firms offering better salaries and prospects: their reasons for dissatisfaction were not solely monetary, and Exhibit 9 indicates results of interviews conducted to try and establish motives for resignation.

EXHIBIT 8 : Departmental Views on Major Blocks and Barriers to Innovation (Rickards 1976)

- interfaces and politics across these
- lack of supervision
- lack of development planning
- lack of motivation
- lack of incentives or recognition for innovative performance
- 'innovations take so long they die'
- uncertainty of financial benefits
- insufficient time for innovation
- internal communication
- time wasted justifying positions
- no satisfactory yardstick of performance
- lack of confidence in reward system
- departmental managers fight for own 'hobbyhorse' ideas
- lack of common objectives for different departments
- inefficient use of resources
- new product/process has too many interfaces to pass
- failure to recognise acceptable and competitive performance standards
- uncertainty about the future of new technology
- badly planned development programme
- lack of control at production stage
- conservative thinking within production department
- lack of good communication between section leaders and subordinates
- poor co-ordination of Applications and Quality Control laboratories with the development programme
- interdepartmental politics
- uncertainty about the future of new technology
- poor morale within the division

EXHIBIT 9 : Resignation Reasons

- feeling of personal devaluation - no respect for professional skills - this awareness exacerbated by the ability to make comparisons with the Swiss experience.

- no feeling of concern within the company for career development - a shirking of responsibility for employees futures by the company.

- demotivating effect of gradual awareness of being in a 'dead-end' position, 'nowhere in the organisation to go and no-one prepared to push for you'.

- 'leadership of Research and Process Development have no understanding of basic pigment technology - this lack of knowledge must impair judgement and thus quality of representation at high-level meetings will be poor'.

- lack of involvement - 'the old Meeting 3 was chaotic and impractical but at least it gave a feeling of involvement - by contrast, present arrangements generate a lack of confidence and a feeling of being kept in the dark'.

- 'we're getting the wrong kind of leadership and we're not getting the structure and direction that we do need!'

- 'things used to be much better when the company was smaller - you could get involved - that's why I'm going to a smaller company, where I think I'll count and be able to contribute'.

- 'impossible to maintain face-to-face contact with people - everything's so formal, all memos and phone calls'.

- 'decisions should be taken from an information base, not from the point of greatest force or influence'.

- 'we lack the right information at the right time - that's why we fail so often'.

- disorganisation and ambiguity of present structure - 'nobody knows who should take decisions so they get taken all over the place and for the wrong reasons'.

- 'no sense of belonging in the department'.

- 'I feel stifled in this company - if you want to do anything, you've got to wade through so much rubbish and so many personalities - it's too formalised, too organised - there's no freedom of action'.

- 'there are too many qualified people here! - no future for someone working their way up, there just aren't any chances of development'.

- 'I'm sick of being treated as a pair of hands - without being shown even basic politeness'.

It was particularly interesting during March and April, to watch preparations for a visit by senior managers from the parent company in Basle. They were to examine proposals for continuous azo manufacture; it was clear that, despite the apparent autonomy of the division, the power to make major strategic decisions of this kind still lay in Switzerland. This would be to Process Development's advantage in that 'selling' the idea to the Swiss would put pressure on more conservative elements on the site to adopt new technology.

The visit took place with a favourable outcome in the form of a go-ahead to take the continuous project to pilot plant level.

Accordingly an internal project team was set up; the researcher was fortunate to obtain the position of secretary to this team, thus affording an opportunity to study the operation at close quarters.

This appointment coincided with an informal survey conducted in the form of critical incident interviews aimed at identifying some common problems encountered in project teams. From these discussions prescriptive suggestions for effective teams were derived (Exhibit 10).

July saw publication of the second quarterly report, which provoked strong reactions. An attempt to mirror the observed situation had been made; it was apparent that at chemist and assistant level this was an accurate reflection of their experience of the department. However senior members, particularly some section leaders were unhappy about criticism of their approaches and styles (which they perceived in the report despite its anonymous presentation). In general, it was apparent that the real issue was one of differential perspectives - both sides were 'right' but neither could see the reasons for the other's position.

The impact of this report was significantly greater than the previous one and it reinforced the view that the research had moved into a more active phase.

EXHIBIT 10 : Suggestions for Improved Project Teams

A survey conducted throughout the department aimed at identifying what was wrong with project teams revealed a number of problem areas. Participants were then invited to specify their suggestions for an 'ideal' project team; these prescriptive ideas are reproduced here as they appeared in the second quarterly report.

(i) membership of operational teams or committees should be confined to those directly connected with work in progress: peripheral membership was felt by some to be obstructive. Equally, contact between departments with an interest in the project can be improved by having a representative involved; this can often be of value in future development of the work. The real criticism here seems to be of the level of representation: there is a recognition of the fact that higher level involvement is necessary but this can give rise to decisions being taken from an under- or misinformed position. Where the fault lies is difficult to locate: what is required is more direct representation from agencies peripherally involved, and improved communication to keep these areas well-informed.

(ii) the team leader should be a specialist in the field of management and interpersonal skills rather than a 'task' specialist: the remainder of the team should be representative experts in their field, offering a consultative service for different aspects of the work. Against this must be set the view that a 'task' specialist could supply an element of strong technical direction, based upon experience and respect.

The deciding factor in this issue is the type of team being considered: an experienced and successful team of contributing experts will need a minimum of direction and control whereas a group with personality clashes, interfacial tensions, dominant and submissive characters etc. will require a strong and skilled leader to operate successfully.

(iii) decision-making responsibility should be vested in these teams and that, within certain pre-arranged and clearly defined limits, they should be autonomous agencies, answerable for all action undertaken. This raises again the overall problem of delegation of responsibility: in the first place, what can be delegated successfully?, and in the second, will it be responsibly accepted? In the case of most Process Development teams, there are limits to decision-making possible at this level since many external factors will modify the overall decision at higher level. For the same reason, the sheer volume of information on a wide range of factors which is required will preclude any real autonomous control of projects: too many people need to be involved at different levels. However, the view expressed is indicative of a feeling within the department which can best be described as a desire for a closer feeling of involvement and control.

(iv) the decision-making process should be based upon the best solution worked out from all available information. In particular, the contribution of each member of the team (whatever his status) should be ranked equally, so that overriding of corporate decisions for non-rational or political motives can be reduced to a minimum. The problem here is really that mentioned in point (ii) above, namely that such a suggestion will only work in a situation in which the team members are capable of making their individual contributions. In most practical situations, as a consequence of a variety of behavioural factors, there is a need for a 'parent-child' form of control from the team leader trying to steer the team towards as acceptable a solution as possible.

Naturally, this mode of operation lends itself to criticism, particularly since leader behaviour may be seen as dominant, imposing ideas despite the group's opinions: nevertheless it is difficult to see what alternatives are available under present circumstances.

Much of what has been said here reflects more upon behavioural inexperience in the group work context than on poor team management. What appears to be necessary is a training away from parent/child operations and towards the fuller acceptance of 'adult' responsibility within the group.

The monthly meeting for July produced more evidence for the project's having acted as an irritant: there was a high incidence of defensive behaviour. In particular it was felt that the fundamental problems underlying the reported symptoms of discontent lay in an area which was, as yet, very poorly understood on site. Further, whilst diagnosis could be refined by the process of observation, reporting and feedback discussion, the mechanisms, tools and commitment for change had to come from within the organisation and at higher levels.

Based on this improving diagnosis, and in keeping with the general action research paradigm, strategies for intervention and change were also developed during this period. Amongst formal instruments used were the organisational mapping questionnaire and the work preference questionnaire (both described in the methodology section). Exhibits 11 and 12 summarise the results of these.

Within the department, a number of significant changes took place in September which had the general effect of rationalising the structure after the departure of the key pilot plant personnel. The opportunity was also taken to regroup taking account of some personality and group issues and the overall effect, whilst upsetting for some individuals, was felt to be beneficial.

During the period when the researcher was on holiday, one of the regular contributors kept a diary of significant events. Apart from the value of this as a device for further involvement, it was interesting to see the major issues viewed from another 'insider' perspective. Exhibit 13 gives examples of this coverage.

An attempt was also made to combine a research instrument with an intervention tool. Assessments of an informal kind (discussed in methodology section) were collected, fed back and discussed with participants. It was indicative of the change in openness in the climate that such an experiment should be received with interest and enthusiasm rather than suspicion. Exhibit 14 discusses this intervention.

The fifth quarterly report dealt with results of this experiment: it was significant in that it attracted interest from outside the department as a possible tool for improving integration within their areas. Once again the focus of the report was major problem issues which continued to arise: discussion of communication, leadership, motivation etc. was offered.

EXHIBIT 11 : Organisational Mapping Questionnaire

This instrument was intended as a 'mapping' device to identify problem areas. Amongst issues of particular interest were:

- objectives (1a)
- hierarchical integration (2l, 2m)
- informal relationships (5h, 5i, 5j, 5n)
- intragroup co-operation (5b)
- intergroup " (5d)
- individual fulfilment (2f)
- information flow (3h)
- group task/role definition (5g)
- non-technological problems (6e, 6f)

Emerging from this is a strong acknowledgment of the role of the informal organisation - in communication, in resolving problems between groups and individuals etc.

This is likely to be the case in a group which is composed of specialists facing tasks of high complexity and uncertainty: they will rely on interpersonal support and flexibility.

Equally interesting is the incidence of integration problems: dissatisfaction with vertical relationships and with levels of understanding and co-operation between groups.

The emphasis on problems appears to be non-technological which supports other research observations. In general within-group perceptions are quite favourable: problems begin to arise when relating to the remainder of the organisation.

Organisational Mapping Questionnaire

Section (1) Objectives

In the context of this department, how far do you feel that:-

(a) the objectives have been realistically planned?

(b) the objectives have been effectively communicated?

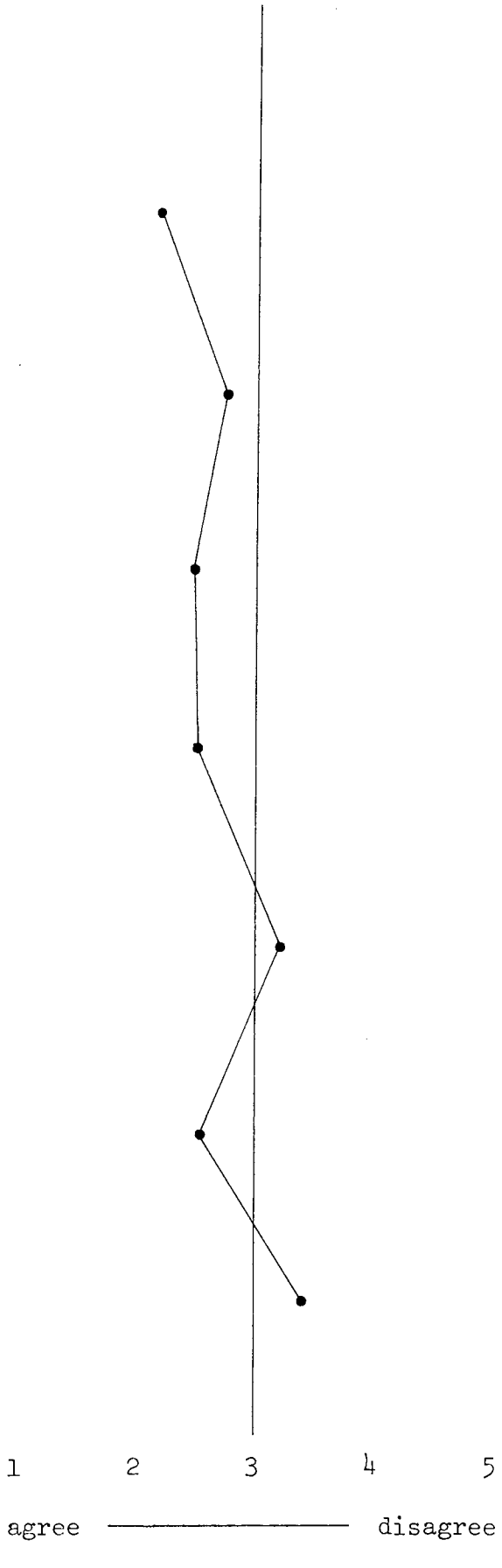
(c) the objectives have been clearly understood?

(d) the objectives have been successfully achieved?

(e) the objectives have been flexibly defined so as to be sensitive to changes outside the department?

(f) the objectives have been planned to make effective use of departmental resources (e.g. people equipment, etc.)?

(g) there is a high level of involvement in the development of a departmental strategy to meet these objectives?



Section (1) Objectives cont'd

In the context of this department, how far do you feel that:-

(h) there is a clear statement of formal R. & D. policy?

(i) the major obstacles to the fulfilment of these objectives arise from non-technological factors?

(j) the major obstacles to the fulfilment of these objectives arise from outside the department?

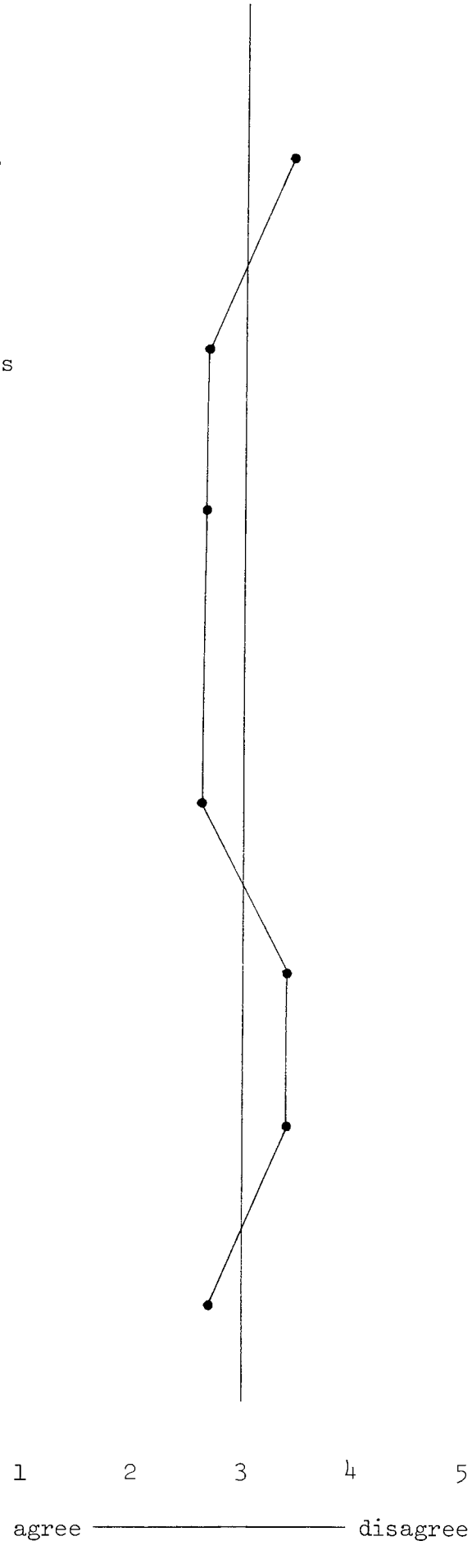
In the context of the Pigments Division organisation, how far do you feel that:-

(k) the objectives have been realistically planned?

(l) the objectives have been effectively communicated?

(m) the objectives have been clearly understood?

(n) the objectives have been successfully achieved?



Section (1) Objectives cont'd

In the context of the Pigments Division organisation, how far do you feel that:-

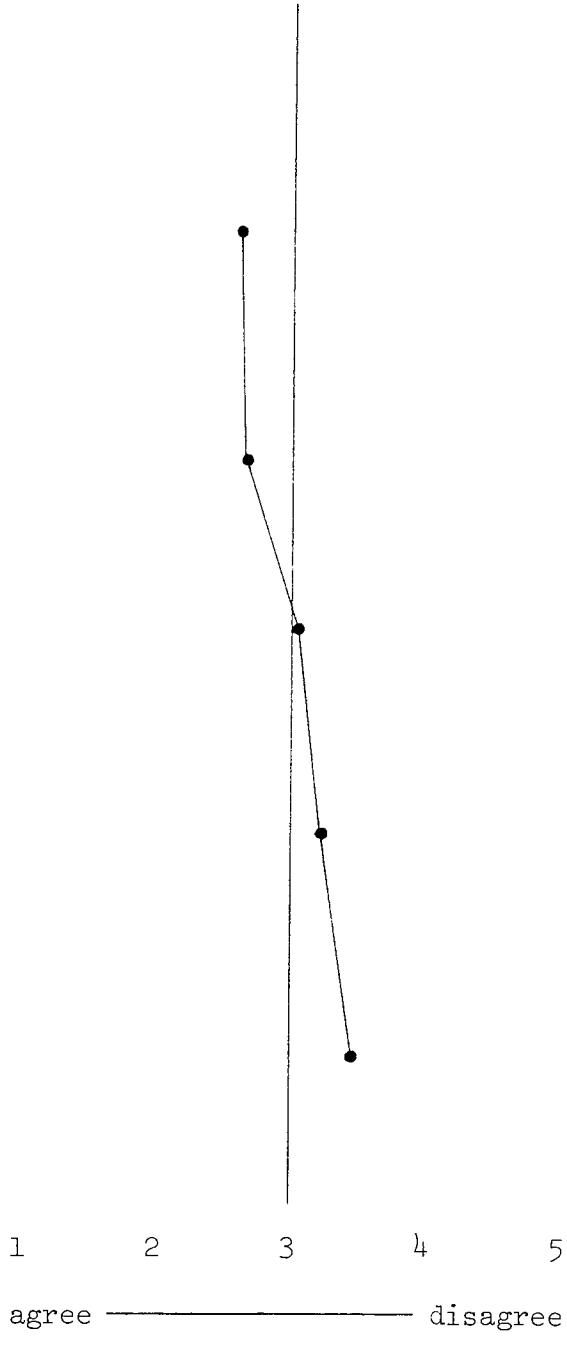
(o) the objectives have been flexibly defined so as to be sensitive to changes within the organisation?

(p) the objectives have been flexibly defined so as to be sensitive to changes outside the organisation?

(q) the objectives are too strongly influenced by Basle?

(r) there is a clear statement of formal R. & D. policy?

(s) there is a clear understanding of the role of R. & D. in the organisation of Pigments Division?



Section (2) Structural Factors

In the context of this department, how far do you feel that:-

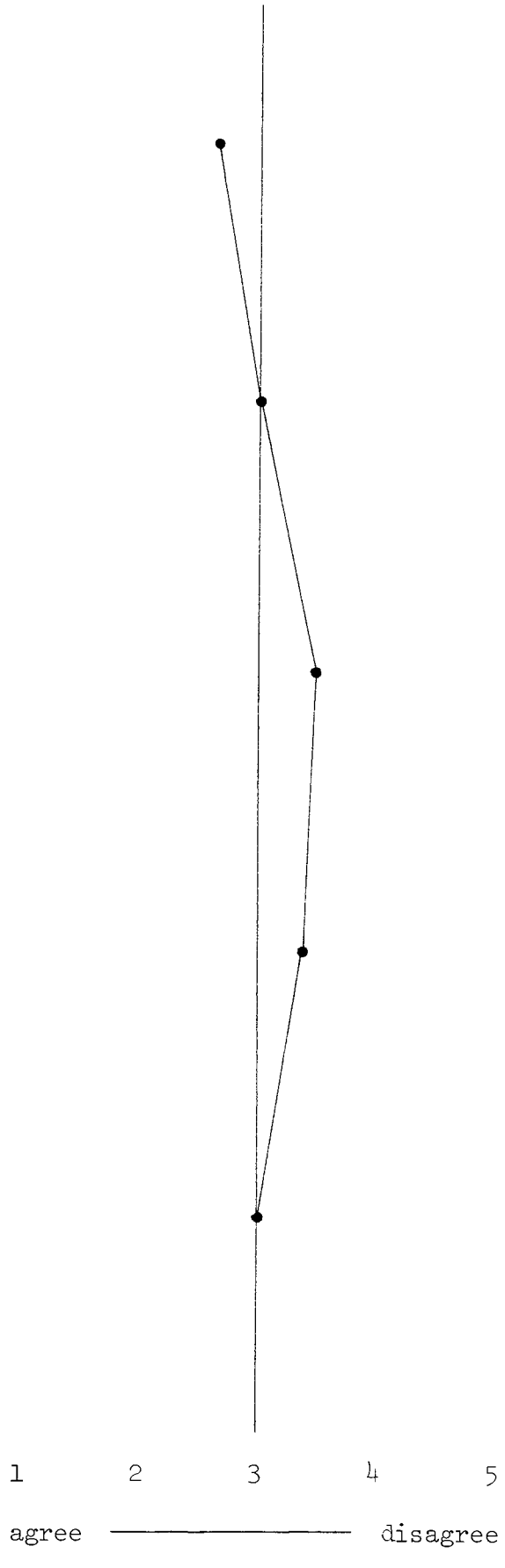
(a) the existing structure makes effective use of available resources (e.g. people, equipment, etc.)?

(b) the existing structure permits the use of individual initiative?

(c) the existing structure allows for greater delegation of responsibility?

(d) the existing structure permits each member of the department to make a significant contribution to, and to feel involved in, the life and work of the department as a whole?

(e) the existing structure is well adapted to the function the department has to perform?



Section (2) Structural Factors cont'd

In the context of the Pigments Division organisation, how far do you feel that:-

(f) the existing structure permits each individual to feel involved in and able to contribute to the life and work of the organisation?

(g) the existing structure allows for delegation of responsibility?

(h) the existing structure is flexibly defined to respond to changes in the outside world?

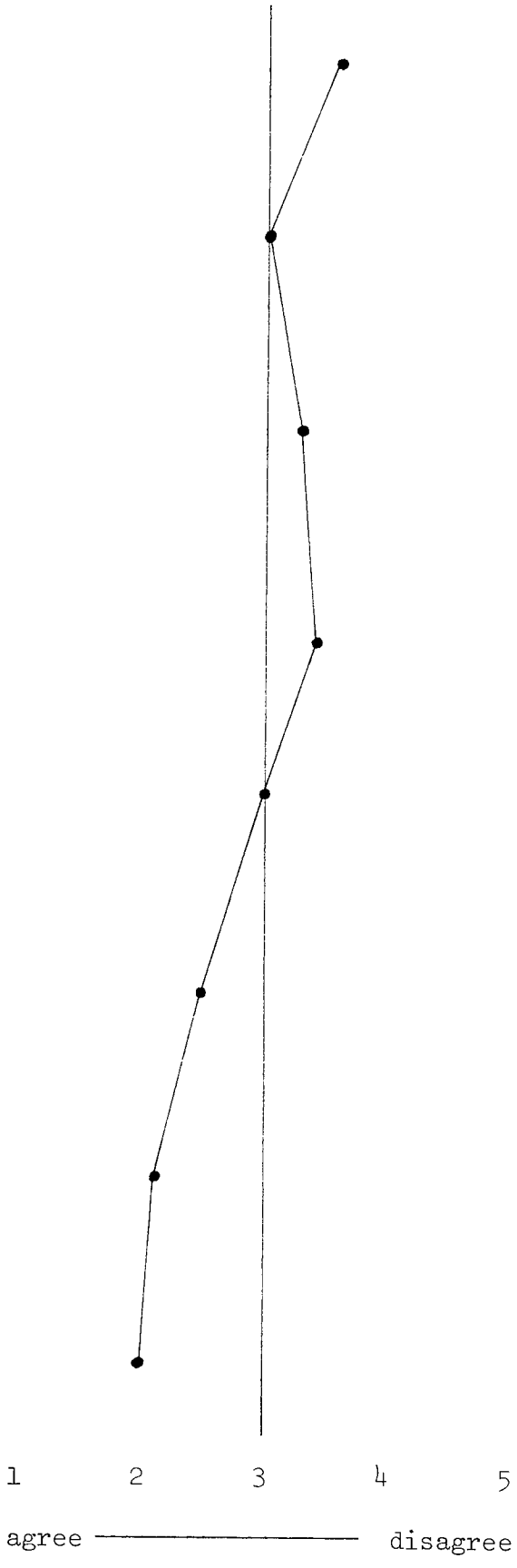
(i) the existing structure can quickly adapt to changes in the world outside?

(j) the existing structure is too far dominated by Basle?

(k) the existing structure is too rigidly defined to permit adequate contact between groups and departments?

(l) there is a gap between different levels in the management hierarchy?

(m) there is a distortion of perception across this gap?



Section (3) Communication

In the context of this department, how far do you feel that:-

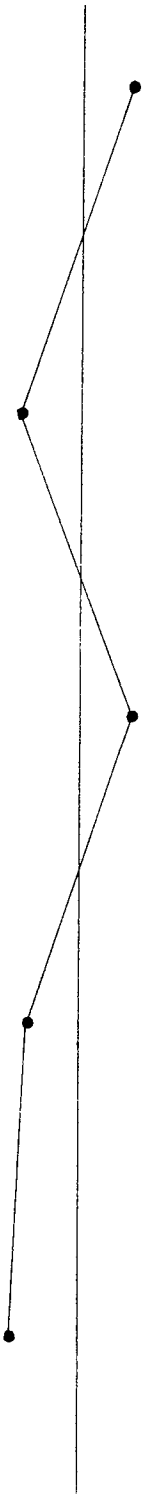
(a) information is effectively communicated?

(b) information is selectively 'filtered' before being communicated?

(c) information is communicated in a timely fashion, so that a sense of involvement and awareness is generated?

(d) information is more completely and openly communicated, i.e. that 'the whole story' gets passed on, by the informal network than by the formal one?

(e) information is more effectively communicated, and in a more rapid fashion by the informal network than by the formal?



1 2 3 4 5

agree ——————— disagree

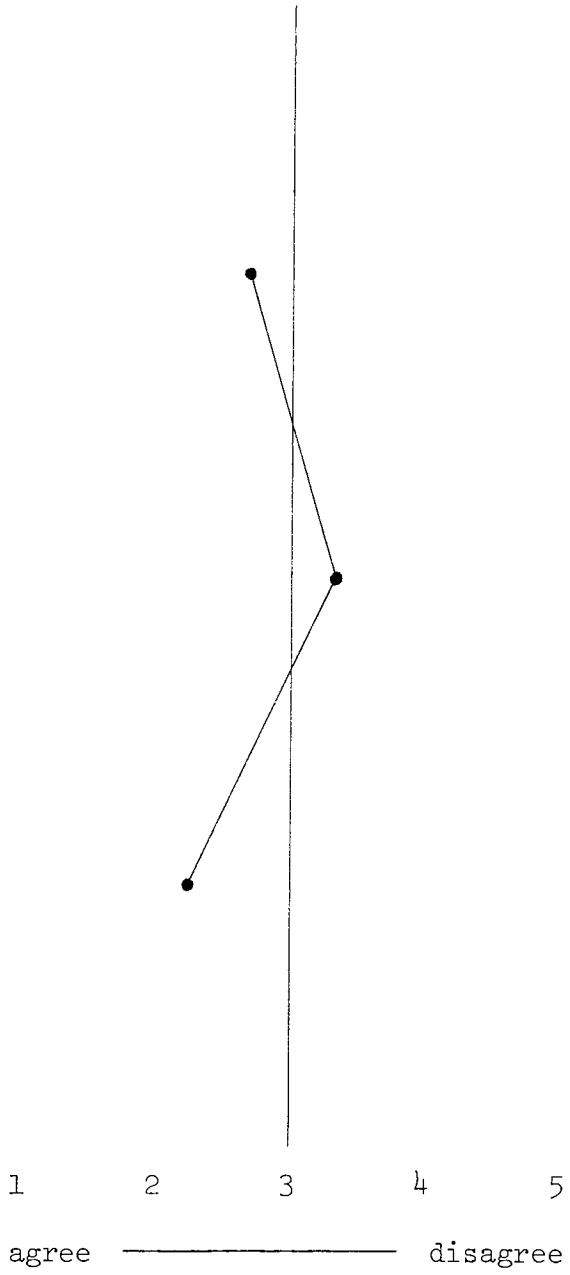
Section (3) Communication cont'd

In the context of this department, how far do you feel that:-

(f) the informal communication network is better adapted to keeping people informed and thus fostering a feeling of involvement and awareness?

(g) the informal communication network represents a distorting factor which contributes little to and may in fact inhibit the passage of correct information?

(h) the informal communication network reaches a much wider 'audience' with a much greater variety of information than does the formal?



Section (3) Communication cont'd

In the context of the Pigments Division organisation, how far do you feel that:-

(i) information is effectively communicated?

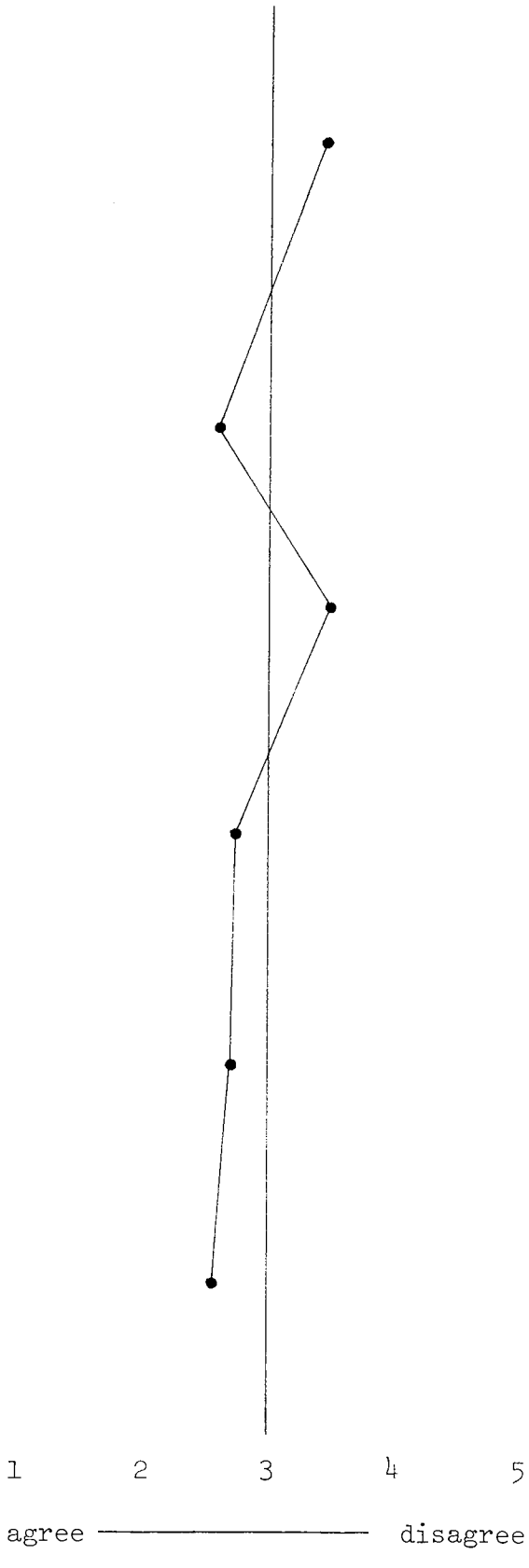
(j) information is passed on a selective 'need to know' basis rather than on a completely open 'telling the whole story' basis?

(k) information is communicated in a timely fashion such that a feeling of awareness and involvement is generated?

(l) information is more effectively communicated, and in a more rapid fashion by informal channels rather than by formal ones?

(m) the informal communication network represents a distorting factor which contributes little to, and may in fact inhibit, the passage of correct information?

(n) the informal communication network reaches a much wider 'audience' with a much greater variety of information than does the formal?



Section (4) Job-related factors

In the context of this department, how far do you feel that:-

(a) jobs are accurately defined?

(b) jobs permit a high degree of self-fulfilment?

(c) jobs offer a realistic opportunity for career development?

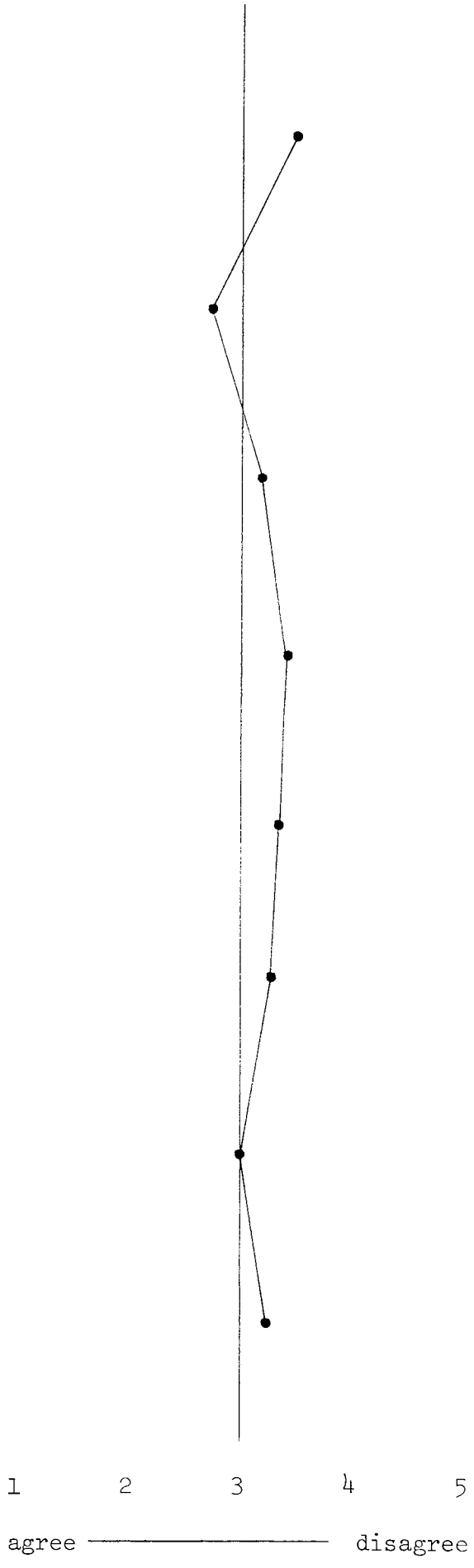
(d) the assessment procedures in use are effective indicators of performance?

(e) existing job descriptions offer the opportunity to contribute to the department as a whole?

(f) the assessment procedures are carried out in a uniform fashion?

(g) the assessment procedures permit an objective analysis of performance?

(h) promotions represent a meaningful change in job characteristics rather than an automatic 'step up the ladder'?



Section (5) Group-related factors

In the context of this department, how far do you feel that:-

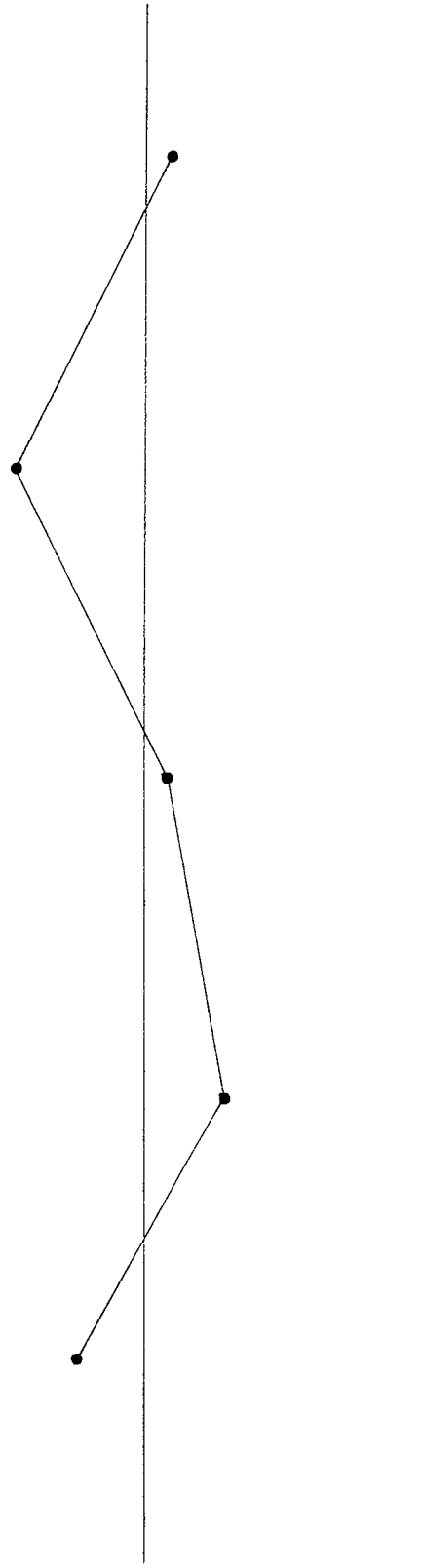
(a) there is good cooperation between groups?

(b) there is good cooperation amongst individuals within groups?

(c) there is a belief that conflicts and disputes can only be resolved in a win/lose fashion rather than by a compromise acceptable to both sides?

(d) there is good mutual understanding between groups and a clear appreciation of the problems and difficulties involved in other areas?

(e) there is a clear definition of the task(s) which the group has to fulfil?



Section (5) Group-related factors cont'd.

In the context of this department, how far do you feel that:-

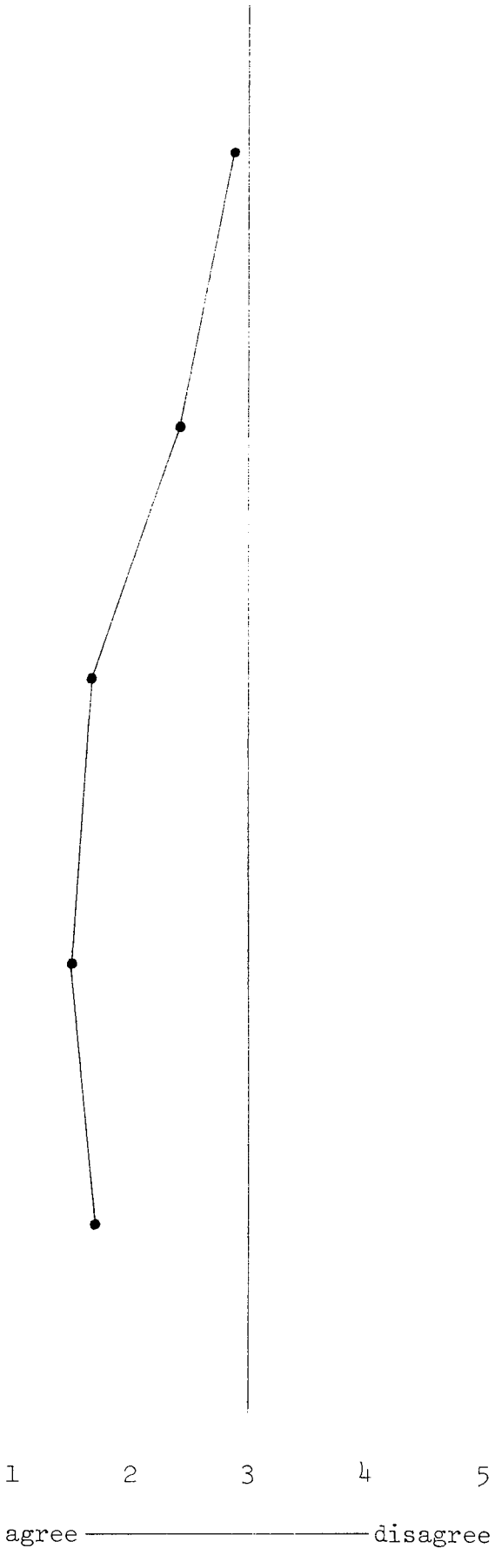
(f) there is a clear definition of the role the group has to play in the department?

(g) the clear understanding of role and task of the group leads to a sense of involvement, awareness and cooperation?

(h) that informal relationships help to strengthen a group from within?

(i) that informal relationships help to avoid confrontation situations between groups?

(j) that informal relationships help to foster a greater self-awareness and improve interaction with others both within and between groups?



Section (5) Group-related factors cont'd

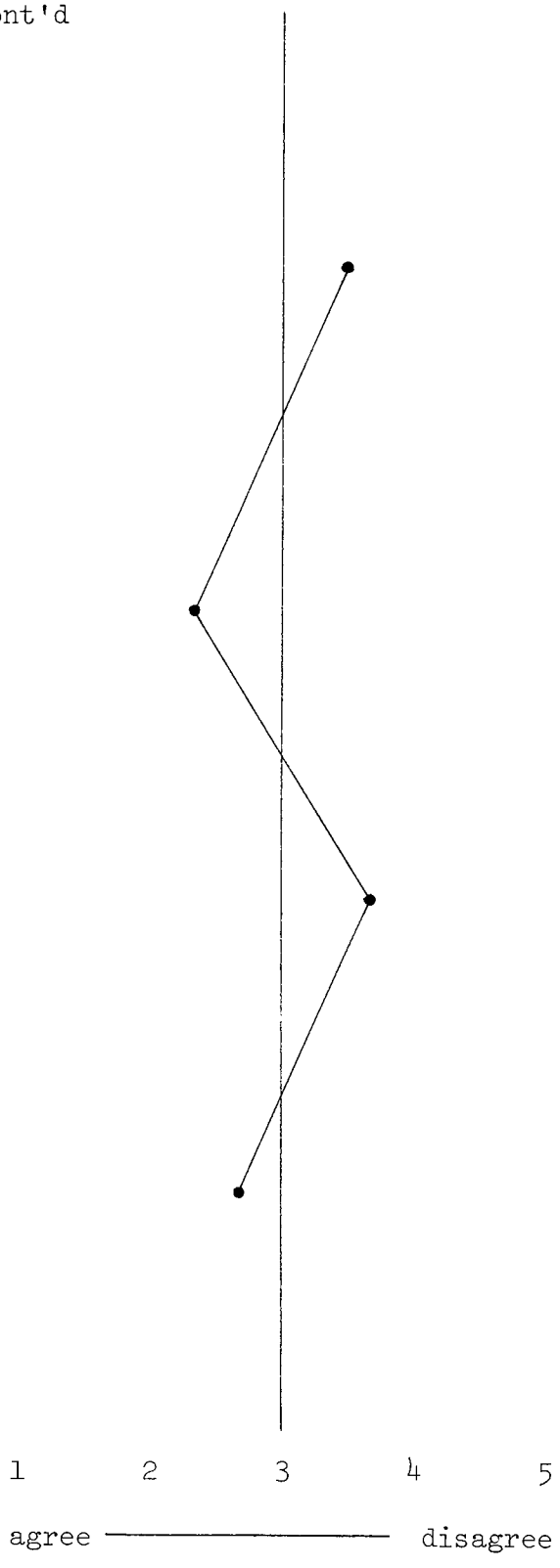
In the context of the Pigments Division organisation, how far do you feel that:-

(k) there is good cooperation between groups?

(l) there is a belief that conflicts and disputes can only be resolved in a win/lose fashion rather than by a compromise acceptable to both sides?

(m) there is good mutual understanding between groups and a clear appreciation of the problems and difficulties involved in other areas?

(n) that informal relationships help to foster a greater self-awareness and improve interaction with others both within and between groups?



Section (6) Innovation

In the context of the Pigments Division organisation, how far do you feel that:-

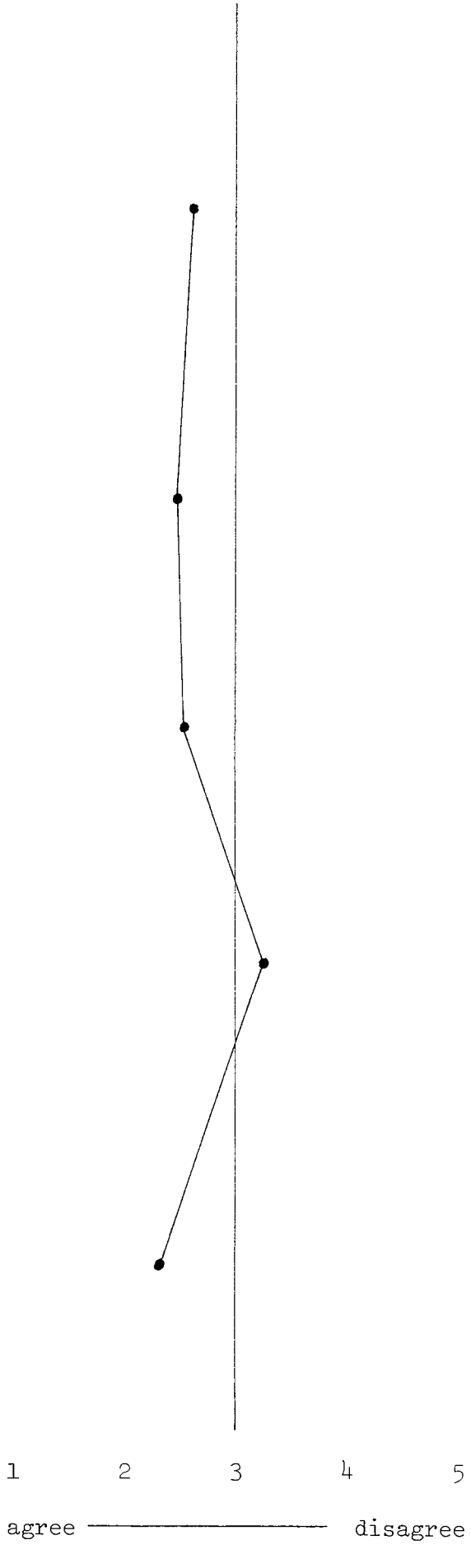
(a) attitudes towards innovation are too conservative?

(b) emphasis is placed on systematic work within procedure rather than on speculative, more radical work?

(c) the overall policy could be described as safe and sure?

(d) major departures from this policy would only result in major problems?

(e) the major barriers to innovation are not in the production of good ideas but in the process of carrying these into practice?



Section (6) Innovation cont'd.

In the context of the Pigments Division organisation, how far do you feel that:-

(f) these problems are not so much a function of the system itself as the personalities and behavioural factors involved?

(g) that the 'streamlining' of Meeting III has led to a 'gap' between functional departments in the innovative process and the R. & D. policy interpretation as performed by Meeting III.

(h) that the setting up of the T.C.G. has helped towards closing this gap by providing a link between functional departments and Meeting III?

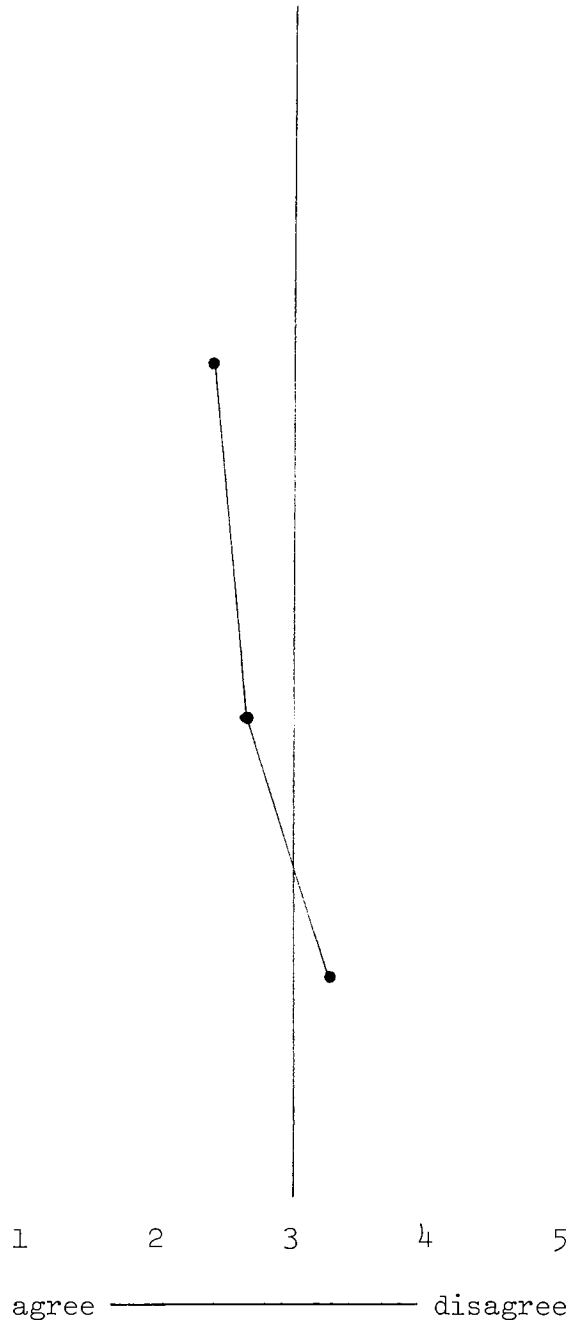


EXHIBIT 12 : Work Preference Questionnaire

This instrument was used to try and establish levels of achievement orientation within the group. Some writers believe that there is a relationship between this and risk-taking/ entrepreneurial behaviour. The average score for the department was high relative to other functional areas in the division.

However, more meaning could perhaps be gleaned from a study of statements which were strongly supported: these related to:

- interesting and challenging work (q5, q12, q23)
- job satisfaction and motivation rather than simple 'hygiene' seeking (q10, q13, q16)
- independence (q11, q15, q17)
- support (q20)

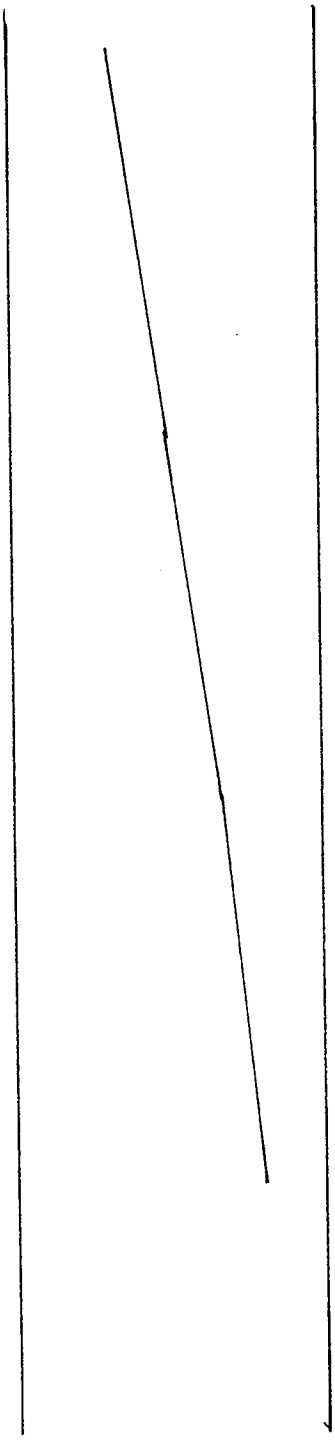
It is suggested that this presents a view of people being principally motivated by the overall challenge, interest and quality of their work.

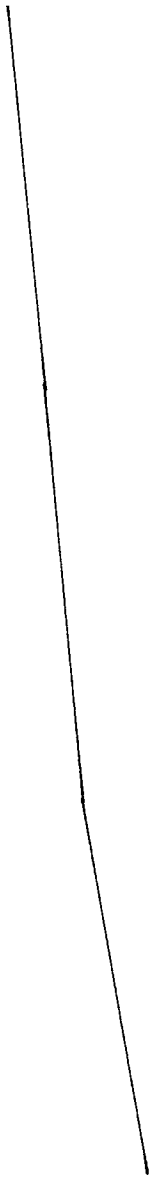
Arguably this implies an orientation towards a 'professional' viewpoint amongst technical specialists as opposed to an institutional one. For this reason, one might expect a higher incidence of risk-taking amongst these professionals with more 'champions' in evidence; it appears, however, that innovators prefer to leave the organisation rather than try and change the system.

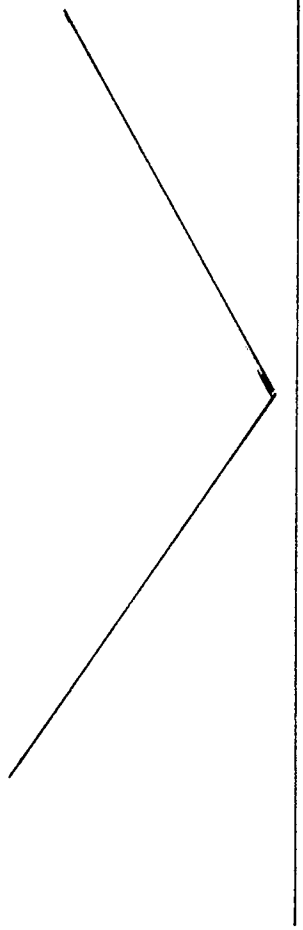
Another consideration is the strong group orientation expressed by the majority of people: given the choice almost all placed group interests and informal relationships above any kind of individual task orientation. This high group feeling may reflect the levels of interpersonal dependence engendered by complex, uncertain tasks and environments.

Work Preference Questionnaire

Would your ideal organisation be one...

1. Where a person's promotion is unpredictable and depends largely on his own good performance.		Where a person can see exactly how his career will progress after certain periods of time.
2. That regards special benefits, such as attractive bonuses, free pension schemes and a company car, as the prime incentive to remain in the job.		That concentrates on tempting new employees with interesting work, although it is not able to pay as much as other organisations providing less interesting work.
3. Where it is emphasised that the 'job comes first', therefore afterwork pleasures should take secondary importance.		Where it is very difficult to carry on work over a weekend period should someone so desire.
4. Where the few changes in tasks that occur allow people to perform one type of work with considerable care and proficiency.		Where there is constant pressure to complete a task well in a short period of time and to then become involved with another task.

5. Where there is a general attitude that, even if the working conditions are poor, much can be compensated by interesting work.		Where little that is favourable can be said about the work itself but where the attitude of management towards its employees' welfare is first class.
6. That gives people jobs that can very likely be done well.		That gives people work which is not so difficult that they would have to rely on luck to do a good job nor so easy that they are bound to succeed.
7. Where it is expected that leisure time will be sacrificed if work pressure is great.		Where it is felt that working late is undesirable because eventually strain will be experienced in normal working hours.
8. That believes that if a person concentrates primarily on working in a warm close fashion with his co-workers, good work must follow.		That regards the successful completion of an employee's assignment as more important than the feelings of that person's co-workers.

9. That expects individuals to help the organisation by fulfilling their own personal goals.		That expects its employees to strongly identify with the organisation rather than think of themselves as individuals apart.
10. Where good working companions and generous holidays are provided to make up for the tedious nature of the work.		Where there is more concern with employees' satisfaction with the actual work that they do than with their general conditions of work.
11. Where each employee is solely responsible for most of the work that he performs.		Where several people are always responsible for, and take the credit for, a particular piece of work.

Would your ideal boss be someone.....

12. Who gives his employees work that they feel sure of doing well without too much effort.

Who gives people work requiring quite a lot of struggling to master.

13. Who insists on finding out how worthwhile his employees see their work but neglects looking into the enjoyment that they get from their work.

Who regards the pleasure that his employees get from their work as more important than the actual worthwhileness of the work.

14. Who emphasises the importance of the work group's responsibility for its decisions rather than particular individuals in the group taking the responsibility.

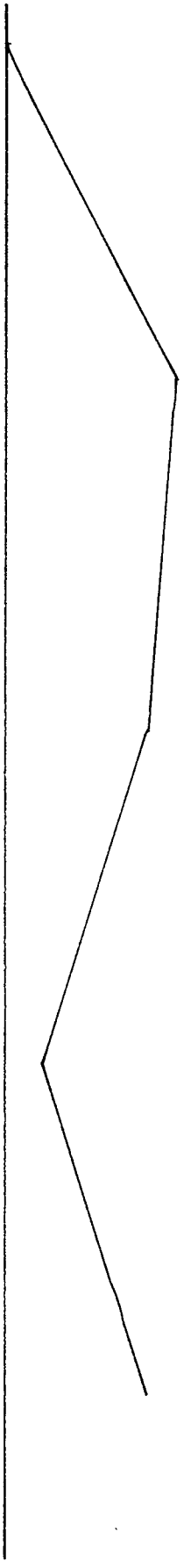
Who relies on a particularly efficient individual in a work group to control the group's activities.

15. Who expects to be consulted only for very exceptional work problems.

Who encourages employees to follow set procedures in their work.

16. Who attempts to provide attractive work for his employees even if it is not of great value to them.

Who would not give people work that they could view as of little value even though it may be highly attractive to them.

17.	Who gives his employees general guidelines on which to base their own decisions about how to proceed with their work.		Who gives clear, very comprehensive instructions on how employees should carry out their work.
18.	Who finds that for group morale it is better to try to preserve good co-worker relationships that may be spoiled by letting people keep working at a task to their own satisfaction.		Who feels that a certain degree of bad feeling amongst employees is worth tolerating if they are very much involved with their work.
19.	Who looks for future employees who will be able to work independently of others.		Who looks for future employees who will primarily be good at getting on well with other employees.
20.	Who would rather employees consulted him with work difficulties than struggle with them themselves.		Who will not interfere with work for which employees have responsibility.
21.	Who expects an individual's work rate to remain relatively uninfluenced by his colleagues.		Who relies on the group as a whole to produce a given amount of work expecting the group to influence an individual's quantity of work done.

22. Who views good employee relations as being most important and incompatible with competitiveness.

Who insists on individuals trying to achieve a better performance rating than their co-workers.

23. Who gives employees work where they need to write fairly detailed arguments about problem solutions.

Who gives employees work that involves very little written reporting or problem discussions.

24. Who feels that working late should be avoided.

Who encourages working late in order to meet a deadline.

EXHIBIT 13 : Extracts from Diary kept during September 1976 by member of Process Development.

"Day (1). HVM etc. at the Research/Production/Marketing processes meeting. Discontent expressed by azo group at lack of information on this, especially as continuous azo was being presented.....

Day (2). Discussions on beads project and how to best influence senior management. Discontent expressed by AW on reshuffles. CN expressed appreciation of JB (the researcher) and the project in causing changes in HVM and his behaviour towards graduates and particularly technicians. Also expressed enthusiasm for style changes in the department. AH unhappy about research targets and relationship between Process Development and Research. Felt that a successful azo group was a target for attack by outsiders. Transfer of SC (an assistant) to azo group from elaborations aroused suspicion in azo area and disappointment in elaborations. However CN (his old boss) sees the transfer as possibly knitting the two groups together more closely and thus a good thing.

Day (3). Discussions amongst continuous azo team as to best way to handle some of the 'people' problems. Possibility of using JB as an intermediary. Speculation at a possible phthalocyanine strike, enhanced by very vague and uninformative formal communication. Problems between test laboratories and azo group - communication failure again.

Day (4). Strike averted. SC arrived in azo group today and will pose some integration problems.

Day (5). Informal discussion between azo group members and HVM on strategy, composition of continuous team etc. Useful exercise because HVM was cornered and once pressed was happy to discuss problems.

Day (6). CON discussions with BJM on strategies to use in getting members of the continuous team moving.

Day (7). Much speculation about departmental changes. CON has forced AH (team leader) to call a meeting of the continuous team to discuss things and get it moving.

Day (8). Continuous team meeting - and a few battles emerging, e.g. over usage of the pilot plant.

Day (9). HVM reveals plans for the next 12 months - could well result in some extensive changes in the department.

Day (10). Holiday.

Day (11). HL over from Basle - he's working on another continuous project. Discussion with TM about role (or rather lack of it) of section leaders in Research. Poor internal communication obviously not confined to Process Development!"

EXHIBIT 14 : Informal Assessments

This was an attempt at identifying the group norms for acceptable levels of performance in a number of factors. As a measuring device it was crude and would need extensive development: nevertheless it gave interesting results which provoked useful discussion.

The graphs and discussion are reproduced here as originally published in the fifth quarterly report. Of particular interest is the 'halo' effect possessed by certain individuals: high scorers do well on all categories. This suggests that the measure does not discriminate very effectively - but it also illustrates the effect which reputation can have on shaping beliefs.

The measure was developed partly because of feelings of dissatisfaction with the existing performance evaluation system: whilst this device was in no way an attempt to replace it, it did try and consider other relevant factors. In general high scores on these categories related to a reputation for good performance in the various activities of the department.

Discussion and graphs from fifth quarterly report

The first thing to emerge from the graphs is that the overall assessment of departmental performance (Fig. 12) is fully acceptable: the myth that the department is fraught with communication problems and steered by shaky leadership does not hold up. Rather, the indications are that any problem area will be on a more local level than across the whole department - and may well be associated with one or two individuals.

Referring to the graphs for specific issues, this view seems to be borne out in that the bulk of the scores occupy a band corresponding to fully acceptable whilst one or two individuals score very high or very low ratings. Significant in this is the fact that these high and low scores consistently emerge, indicating that they may have been rated as much on reputation as on actual performance.

Innovation, particularly in a central department like Process Development, requires a mixture of specialist and generalist skills, both in technical and in behavioural areas. The requirements for working closely with other departments - e.g. production trials and handover - require highly developed communication and interpersonal skills, together with co-operation and an ability to motivate others.

People who score highly in these areas might be expected to have a history of smooth innovation transfer relations with Production: initial interviews in Production departments appear to support this hypothesis. Equally, creative flair and innovative problem-solving may require more individual-oriented skills such as decisiveness and creativity; once again, the past history of those who score well in these areas suggests that their strong points lie in this aspect of the innovation process.

Effective use of resources can be achieved by deployment of people into roles which make best use of their skills- the above would seem to indicate that this truth holds as much for behavioural as for technical skills.

Another factor of great importance in an innovative department is a sense of group identity. Since the work being undertaken is varied, diffuse, and above all, uncertain, there will be a need for sympathetic and supporting behaviour on behalf of the group members. Apart from sustaining the self-confidence of the group in the face of risk and failure - always a consequence of innovation - there is the positive benefit derived from close informal relationships. This includes better communication, cross-fertilisation of ideas and the building up of mutual trust and confidence. Factors such as interpersonal skill and informal contribution can thus play a major role in maintaining an effective department and will indirectly affect other processes like communication and motivation.

Results (Figures 1 to 12)

Fig. (1)	Individual scores:	communication
" (2)	"	decisiveness
" (3)	"	motivating others
" (4)	"	self-motivation
" (5)	"	creativity and innovativeness
" (6)	"	task
" (7)	"	leadership
" (8)	"	interpersonal skills
" (9)	"	co-operation
" (10)	"	informal contribution
" (11)	"	delegation
" (12)	Performance of department as a whole	

Scale in all cases is as follows:

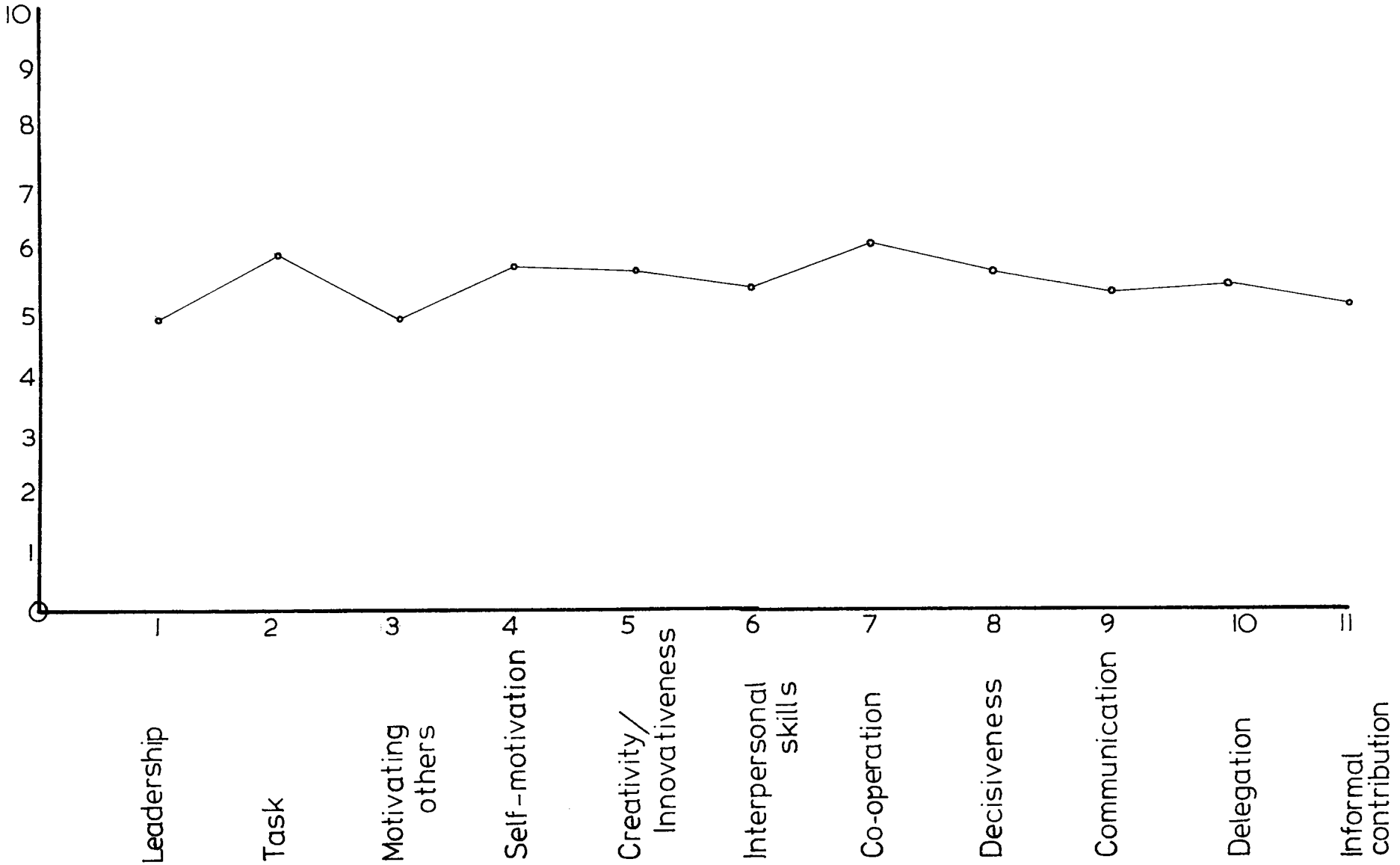
10+ 9-	Outstanding
8+ 7-	Superior
6+ 5-	Fully acceptable
4+ 3-	Incomplete
2+ 1-	Marginal

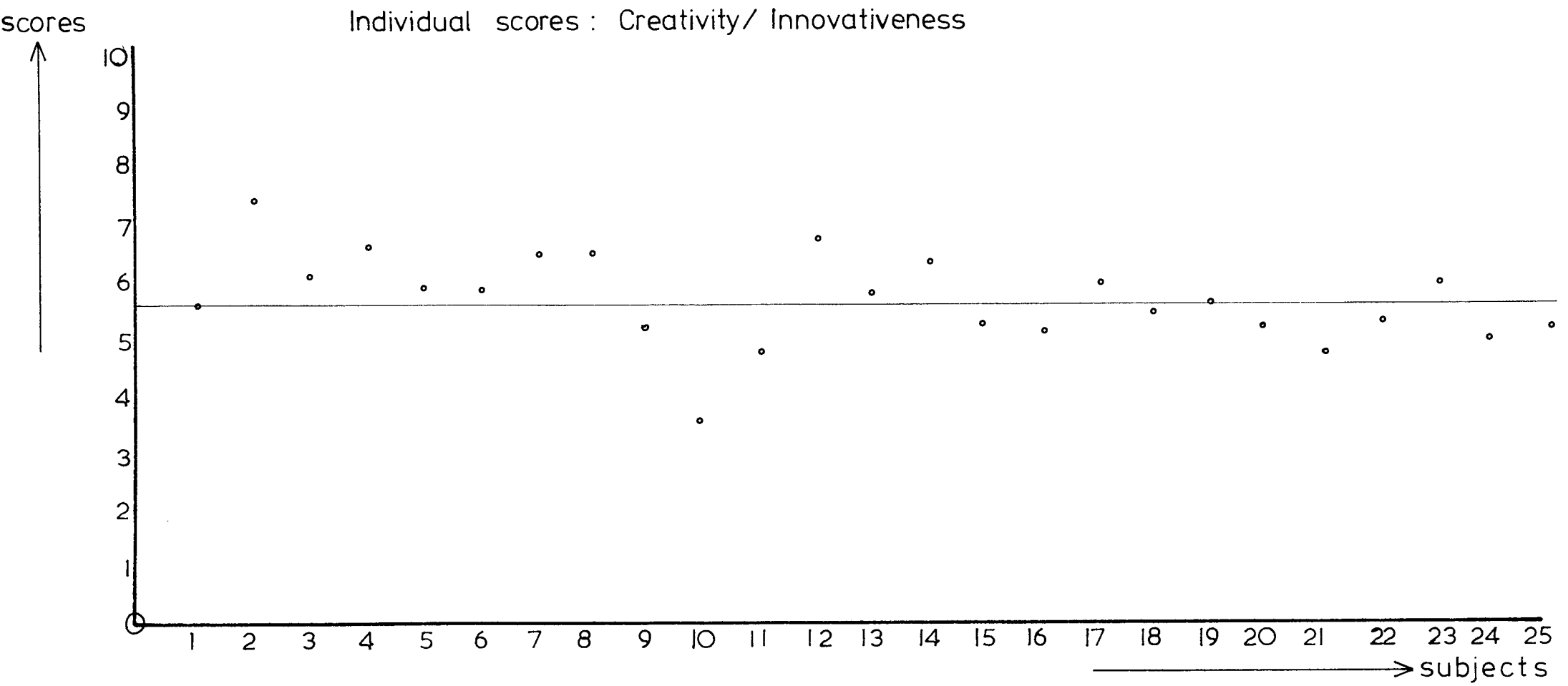
Notes:

(1) The subject numbers remain constant throughout to allow a comparison of individual performance over several issues.

(2) In some cases e.g. Fig. 11 an insufficient number (< 10) rated the subjects on this issue and thus no score is recorded.

Performance of department as a whole [average over 25 subjects]




Individual scores : Creativity/ Innovativeness
scores
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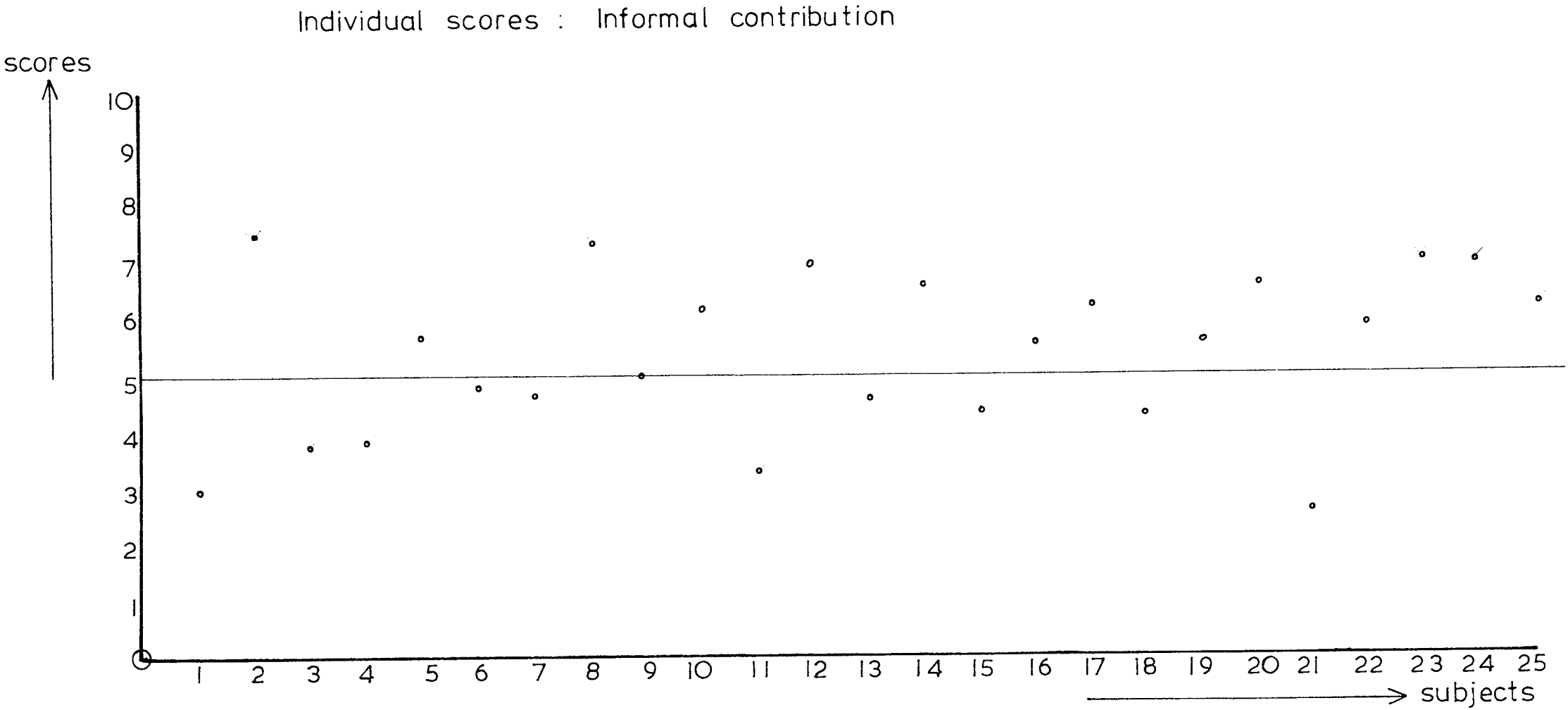
subjects


Individual scores : Informal contribution
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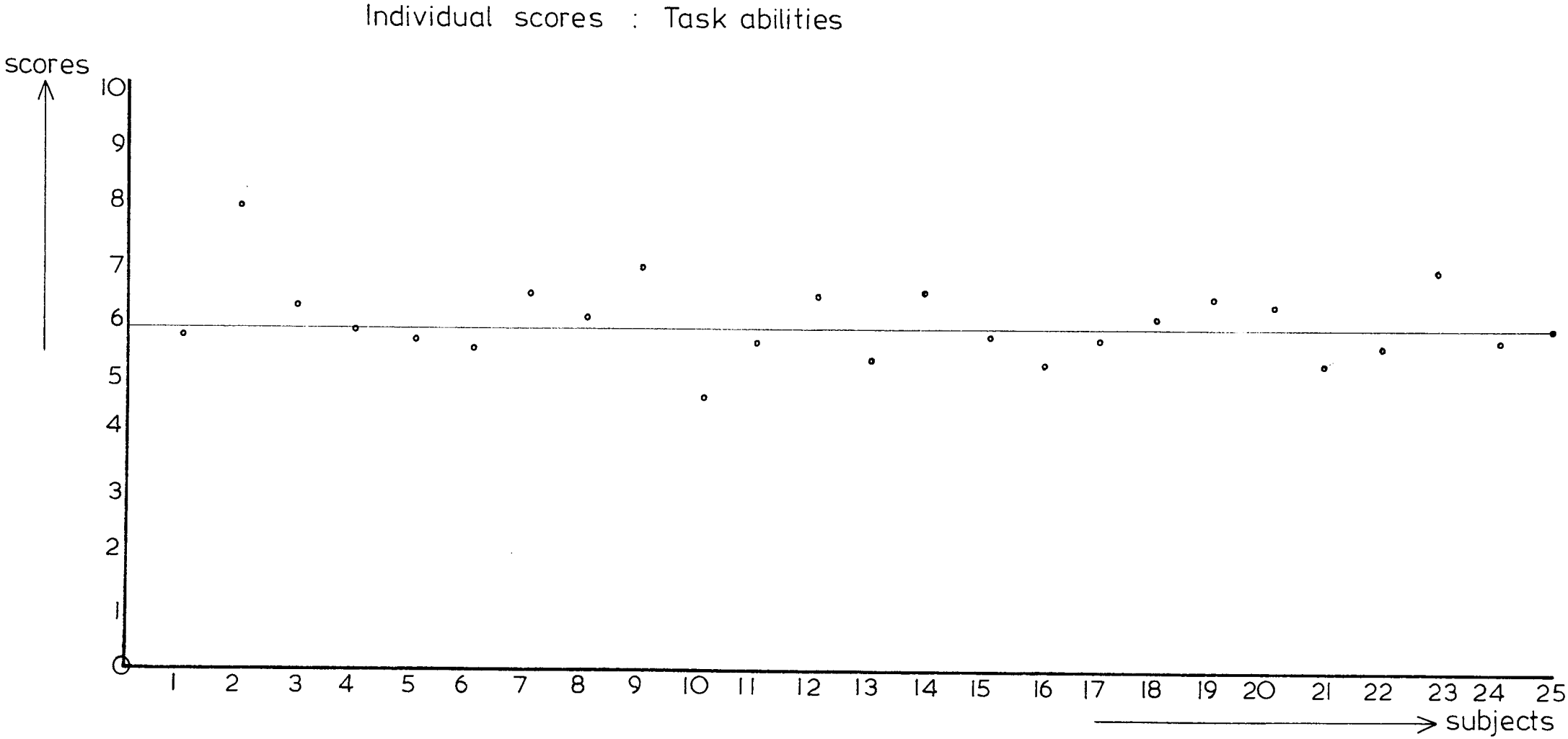
subjects


Individual scores : Task abilities
scores
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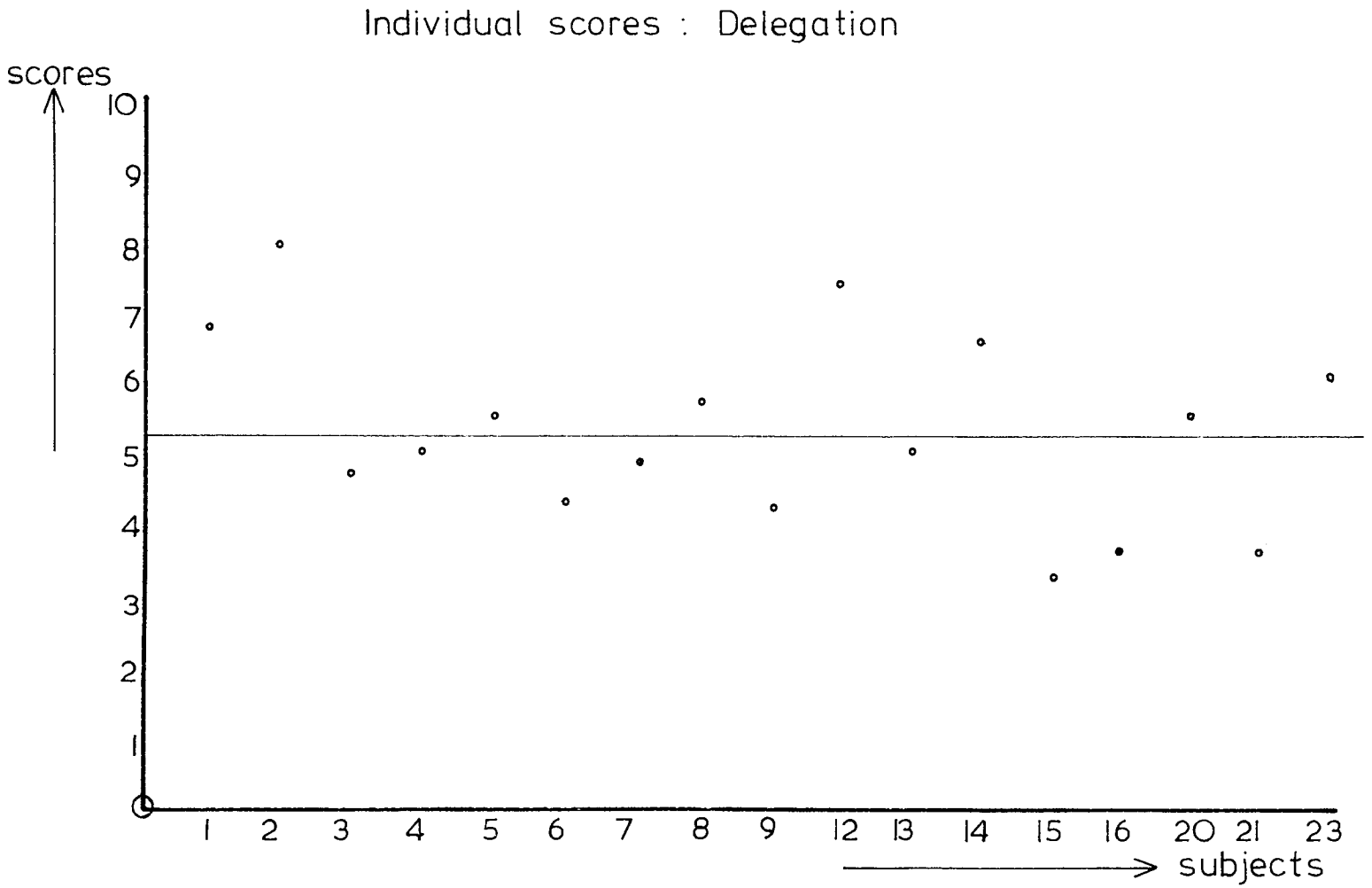
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
subjects


Individual scores : Delegation
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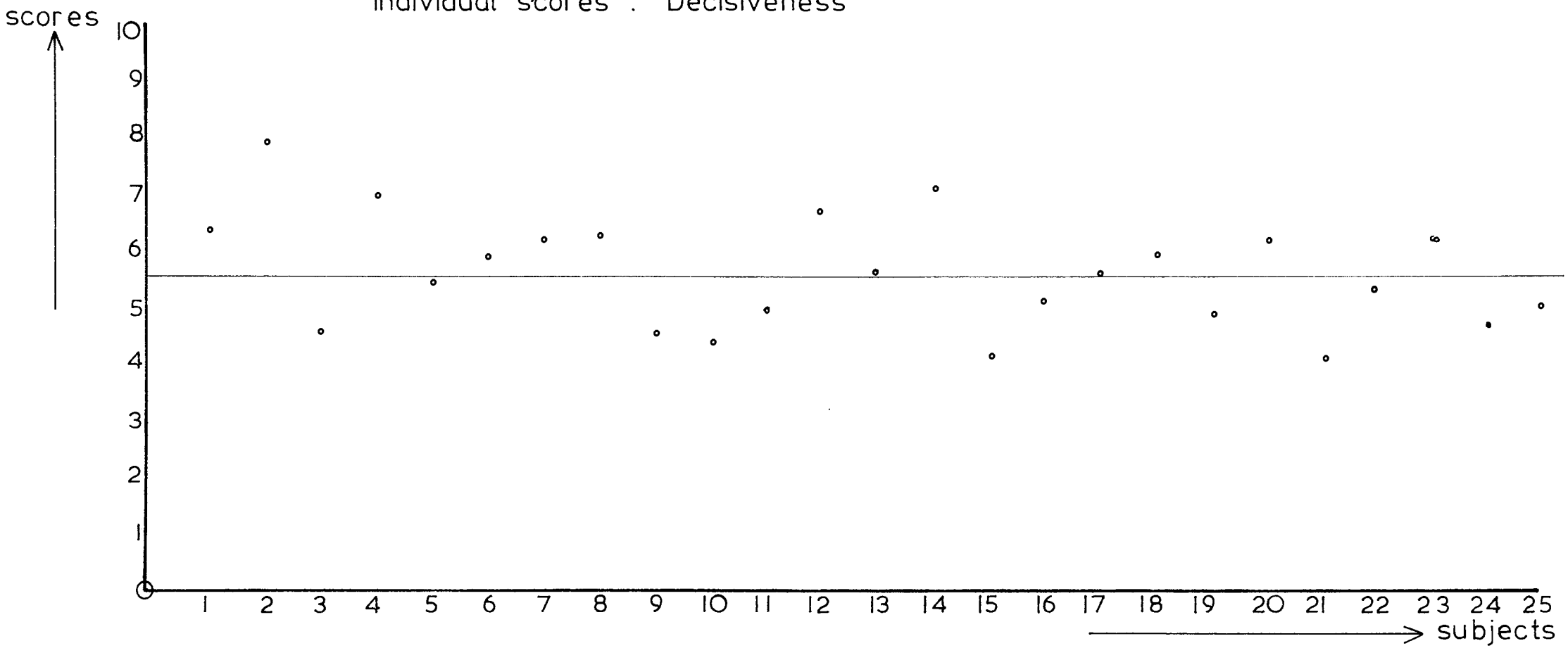
subjects


Individual scores : Decisiveness
scores
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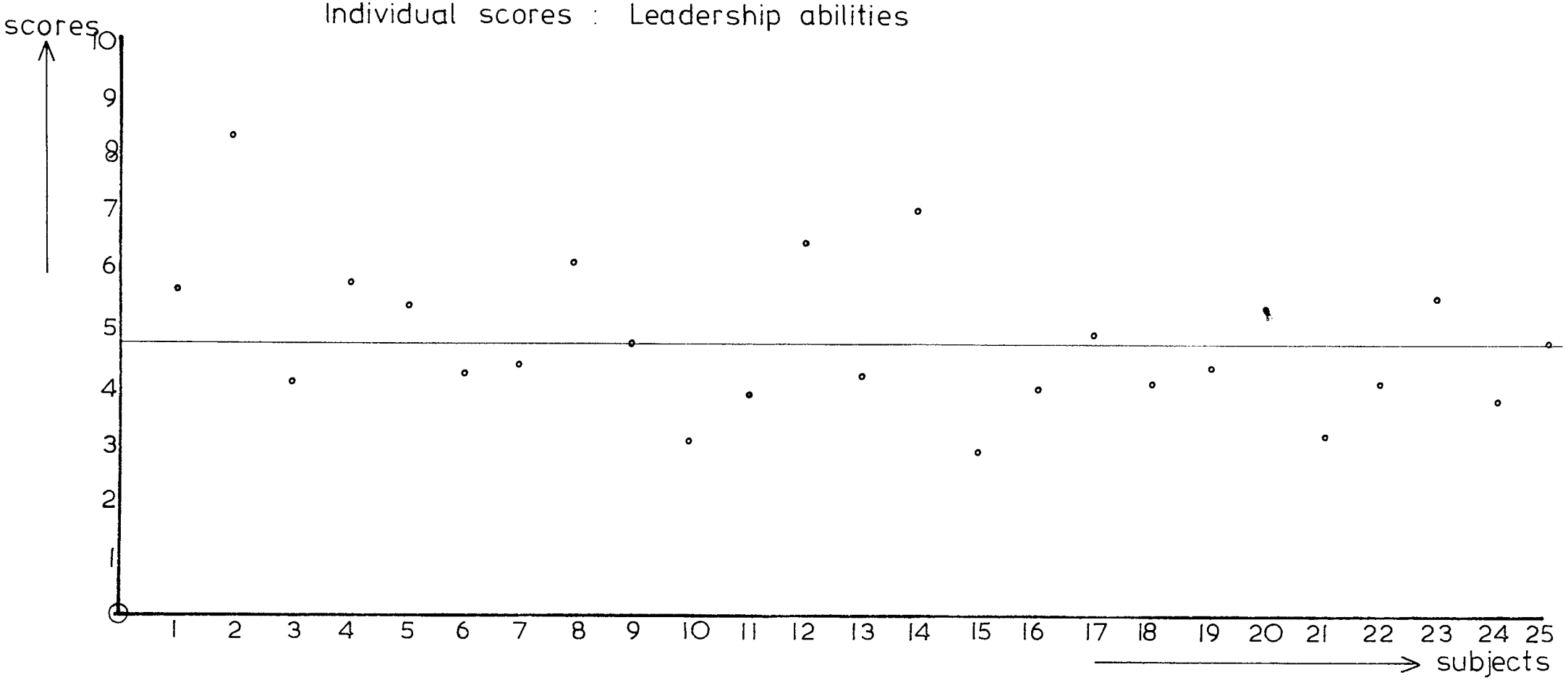
subjects


Individual scores : Leadership abilities
scores
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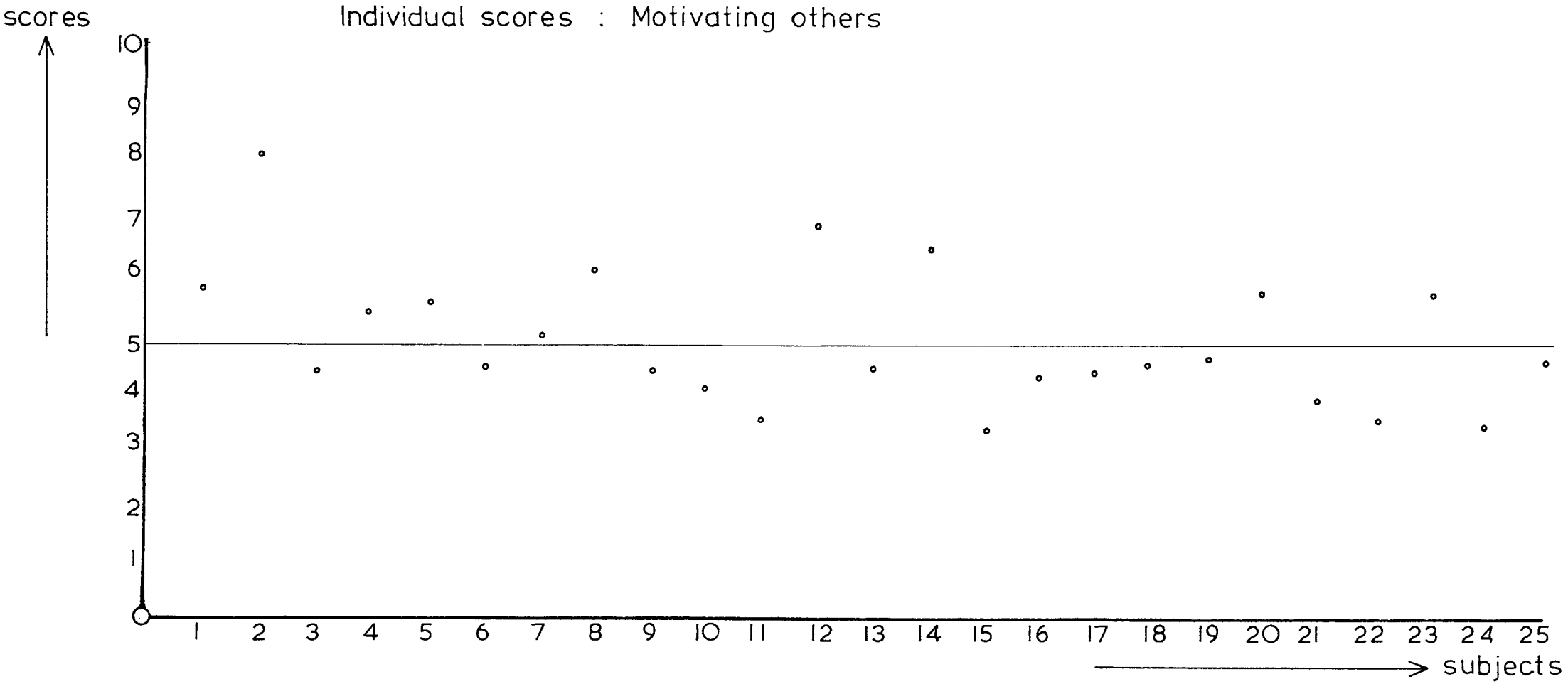
Individual scores : Motivating others
scores
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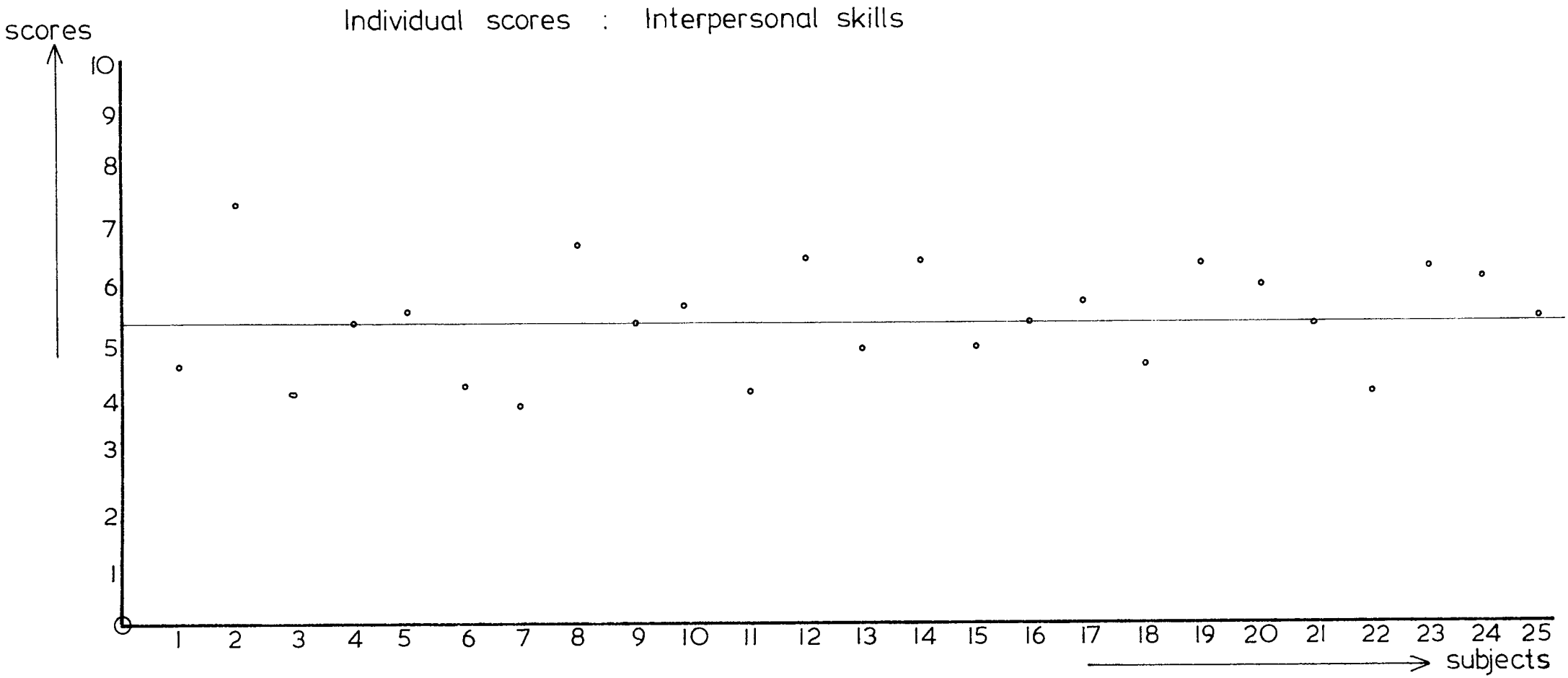
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
subjects


Individual scores : Interpersonal skills
scores
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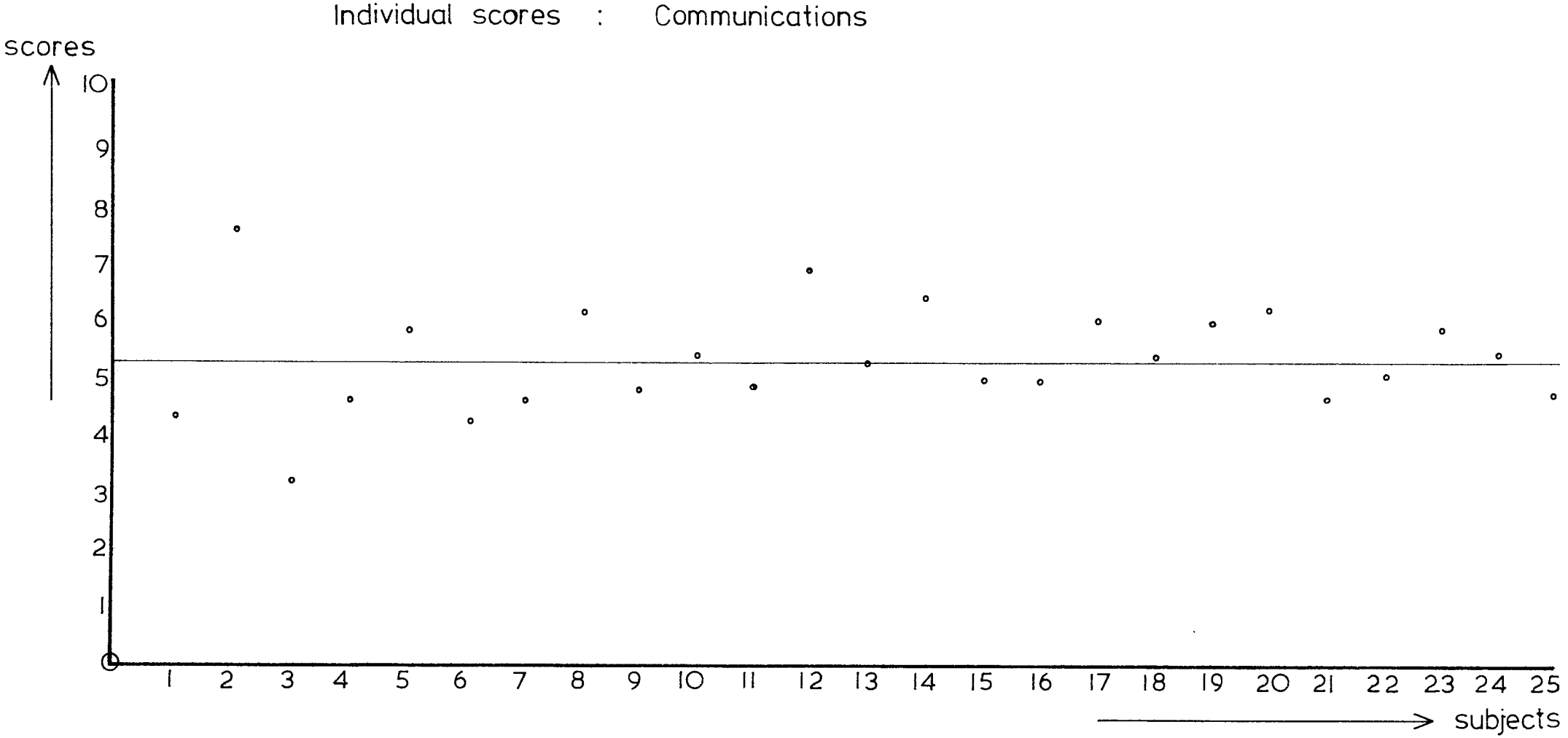
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
subjects


Individual scores : Communications
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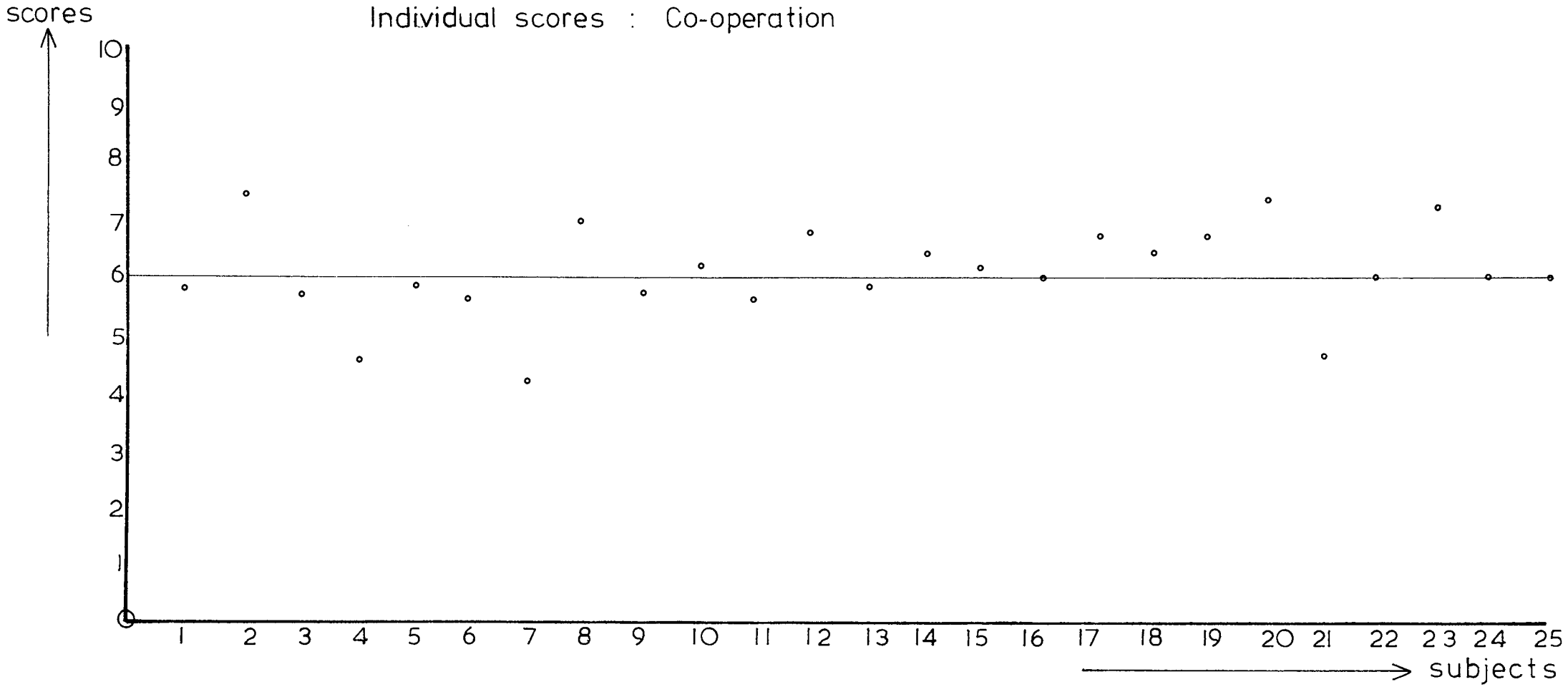
subjects


Individual scores : Co-operation
scores
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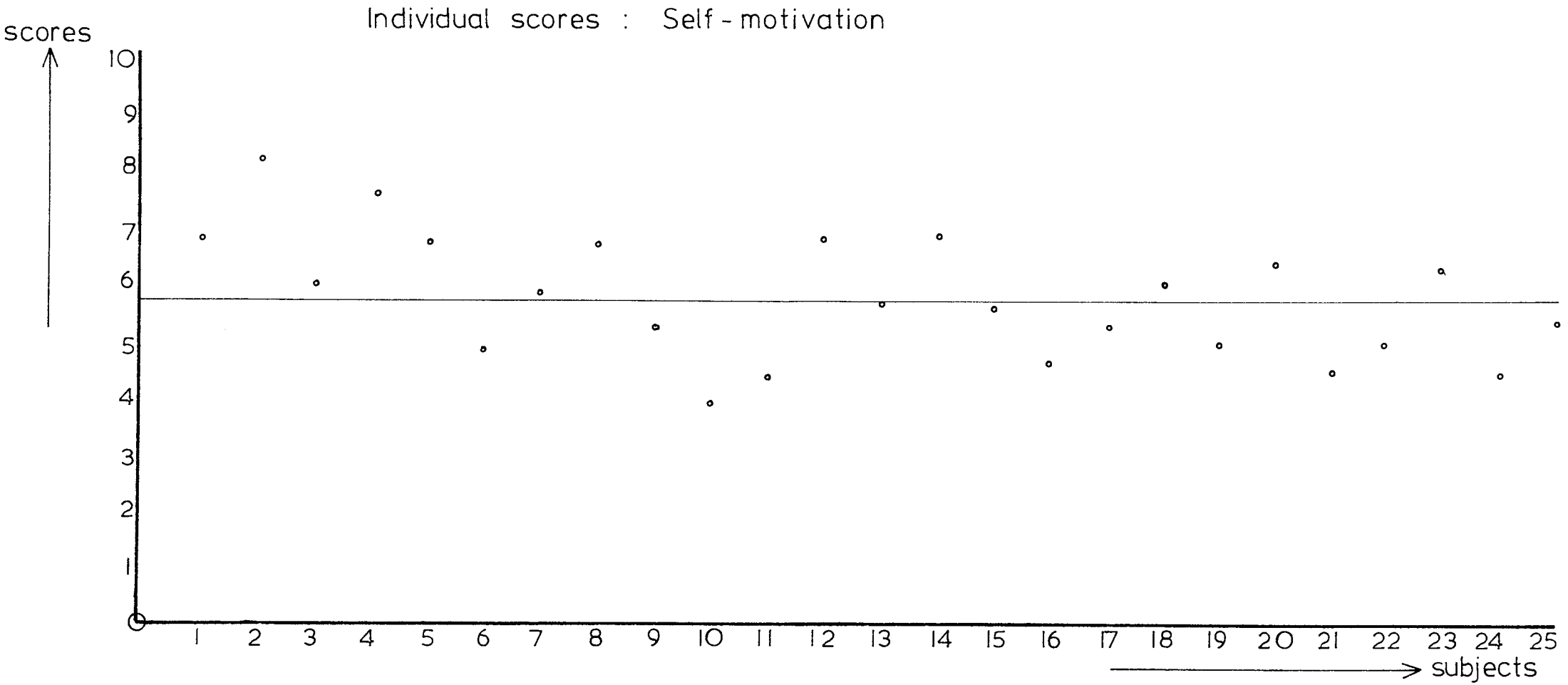
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
subjects


Individual scores : Self - motivation
scores
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1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
subjects

(Studies of other areas were carried out on the basis of their interfacial relationship with Process Development: thus the level of integration between groups became a central issue involving many of the above elements).

By this time, much of the research focus lay outside the department, examining interfaces with other functional groups and the senior management structure.

Research measures continued to be used within the department, notably on analysis of personal recollections of specific innovation projects (discussed later).

Exhibit 15 presents some examples of problem statements collected in the department. The range of these statements indicates the large number of sources for problems in the innovation process: this supports the contention that statistically-based generalisations are of little direct value in guiding the management of innovation.

EXHIBIT 15 : Problem Issues emerging within Process Development

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- split between azo group and remainder of department, in social interaction and in working relationships, co-operation, communication etc.

- 'conservative' management style of azo group leader compared to other section leaders.

- azo pigment manufacture an 'alchemists guild' needing years of experience to enter.

- attitudes in azo group too fixed - 'no, it can't be done' based on years of experience and successful problem-solving - lack of flexibility to try new things beyond experience - loss of inspired approach.

- need to 'pump out' information from the azo group - not readily communicated.

- generally insecure atmosphere in organisation, fears of redundancy and cutback.

- problems of dual location of company.

- 'too many chiefs' far too few senior management jobs.

- tendency for people to write reports etc. to justify themselves in the face of looming job insecurity.

- departmental manager an 'outsider'. Too hesitant about taking decisions, held in poor regard by senior site management. Appears to manage by default: lack of departmental respect for his ineffectual style means they get on despite him. Poor at relating down to junior staff - 'doesn't even know their names'. Tends to go for incremental innovation, won't take risks with speculative projects.

- 'on production trials the people you actually work with get involved and come up with some great ideas and improvised solutions - the real resistance is political and at the management level'.

- 'too many groups get involved in even a simple transfer'.

- 'managers never encourage - and people do value a pat on the head'.

- ' managers in this department treat me like a child, so I respond in that fashion - I'm only using a fraction of my capabilities here'.

- 'duplication of effort within the department - DM working as chemical engineer and CON/AH as chemists on same problems on continuous azo - with no consultation or communication'.

- 'Research never let us help - but they haven't a clue about scale-up - they're still looking for a 6,000 gallon beaker!'

- 'uncertainty and discontent following MC's leaving for a much getter job overseas - weakens the department and makes people dissatisfied'.

- 'problems with test laboratories'.

- 'teams don't work because more people are involved than are functionally necessary - politics means that minutes get 'doctored' - the real work is done by informal groups, but they lack authority'.

- 'groups don't get enough autonomy - they're always running to higher management for authority to do anything and this brings in the political aspect'.

- 'personality problems in groups'.

- 'lack of any real exchange of ideas - it's all politicking on project teams'.

- 'nobody listens - if you don't get your point on the minutes, you might just as well have kept your mouth shut!'.

- 'good projects reduced to mediocre ones because of lack of finance'.

- 'problems of delay in new product development due to queuing difficulties - getting on the plant, getting material tested etc. in competition with other products'.

- 'communication problems with Research - lack of co-operation above chemist level - 'editing' and rewriting of joint reports after joint meetings. Belief that this represents another manifestation of 'empire building' by senior management'.

- 'duplication of effort between Research and Process Development'.

- 'azo group are like an information vortex, sucking everything in but giving nothing out'.

- 'low standards and availability of maintenance'.

- 'insufficient resources, especially people, to perform departmental tasks'.

- 'total lack of risk-taking or adventurous spirit in climate of organisation - if they could bottle this atmosphere, it would knock Horlicks right off the market!'

- 'site values, particularly amongst the 'old guard' judge on performance, toughness and uncompromising behaviour - no room for shades of grey, but dominant need is for flexibility'.

- 'Research and Process Development live by novelty, Production by doing the same thing - and never the twain shall meet is the attitude'.

- 'what we need is for Harold Wilson to join us now he's out of a job - because we desperately need a good politician to fight back for us!'

- 'when you talk about a continuous plant everyone thinks it's a great idea - but not for the Paisley site! They're paralysed in their conservatism and commitment to existing technology - 'how we've always done it''.

- ' the organisation is stagnant - there's no opportunity to move around'.

- 'departmental manager is afraid of his boss!'

- 'lack of career development opportunities - 'it's not just money that makes people dissatisfied'.

- 'attrition of idea content as it passes along the 'committee' line - too many people involved in the carriage process'.

- 'too much corporate decision-making - no individuals prepared to take responsibility'.

- 'no credit passes down line but recriminations are'.

- 'departmental manager seen as insecure. Also seen as prejudiced against certain individuals, notably those whose values conflict with his own. Favours engineers over chemists. Believes in 'time-serving'.'

- 'positional anomalies e.g. research associate or acting section leader? - ambiguous definition of roles - lack of management skills at manager level due to wrong criteria used in promotion'.

- 'external pressure to absorb Process Development into Research'.

- 'lack of consultation on project teams; 'territorial rights' and personal influence determine activity - 'blocking' by senior members - whole less than sum of parts'.

- 'organisation is a follower, not an innovator - this shapes people's minds into a conservative standpoint'.

- 'communications within department poor - informal channels only source available - formal channels often fail completely'.

- 'mistrust of others - playing close to the chest for fear of having ideas poached'.

- 'pride' factor - too much concern with personal/group reputation to refer a problem back to an expert - would rather attempt a solution based on inexperience'.

- 'old guard' values on the site, laying emphasis on 'hygiene' factors - mechanistic traditions, do it by the book.

- 'frustration at cancellation of polycyclics project.'

- 'lack of clear definition of company and (particularly) divisional objectives'.

- 'Process Development blamed for slowing down the progess of new products despite the facts - seen as the 'scapegoat department'.

- 'lack of motivation - and no way of changing this via financial incentives'.

- 'problem of 'trying to sell chemical engineering in a chemistry works' - a losing battle'.

- unionisation conflicts, at personal and at policy/negotiating level, with emergence of staff unions.

- dissatisfaction with staffing structure.

- cynicism of external agencies (e.g. Production personnel) about role or contribution of Process Development.

- skill interface conflicts (chemists vs chemical engineers).

- production resistance to change.

- personal demotivation and frustration at project cancellation.

- problems of lack of sophistication (e.g. instrumentation) possible on production plant - limits innovation to foolproof ideas - 'they just don't care'.

- 'Process Development 'stuck in the middle', between Research blaming them for messing up their sophisticated product and Production blaming them for too complex a new product/process'.

- management failure to support staff.

- 'management out of touch with operational world of pigment development, therefore poor representaiton of the department at external meetings. Poor communication back as well.

- section leader too finicky and precise - a fault on production trials'.

- 'pinch-penny' attitude, skimping and axing projects just to show good budget figures'.

- section leader problems - dissatisfaction of graduates, non-communication and filtering - 'playing it close to his chest'.

- project teams - 'do they help integration or just create more problems?'.

- 'communication problems up and down to high level policy meetings (Meeting 3) and co-ordination meetings (T.C.G.) - misrepresentation problems, have to go through the line though line manager may be aware of operational situation'.

- 'Berlin wall' between Research and Process Development - due to time scales, rates of operation, location differences etc.'

Dominant themes appear to centre around integration of various kinds. At an individual level these are associated with issues of motivation, alienation, conflict of views on strategy, values, beliefs, attitudes etc. Within groups there are leadership and personal style conflicts, skill problems etc. Between groups come problems of different orientations, languages, political affiliations etc.

Other issues centred on driving forces for innovation - resources, ideas, product champions, influence promoters, etc.

The implications of these will be discussed in the following chapter.

(ii) Case Histories of Specific Innovations

During the research a number of interviews were conducted with members of Process Development to collect individual recollections of the salient features of any innovative projects which they had been associated with. This represented critical incident data, but it was hoped that memories would not be restricted to major innovations only. As it turned out, in many cases people used files and other records to refresh their memories; further, the general activities of the group over time involved a large number of incremental changes rather than discretely identifiable radical changes. So it was possible to collect a fairly representative picture of the problem issues which cropped up in the innovation process over the preceding few years. Further, by referring to the T.C.G./Meeting 3 correspondence on the fate of new products it was possible in some cases to compare experiences and viewpoints at different levels.

(The cases reported here are paraphrased from the original interviews: as such they are essentially personal accounts rather than the 'official' story).

Case number (i)

This product was a new metal complex pigment and needs to be seen first of all in a historical context. Metal complexes were one of the few (some say the only) contributions made by the research group working on toally new chemical approaches in line with the long term research strategy. The first product, a yellow was received with scepticism at first but gradually accepted on the site. On the market place it became one of the leading products, particularly since its properties made it attractive to the automobile industry as a paint finish. The ultimate success of this product was to some extent a vindication of the much-debated research strategy; however it began to appear as if this were a flash in the pan since further products on the range were not forthcoming. The degree of production interest in the possibilities of such a range can be seen from the fact that a new plant was set aside for their manufacture.

The new chemistry group working on developing this range had progressed several potential products through the early stages of the phase system as far as phase three. One such product was a red, the subject of this case history.

In November 1973 an aqueous process for making this molecule was handed over to Process Development; their only previous involvement with this project had been in helping to solve some raw material handling difficulties in phase three.

December 1973 saw this product handed back to Research and phase three because of inferior overspray fastness due to oxidation over time of one of the components.

In March 1974 a new process was handed over with the oxidation 'cured' by the addition of massive quantities of a suitable agent. The Process Development chemist involved was unhappy with it because the new addition produced sulphur dioxide in large quantities during the process, thus making working conditions very difficult. More important was the lengthy process time involved (12-13 hours, including 8 hours of SO_2 evolution). However the department were 'saddled with it' and work went forward to try and develop the process (Route A).

A number of routes were investigated, especially looking at the possible use of antioxidants and pH stabilisers, but these proved unsuccessful. Eventually a viable route was worked out (Route B) but in discussion with the Research people involved, they maintained that they had already tried these other routes and that they did not work.

The consequence of this was that the Process Development Chemist kept up investigations on two routes - one handed over from Research and one which he maintained was a more viable route.

In October 1974, the Research product underwent pilot plant trials and was found to be provisionally acceptable to a phase four standard; samples were sent for lightfastness tests in Florida and Arizona. (These tests are very important for paint finishes, but in order to test products adequately, they are exposed for long periods of time - in this case a year). At the same time the alternative route product had been submitted for evaluation to Manchester; whilst the results were not especially significant, a sample of this product was also sent for testing in the U.S.A.

March 1975 saw Process Development prepared to carry the Research product into production when the lightfastness results came back. All samples had failed due to severe darkening. The Research product consequently lost its phase four standard. A joint Research/Process Development team was set up to try and find out what had caused the failure but they were hampered by the fact that they no longer had a sample of the phase three accepted material. Thus they had first to make a new batch for comparison.

This was made and found to be colouristically dissimilar, and with inferior lightfastness. Ultimately the fault was traced to poor quality of one of the starting raw materials purchased from outside the company.

Meanwhile, Applications had been asked to keep abreast of the lightfastness test results still coming in from the States. This information was circulated to Research but not to Process Development. When the departmental manager asked, he was told that the tests had not been done. However the Process Development chemist found out that this was untrue via informal channels and a major row ensued which led to Process Development receiving a verbal report.

In mid 1976 it was decided that the project needed rationalisation. The view expressed was that the most likely route lay in the research product which was in phase four. Rumour has it that a memo on file somewhere has the Research Director saying that the route B product had 'caused more trouble than it was worth'. The provisional decision was to continue with a different version of the route A (Research) product.

However, by this time Basle had seen samples of the route B product and 'recognised outstanding colouristic performance, overcoming many of the route A difficulties (like gloss shade transparency).

The UK were not keen on processing this product for a variety of reasons, e.g. Research and Applications because of their commitment to the route A product. As one chemist put it 'no one wanted to espouse the route B product but everyone wanted its properties'.

By May 1976, the route B product was given a Phase 2 standard. The samples came back from Florida weathering tests and both A and B route products passed easily. The route B product was now officially backed by all concerned.

However, phase three development of the product, carried out by Process Development and Research involved much friction between the two groups. An example reported was the issuing of 'joint' reports by Research which had not been prepared in consultation with Process Development.

It was decided to jump straight from phase 3 stage to full-scale plant: however a 'long and arduous battle' was still to be fought with the Industrial Chemicals Division on the issue of raw material manufacture. Outside suppliers were also tried. Eventually a phase 3 standard was obtained based on pilot plant batches made with Industrial Chemicals Division material reprocessed on site.

March 1977 saw a series of five full-scale plant trials which the researcher participated in. Two of these were unsuccessful due to failure to anticipate scale-up problems (stirring etc.) but the other three were fine.

July 1977 saw a further 800 kg. of the material made and tested.

In analysing the history of the product, comment was made about the problems of working with Research: the point at which their involvement finished (May 1976) left a lot of bad feeling. Applications were also a problem: however the product was now in the hands of a product executive who had smoothed some of the problems out.

The judgement of senior management was criticised for having failed to evaluate the product honestly: their commitment to other routes led to the route B one being held back in the phase system, starved of resources and generally lacking support - 'it was always in the shadow of other product routes'.

A further problem to be debated is the rigidity of the phase system for progressing new products.

Process Development ought to initiate alternative processes at phase 3 level, but there are objections (e.g. from Basle) to their missing out the early stages. The present state of affairs creates anomalies like robust pilot plant batches ready for production trials but still only having official phase 2 standards. It was felt that there was a general lack of understanding by the chemists as to just how the system should be applied.

A further problem was the suggestion that Research produced so little at phase 3 that it became necessary for Process Development to initiate new products: this often led to duplication of effort between the two groups. The chemist's attitude in Process Development was to say 'if we shouldn't be doing this, what should we be doing?': they felt that they were far more realistic in their approach to innovation than Research.

Case (ii)

This was a yellow pigment for decorative paints, designed by Research to replace an earlier product with improved flow and heat stability.

In August 1973 Research handed over a process with the condition that in phase 4 the dispersibility be improved: this was in compliance with an Applications request.

Process Development carried out extensive laboratory work to investigate parameters involved and found some small process changes which slightly improved dispersibility.

Several batches were made in the pilot plant but problems once again arose because Applications ran out of phase 3 standard to test them against. Eventually they were tested against a revised standard.

Plant trials of this product were a total failure: it would not disperse at all. The problem was taken back to the laboratories: a nine month wait for plant availability followed. Eventually 3 batches were made at full-scale and were all passed as OK at phase 4 standard.

Another delay of 6 months preceded the proposed handover session with Production, again due to plant availability problems. The batches made failed to measure up to phase 4 standard but it was later found that the test method had been changed and was now more rigorous.

The product went back to the laboratories and work on heat stability parameters was carried out: eventually the problem was solved but it was apparent that these parameters affected dispersibility. The final product would have to represent a compromise of some kind.

Plant trials still gave poor dispersibility but laboratory work indicated that a slight change in the paint formulation used could achieve a very stable and dispersible product. This approach was rejected by Applications because they wouldn't accept the goalposts being changed.

A series of 21 plant batches were made and the Paisley testing group rejected three quarters of them. Manchester testing however accepted them with some phase 4 reservations: this illustrates some of the problems of two testing groups, one on and one off-site.

Eventual handover to production was successful and the product is currently being made to a high standard. The only problem is that the process itself is very sensitive and needs more care than it necessarily gets under normal production conditions.

In general liaison, including follow-up work by Process Development, with Production was felt to be good on this product.

Case (iii)

This was a development project based on the yellow metal complex pigment invented in Research by the new chemistry group. Process Development were involved around 1970 with Research - at this time there was no formal handover system.

Research made use of raw materials which were available on site and developed a suitable laboratory process. Scale-up was carried out using a training plant in the azo block: 25 Kg. size batches were made, tested and problems overcome. (Again, this was before pilot plant facilities were available). By the end of 1971 they had a viable process and a good product.

However by the time Process Development took it over, there were no raw materials available, so the first task was to scrub out a suitable plant and manufacture large batches of intermediate, followed by pigment manufacture. There was considerable pressure on them to do this quickly since samples of the product had to be sent for weathering tests which would take 12 months: the market was already waiting for the product.

As the product batches were made quickly, the raw materials testing was carried out simultaneously instead of prior to manufacture. When the product test results came back, the batches were all failed for major colouristic faults. Once again a post-mortem was carried out in conjunction with Research - 'everyone was getting angry and desperate and arguing about whose fault it was'. The problem had to lie with the raw materials but no chemical difference had shown up in analysis. Eventually Process Development tried a shot in the dark - on the assumption that the old materials had lain around the site for about six years, it was possible that extensive oxidation had taken place. A new process, involving oxidation was tried and it worked very effectively.

In August 1972 full scale trials on production plant made 16 out of 17 acceptable batches. September and October were spent in continuous shifts making intermediate and pigment for stock. In november, Production grinds of all the material made since the start of the project were made, and the resulting blended material was acceptable.

In 1973 it was decided to build a special metal complex plant to accommodate the process. This was modelled on the azo plant already used and incorporated a small grinding unit: the intention was to model as closely as possible the successful conditions of the 1972 work.

This plant was commissioned in July 1973, and became a full Production unit in February 1974: it continues to work very effectively.

In commenting on the project, criticism was made of the Industrial Chemicals Division and the problems in the early days of getting suitable raw materials made: this situation has apparently improved considerably since 1973.

Production were apparently unco-operative in that they refused to take over until everything was sorted out. Research had made difficulties by using old materials and by putting a process which they didn't fully understand onto the plant. The significance of the product was apparent since it was felt by some to be the first commercially successful one to come out of Research - they might have been guilty of 'overselling' it before it was fully ready.

Case (iv)

This product was developed in Research to phase 3 standard, as required by the transfer system. It was handed over to Process Development who carried out laboratory work, identified some process controls and began pilot plant trials.

Out of the four batches in the run, only one was acceptable; further laboratory work failed to identify reasons for this. A second pilot plant run was more successful and the batches achieved a phase 4 standard. (One possible reason for the failure may have been errors on the part of the technician supervising the manufacture in the first batches).

Production batches were the next step but these were unsuccessful: the product had poor gloss properties and, more importantly from a process point of view, tended to compact on pressing giving rise to 'concrete slabs'.

The latter difficulties were resolved but the gloss problem persisted: finally, after some six months work a solution was found and tried out on the pilot plant. These batches were not tested for heat stability.

When the next round of production batches were made, they failed on heat stability. A further period of laboratory and pilot plant work solved this problem and the product was taken back for production scale trials. Different plants were used, successfully in all cases: this demonstrated the robust nature of the process.

Some minor problems emerged in the colouristics and the production control laboratory worked on them. They claimed to have produced a modification, but because of the lack of contact with Process Development, they ignored the early work that had been done. The consequence was that they produced 'concrete slabs' on pressing - this material was useless because it could not be ground. When challenged they apparently said that they thought Process Development were 'just being finicky' in specifying a lower press volume - an apt illustration of the differing attitudes involved.

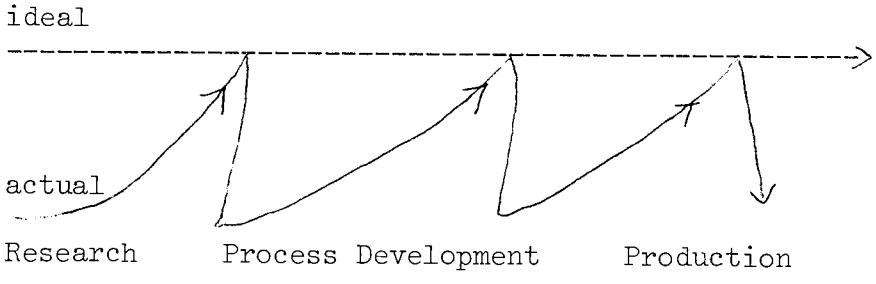
Resolution of the actual technological difficulties was not the end of the story however. Meeting 3 decided that this product was no longer required because of the emergence on the market of a superior competition product. The timing of this decision left a lot to be desired since the product was advanced far enough for production to be involved in launch stock preparation.

Feeling was that launch stock manufacture could have been completed, but there were undeniably too many products in the range at this time. Consequently the project was 'deactivated in phase 5' - shelved - and exists now as having been handed over to and accepted by Production.

Commentary on the project suggests that Research weren't very helpful: the chemist involved left and the Technical Project Report (the major information source) was delayed. This meant that information flowing between the two departments was severely limited.

Process Development's mistakes included failure to test a principal variable after major process changes in scale-up. Production adopted a somewhat cavalier attitude and created more problems by not taking advantage of the Process Development experience.

Overall the project suffered delays which might have been avoided or minimised: there was a distinct lack of co-ordinated effort. Instead of a fluid motion through the phase system, it was essentially a staggered, stagewise operation, i.e.



Case (v)

This was a red product developed in response to a request from Basle (1975) for a product for the publication gravure ink market. Specifically, the UK market requirement was for a different shade so that there was no existing product on the range which would suit the European market.

Basle attempted to market the developed product in Europe and it was acceptable as far as shade was concerned. However dispersibility problems and batch-to-batch variations made in unacceptable as it stood.

Thus the UK Company were faced with the options of two products - one with correct shade but poor dispersibility, the other with the wrong shade but excellent dispersibility. Product Management thought that a quick solution might be possible with some combination or modification of these. The order went to Process Development to get a product in Production by September, 1976 - i.e. within 9 monthss.

Both possible products were worked on by different groups: however, whilst they enhanced the existing properties of the basis products they could not achieve the extra property required. Work was also held up by variations in the test methods used - there appeared to be a lack of co-ordination about what to test and how to test it. This led to the use of three distinct methods during the course of the work.

Eventually one product began to show promise, on laboratory scale: however every time it went to the pilot plant it failed. Finally a new laboratory process was identified which produced a suitable product by use of a resin and additive treatment. July 1976 saw this developed as a consistent laboratory process.

Pilot plant trials in August 1976 made five batches whose colouristics were acceptable but whose dispersibility varied. It appeared that this depended upon a whole range of factors, many of them tied up with the tester and the test method used. The feeling at this point was of being on the verge of a good product but confused by slight problems.

As one chemist put it,'if the pilot plant run had given consistent results we would have made the September target'. As it was, the formal decision was that the shot had failed due to faulty instrumentation in the pilot plant, and to other causes.

In October 1976, two more pilot plant batches were made after the instrumentation had been improved - they were acceptable colouristically and almost acceptable on dispersibility. Investigation conducted with the dispersion laboratories aimed at optimising the testing revealed that the product was potentially very dispersible. The problem was that it was very sensitive to testing under certain conditions.

However, in December 1976 when it appeared that the product was viable, Meeting 3 suspended any further work. This was implementing a major strategic decision to get out of the gravure market (which caused many problems, discussed later). Samples at Wythenshawe were given a phase 3 standard and the project was shelved. Opinion has it that it could be a phase 4 and 5 product in a very short space of time. Further, the phase 3 properties could be enhanced by a study of the drying and grinding conditions involved.

Consequently most people felt it was very disappointing to have missed the boat by so little: 2 months over on a nine month deadline was felt to be an achievement to be proud of. Instead the project was shelved.

Case (vi)

This was a major innovation project connected with the phthalocyanine plant: essentially radical and process orientated. The intention was to provide a milling and finishing extension to one of the existing phthalocyanine plants.

The major innovation involved was a shift from batch to continuous operation. Existing plant facilities had six mills connected to finishing lines on a batch basis: the intention was to increase capacity by 4 more mills but to utilise continuous technology.

Much as with the continuous azo work, a large number of discrete projects could be brought together into this plant - for example, continuous solvent treatment, acidification, filtration and drying. In many ways the key to this project was experience in expanding technology and much could be usefully applied in the azo area, to other pigment operations and potentially to other divisions.

Process Development had been extensively involved in work in various aspects of continuous technology: the major issue in the project was the problem of continuous solvent treatment. Various options were investigated and eventually a process involving multistage mixing at high pressures was chosen.

The basis of this design was that higher temperatures gave shorter residence times and thus conveniently sized vessels for the plant. A pilot rig was set up in one of the production units directly linked to an operational mill. Trials were carried out and a number of details worked out e.g. the heat exchanger design and the introduction of continuous evaporation technology to remove solvent.

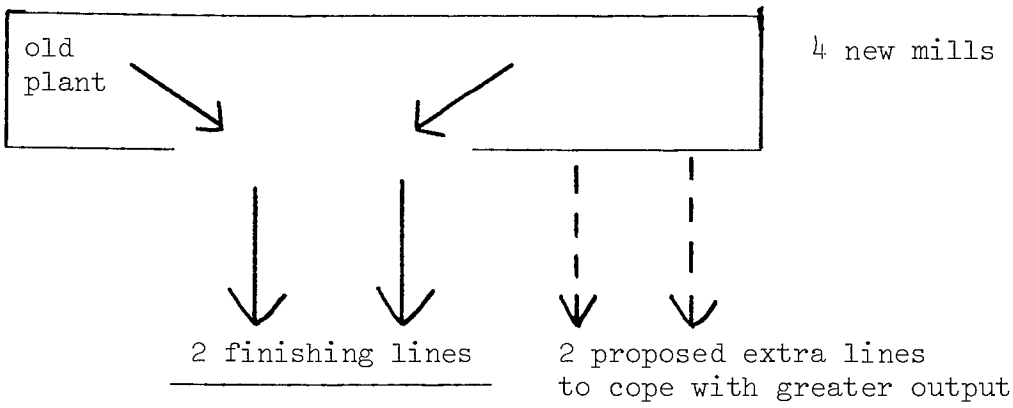
The basic plan was to design a process around a specific product which was the top seller in the phthalocyanine range. Other product options could then be tried and integrated into the plant. Importantly, the major product was salt-milled under normal circumstances. (Salt milling was also investigated, and new technology also existed for the milling under low salt or salt-free conditions which increased the pigment in a given mill batch and increased output as a consequence).

The possibility of introducing salt-free milling was considered in the design of the proposed plant. If output were increased in line with the above principle, then the finishing lines would lack the capacity to handle the new output: accordingly the proposed plant also included options for new finishing lines. Thus the proposed plant extension was:

The plant was dismantled to check on any problems but again these were only minor. However, when it was put back together and water tested under pressure, one of the engineers noticed weeping around the multi-compartment mixer. This turned out to be a classic case of stress corrosion and led to a major rethink about materials of construction. Costs were increased as a result of using more expensive alloys and replacing more frequently: these increases were added to design changes in other elements such as the substitution of scraped surface for plate heat exchangers.

A detailed project report was submitted in October 1972 aimed at getting investment approval from Basle. This decision was finally taken and the project economic evaluation approved around May 1973: it was now on its way through the system.

Work was carried out throughout 1973 by several groups, principally Process Development. The progress report in October 1973 said that commissioning was scheduled for July 1975, and that the acquisition of items was so far going well. The costs had risen slightly from £1.3m in May to £1.4m. Similarly the February 1974 progress meeting reported everything going smoothly: however later in 1974 major changes took place which jeopardised the whole project.



Thus it can be seen that this was an extremely ambitious and far-sighted project aimed at radically changing major technological elements.

In 1972 a project team was set up involving representatives from:

Product Management

Central Engineering

Production

Process Development

By May 1972, things were moving very fast and a sustained continuous run over a whole week did much to boost confidence. In particular, people's fears about operating conditions (60 psi, 130°C) were eased by this. Product manufactured was of an excellent quality and had a very good α to β form conversion ratio: everyone was pleased.

These centred around four key issues:

(i) Change in overall economic climate - investment clampdown.

(ii) Flixborough.

(iii) Development of salt-free milling.

(iv) Appointment of new Chief Engineer.

In the first case, the poor overall economic climate led to a major recession and investment restriction as discussed in an earlier chapter. The major problem associated with this was that most of the equipment had already been purchased and was in store.

The safety issue was of particular significance since it polarised opinions. In the wake of Flixborough, there was great concern about processes using solvents under high pressure and at high temperatures. As one engineer put it, 'Paisley might have gone ahead based on their experience of operating this plant, but there was panic in the air'. Basle and the new Chief Engineer were unhappy about it and the solvent treatment process was abandoned because it was felt to be too risky.

The cancellation led to the setting up of a team to examine alternative solvent treatment options - noticeably involving only one member of the original team. This team reported in June 1975: their main recommendations were for an atmospheric pressure process operating at 80°C. Other alternative routes including replacement of the solvent by a less volatile one were also advanced: some of these are currently bearing fruit as innovations in their own right.

The work was shifted from the production unit to the new pilot plant in 1976: by August tests were started on an atmospheric pressure process. By December 1976, most of the process had been shown to be viable for solvent treatment.

However, the development of other options - particularly an emulsion process - had led to the availability of suitable alternative technology and current proposals are for mixing the two options, one on each finishing line. In particular the emulsion route is safer and offers more flexibility in terms of the pigments which can be handled.

In October 1976 Basle gave the go-ahead for restarting the investment programme in this direction. The current date estimated for commissioning is August 1978 - i.e. three years from the original July 1975 date.

Analysis with hindsight by those involved suggests that the Chief Engineer was in a key position at the time the decision was taken. Although he arrived at a critical time, the decision appears to have been taken on safety grounds. However, as several people canted, 'he must have acquired his reputation as a hatchet-man from somewhere'.

There have been positive benefits accruing from the project, notably in the radical change in safety attitudes: what was acceptable two years ago would not now be allowed to happen.

Case (vii)

This involved a radical project, an attempt to manufacture phthalocyanine pigments by a totally different route. It arose out of the generally-declared research strategy to make pigment technology more of a science than a poorly understood art: exploration of areas like mechanism of formation etc. led to several projects including this one being identified.

The process in this case was for a direct synthesis instead of moving via intermediates. Shortly after work was started, a number of Japanese patents dealing with this area were published: opinion was split about continuing but a Research team was finally set up to carry out a feasibility study. Their remit was essentially to provide justification for this route, and to do so quickly.

They began with a survey and comparison of methods of manufacturing phthalocyanine including radical options. Eventual selection of a direct synthesis route was followed by rather lukewarm commitment and suspicion of its technical feasibility. However, work proceeded and after two years, a range of extremely promising processes had been developed.

Basle were very keen in view of the advantages offered, which included:

- lower toxicity, environmentally better
- capital, not labour intensive
- energy saving (at the time of the energy crisis this was very significant)

The major disadvantage was that the raw material for the synthesis was only available from one company who held a monopoly on its manufacture. Since this company was a direct competitor in the pigments industry, it was felt that this could represent a threat of manipulation. Equally the company could not justify investing in a plant to make it for themselves since the quantities involved would be too small.

Basle gave the go-ahead for a project team involving Research, Process Development, Production and Engineering to be set-up. Early work on developing viable industrial processes based on laboratory experience was encouraging. However the project was shelved shortly after this.

The 'official' reason was that the company had decided at senior management level not to try and continue to compete in the 'big league'. An admission, basically, that they were operating 'in the second division'. This meant, amongst other things that there was no money available, even for a pilot plant operation.

Comment on this project by one of the chemists involved indicates clearly how far it is possible to personally commit oneself to an idea. He comments 'it depresses me - the company won't take any risks. We're always going to be a follower, never a leader, despite our potential to change this. I can't let go of the idea, though - my heart's just not in my present work'.

Ironically, it appears that many of the original objectives have been overcome and there is a high degree of commitment by the company to a similar process currently being worked on. As one of the Research chemists put it 'there is a rumour that we wasted three years on a process that failed because of raw material supply problems. This is patently untrue because most of the technology developed in those three years was absorbed into other thinking - and is now being applied successfully'. Naturally the original chemist involved feels that since the general principles of his project are being applied, he could have carried on: this adds to his disillusionment with the ability of management to make correct decisions.

Probing a little deeper reveals some very personal reasons for the strong sense of bitterness and lack of motivation which he currently feels. The management style used by his superior at this time was felt to be far too rigid for research activity - there were restrictions on any personal autonomy.

This led to an increasing number of conflicts: these were added to because the chemist remained committed to his process. 'I went through agonies of frustration - the pigments we produced were better than any produced by normal technology. No-one wanted to know, though and I became more and more isolated as a result'. Eventually he was transferred from Research to Process Development: he sees this as having been 'a political expedient, shifting a problem character. It was like I'd been sentenced to the Siberia of the project team for two years and then exiled to a different department'. Since he was reluctant to leave the UK, the number of jobs with other companies was restricted, so he could not easily leave. 'I'd have left if I could - those were the worst years of my life - I feel that this project branded me with a bad reputation. It's a deadly thing - you come to a company full of good ideas and enthusiasm but the hypocrisy and the lack of honesty kills it all off'.

Case (viii)

This was a project aimed at improving a 'problem' process - unpleasant conditions, leaking plant, evolution of noxious gases etc. made it a difficult route. Inevitably there was a strong feeling in the UK and Basle that the green market might be something to pull out of. A decision was finally taken not to spend money on an improved plant to meet growing market demand, but instead to work with another manufacturer. The UK company would supply knowledge, raw materials and marketing but the actual manufacturing process would be carried out elsewhere. Inevitably this was a low profitability arrangement, but it was generally believed to be a short-term step prior to taking over the processing operation as well. In the event this plan backfired somewhat and the other company cornered the market where they continued to dominate.

At the same time, Research had found a process which excluded undesirable elements: at this stage there were no pilot plant facilities so it was tried straight on the production plant. The project went well: a year in the laboratory led to acceptance of the standard, two years in Process Development, making batches and ironing out problems, manufacture of production launch stock and circulation of samples to the market.

The product was generally accepted by the market as 'reasonably cheap and technically superior to the market'. On the strength of this, it was a potential 'winner' and the Technical Director wanted to launch this and lead the market.

However, the major argument against this was that plant was also needed for blue production and this had a higher priority since it was a more profitable product. The investment go-ahead never came however because of the slump.

Back in the laboratory, an alternative was developed which represented a 30% improvement and considerable cheapening. Pilot plant trials revealed that they had a potential winner of a process. The project was shelved however, because of the outside manufacturing deal.

Later discussions suggest that the variation of strategy was a result of a conflict between the Basle/Production lobby who wanted to get out of the market, and others who wanted to stay in with a new process.

Consequently, there was considerable loss of motivation amongst the chemists involved - 'it's now twenty times harder to motivate me to believe in anything in this company' was one comment. There was a growing belief in the inability of the company to take risks or to make radical changes - 'we might as well buy our technology in as to employ a Research and Development group and then not take any risks'. Also criticised was 'the view that chemists shouldn't think about wider issues - much less kick up a fuss about them - that's for management to take care of'. The feeling was that the chemists had a stake in the project and should therefore have some say in the decision-making involved.

Case (ix)

This was a product transferred from another company where Paisley were to contribute milling technology to an established process.

Process Development worked on suitable solvent recovery and milling specifications. Trials in the Production Elaborations unit working on a 200 litre mill were carried out to try and make 2 tons of test manufactured product. 'Despite zero co-operation from Production', all went well until a seal went on the mill.

Complaints came from Production about this because it put one of their mills out of commission: nevertheless, the purpose of the trials had been to prove the long-term viability on large scale of the process, and to identify the mill requirements.

The project was ultimately shelved as a consequence of the recession: however there is a feeling that it would never have survived. Initial costings suggested that the return on investment for a full-scale plant in Production would not have been very attractive. Comments about this being 'another Paisley disease' were made: 'if it's not going to work, someone should stand up and say so, but no-one ever does'. 'Pigheadedness is another problem - people will often stand blindly by a per project in the face of facts - you can waste a lot of time that way'.

Case (x)

This was a major process improvement involving the introduction of continuous salt-free milling: many people regard it as one of the most significant contributions Process Development have made.

Those involved described it as an uphill struggle - it had always been a target and had finally paid off by increasing production tonnage of major phthalocyanine products. It was also a much easier process than that which it replaced which increased its attractiveness to Production.

Whilst this was a fairly smooth project, one or two problems emerged. Notable was the difficulty of getting time on the plant: steady progress was made in the laboratory and on pilot plant but huge strides were made every time full plant trials took place. 'The company should give a reasonable chance to Research and Development on the plant: there's more at stake than what to do with the substandard material produced if the trial fails'.

In the case of this project, four trials on production plant gave rise to two viable products which lends support to the view of Research and Development having more time made available to them. The problem seems to be related to the generally cautious attitude towards innovation in the company.

Case (xi)

This was a major project involving an interdisciplinary team of engineers and chemists looking at a new method of manufacture and with interests in the process itself, cheapening by technology etc. The gap between laboratory-scale work and the proposed plant was much wider than usual and illustrated the essentially radical nature of this innovation for the Paisley site. In fact the team's task was really to perform a feasibility study rather than a full innovation programme.

In addition to the radical technology involved, the project also proposed massive capacity increases: Marketing were thus invited to join the team. Similarly new raw materials handling meant calling on other areas of expertise: it soon became clear that the team was in fact engaged on finding the relevant problem areas. Having highlighted these, information was passed to higher levels to facilitate the decision-making associated with these major proposals.

At the time of the research, the project had been shelved but much of the technology developed was being used for another less radical process - 'the typical Ciba-Geigy way' as one chemist remarked. The project itself was abandoned due to factors like cost, raw material availability, lack of justification for increased capacity etc.

The significant factor was the project team itself which was 'the worst I've ever worked on'. Reasons for this included poor communication confined to formal contact only, personality clashes, scoring points off others - a case of 'never mind the project, who's winning' - the whole poorly controlled if not actively encouraged by the team leader, 'He never did anything as leader to try and promote openness or co-operation'. Arguably all those involved have changed, but at the time it represented a very unusual set of conditions with prestige/pressure from outside and intense personal friction within.

Case (xii)

This was a transfer product from Basle and there was much cynicism since it involved taking a highly sophisticated and sensitive product/process and converting it to 'a simple Paisley bucket job'.

Aware of this, the chemist was very careful to build up a strong background to the process for those potential adopters. The trials took place on a number of short runs: out of 20 batches 19 were successful. The general impression was that it had been a major success - a model transfer which is still talked about today, as the researcher discovered.

In addition to very careful preparation, the chemist involved suggested that good informal relationships had contributed greatly. There had been a short strike sometime earlier and many people had worked in production alongside supervisors and production personnel: it is likely that relationships born out of this shared experience were very important in determining the quality of subsequent interaction.

Case (xiii)

This was a piece of process technology innovation concerned with milling operations. The machine in question was supposed to be located in the pilot plant for trials and commissioning but delays eventually led to its being installed in one of the production units.

A major flaw in the investment in this became apparent: it was too large for pilot plant scale trials and too small for production use. The absence of any other sized machine on the range meant that it stood idle for some 12 months. Eventually development trials were started on full-scale batches: this exaggerated the effects of normal teething troubles during the learning process.

Production attitudes in the early work were unfavourable: the machine was in their way and they were too busy to allow anything but the lowest priority to production trials. However these attitudes gradually changed through curiosity to acknowledgement of the potential value of the machine. The opposite problem began to appear where production placed such a high priority on using it that it was impossible to get near it for optimising work by Process Development!

One of the major difficulties in the early stages of the work was the lack of anyone in the production unit to relate to at any level - the plant manager and chemist were too busy, the supervisors suspicious and unwilling to get involved in the new project. A turning point occurred when a new plant chemist took over, and the bridge was further strengthened by having one of the Process Development technicians spend almost all of his time in the production unit.

Summary

These case histories illustrate the wide range of sources of problems in the innovation process. Coping with highly dynamic markets requires close co-operation and high flexibility.

In the examples given, the ways in which the system breaks down can be seen: strategic misjudgement, market variation, low co-operation between groups, plant unavailability etc. are typical reasons. Arguably these represent problems of integration and, as such, will be discussed later.

The high rate of failure of new products was a matter of sufficient concern to prompt the T.C.G. to prepare a report on 'The fate of new products' which detailed causes of failure: this was submitted to Meeting 3 (and is discussed later).

Failure rates reported here may seem high but in fact compare very typically with information on other companies. Robertson (1974) gives qualitative examples and also suggests the following (1978).

- Allen (1965) - sixty per cent failure rate in NASA applications companies.

- McIver (1969) - 24 out of 25 new products fail in test market (consumer products industries) - 92 per cent of new products in food industries are withdrawn from sale within two years.

- Booz-Allen and Hamilton - 90 per cent in consumer products.

- Rand Corporation - 90 percent in consumer products.

- Reekie (1971) - the above are all related to failures on the market - studies of shelved products give even higher figures.

This suggests that the experience reported here is by no means unique: high failure rates are naturally a matter for concern but do not necessarily reflect on inability to innovate successfully.

(iii) Case History of a Major Radical Innovation

Continuous azo project case history

During the period from February to December 1976 the researcher was actively involved in a major innovation project involving the introduction of continuous technology to production. An attempt is made here to draw a rough case history of this project and to analyse the influential issues involved.

As has already been indicated, the traditional methods of making azo pigments were essentially labour-intensive, requiring skilled process operators. Even with these conditions, the actual outcome of the process was uncertain since it was such a sensitive manufacture.

Despite problems associated with this method of making pigments, the technology had changed little from the early days of the industry. Indeed, discussions with many of the production staff in the azo area suggested that they felt a pride in the fact that they could still produce material of good standard on out-of-date plant and under very difficult conditions.

Because two of the plants producing a large proportion of the azo products were getting old, (they were built just after the war), investment plans had been advanced for the extension of the third (and much more modern) unit. With the recession in 1974, investment plans were frozen, but by 1976 it was apparent that the plant would be built. The question which most concerned Research and Development at this time was the kind of technology which should go into the plant.

The task of Process Development included a remit to improve the technology of the site as and where appropriate, and, in particular, to oversee the transition where possible, from batch to continuous operation. Azo technology had been a prime target for some time and a number of projects investigating continuous technology were already in hand.

Continuous azo manufacture was not a new concept; work had, for example been carried out in Switzerland on various systems for the operation of continuous coupling. Nevertheless, a number of problems remained to be solved. It is difficult to discuss the practical aspects of this work without disclosing confidential information, but the principle aimed for by the group was to make continuous, and, if possible, automatic as much of the process, as possible.

Automatic materials handling at the start of the process was a distinct possibility, but the technology for that could probably be bought in from outside. Equally, the filtration and drying at the other end of the process had already been investigated with the result that one of the plants in the existing azo unit involved a continuous filter/dryer; this was still undergoing assessment. This plant also involved a number of attempts to automate control activities. Thus the major areas to be investigated were the make-up of diazo and tetrazo-solutions for coupling, and the actual coupling process itself.

A continuous pilot plant for the former was already undergoing trials at the time the research commenced, and the researcher was involved in work connected with the continuous coupling system. By Easter of 1976, it was apparent that there were possibilities for continuous azo manufacture using the system being developed. Interest both on site and in the parent company is Switzerland was shown and, following a visit by senior Swiss managers, the go-ahead for the construction of a pilot-plant was given. A project team was set up to develop this and the researcher was appointed secretary this provided a very useful opportunity for studying the project.

The team was set up in May 1976, with terms of reference detailed in Exhibit 17. In composition it was largely a Process Development team, with other members co-opted to liaise with other departments likely to be involved. Early discussions were principally concerned with obtaining some estimate of potential costs; the internal investment system meant that a ceiling of £40,000 existed, above which a formal proposal would have to be put before the relevant investment committee.

Meetings continued into September, with the Swiss sending over their expert on continuous work to share ideas etc. However, shortly after that it was decided that the potential of the project justified its being considered in the overall plans for the new azo plant. This project had recently been restarted, and there was some feeling of surprise at this turn in events since it had generally been assumed that the new plant would not involve any radically new technology.

A new project team was set up, involving elements of the original but also representatives from Production, Engineering, Instrumentation etc. At the first meeting it was explained that the main reason for setting up the team had been the costs of the proposed pilot plant. These fell outside the range of a minor capital project and thus the initial task of the team would be to prepare a formal investment proposal/project report for submission to Basle. (All major investment funds in the company are raised internally through Switzerland; thus all major/

/proposals have to go through Basle).

The Production Manager was present on the team in his capacity as project principal for the new azo plant project, and his task was to assess the implications which the continuous azo process might have for that project. Time was short, both for submission of the report to Basle and also for decisions regarding the new plant (since this was already at an advanced stage of design).

The team met on several occasions to discuss various technical details and planned layouts. No decision had been taken regarding inclusion in the new plant but the feeling was that it was a useful short-term goal to aim for. Beyond this, it was not clear how continuous technology would fit into general company stragegy. Exhibit 18 indicates the proposed contents of the project report which was under preparation at this time.

At a meeting in November, however, reservations were expressed by several people at the progress and aims of the work. Exhibit 19 summarises these. As a result of this meeting, the original proposals for preparing reports and justification were abandoned and the team disbanded. It was agreed that the project required more development work and the various Process Development members undertook to carry this out.

This marked the end of the first phase in the project; direct involvement of the researcher also ended here. Nevertheless, the project continued to have an input to the new azo plant proposals, and was ultimately adopted as the technology for at least some lines in that building.

EXHIBIT 17 : Continuous Azo Process

Background and Terms of Reference for Project Team

Summary

Process Development have developed a process in the laboratory for the continuous production of azo products. Potential advantages of the new process are:

1. Better control of product quality using instrumental process control, and on the evidence to date, improved product quality.

2. Savings in capital required to build future plant by using smaller and simpler buildings and vessels than are required for batch plant.

3. Better working conditions and a cleaner plant.

4. The ability to operate production lines of very much larger output than batch plant and so reduce direct labour costs.

The disadvantages are:

1. Greater dependence on the skills required to operate and maintain instrumental plant.

2. Less scope for reducing labour cost when the plant is not fully utilised.

3. Major process changes to accommodate new products may require alterations to the plant.

Terms of Reference

1. Definition of a range of products with annual sales totalling at least 600 tons, which can conveniently be produced on a single production line.

   Technical feasibility, market preference, and operating factors will be fully considered.

2. Assessment of the economic factors. Development and Capital costs. Reduction in operating cost and its sensitivity to 7 day working, under utilisation of the plant, frequency of product change.

3. Design of a suitable pilot plant.

4. Definition of any relevant ancillary work e.g. improved methods of handling raw materials, methods of producing new and improved products etc.

5. Operation of the pilot plant to provide design data and establish the reliability of the systems.

6. Costing of a full scale production unit.

7. Full appraisal of all relevant facts and recommended future action.

EXHIBIT 18 : Project Report - Provisional Contents List

(i) Justification/Aims

- Background
- Products
- Potential Advantages
- Requirement of PP
- Aims
- Time Scale
- Patent Situation
- Risk/Chances of Success

(ii) Location - alternatives

(iii) Size/output - reasons

(iv) Process description/layout

(v) Dependence on other areas/Effect on other areas

(vi) Envisaged work programme

(a) PP
(b) Filtration and drying
(c) R.M. handling/storage/control
(d) Diazo/CC/make up/control
(e) Early work

(vii) Resources - People
- R.M.'s
- Time

(viii) Safety

(ix) Ecology

(x) Equipment List - costs $\pm$ 10%

(xi) Timetable

(xii) Project Team

It was felt that an extra section on running costs should be added to this list.

EXHIBIT 19 : Reservations about the project

Since the last meeting, work had progressed on the plant flowsheet, specification and layout. Before discussion of this however certain reservations were expressed which led to considerable debate on the direction and aims of the project. The plant had been designed to meet a number of aims, e.g.

1. To demonstrate continuous production of Azo pigments.

2. To demonstrate advantages of continuous production.

3. To prove instrument reliability.

4. To investigate areas of reaction and aftertreatment that cannot be satisfactorily examined on the present laboratory-scale.

5. To provide a demonstration/training plant.

6. To provide the necessary data for plant scale-up.

It was now being questioned whether the scheme proposed would satisfactorily meet such objectives. The areas of doubt expressed, although certainly not agreed by the meeting, can be summarised as follows:-

1. Questions as to whether the plant would work reliably enough to prove product quality/reproducibility, instruments etc.

2. The plant could be considered too small to prove flowmeters, control valves, scale-up of reactor/agitation.

3. The plant did not need to be so large for the investigation of some other areas.

4. The design is too flexible and the plant would be too well-equipped and engineered for its purpose. The plant is basically a development rig that should be capable of being modified quickly and easily.

5. Although a cost was not complete, it appeared that it would exceed £100,000. The only apparent advantages of such a continuous plant lay in the area of product improvement. Could such advantages be further demonstrated before proceeding with such an investment?

Following much discussion the meeting agreed that it did not wish to progress the present scheme to the preparation of an Investment Proposal/Project Report until it and alternatives had been considered in more detail. The target of mid-November would therefore not be met.

A number of issues emerge from observations of this project which are relevant to a study of factors affecting the innovation process. The first of these is the existence of various groups with differing attitudes towards the project.

Making some rather broad assumptions, there appeared to be at least four groups with different views.

(a) the innovators: largely composed of the Process Development team, this group were essentially committed to the idea of improving technology on the site. Reasons for this were often complex - e.g. the chemical engineers felt that the site had been a chemical works run by chemists for too long - they were aware of many simple improvements which could be made by the application of engineering principles. The chemists had, on the other hand, been involved with the traditional methods of manufacture for a considerable time and were keen to improve the quality and reproducibility of products by better control etc. (These groups also had their differences and conflicts which will be considered later. In broad terms, however, they were in favour of the introduction of continuous technology.)

(b) The Swiss: The major role of this group in the early days was that of a positive influence towards new technology. Despite the apparent autonomy of the division, links with the parent pigments division were very strong and opinion in Switzerland, coupled with the control of the purse-strings, tended to lead that of the UK company. Thus a commitment on behalf of the Swiss to radical innovation in the form of continuous technology introduction had the effect of pushing the UK into following suit.

(c) The adopters: The potential users of the new process would be Production and it was apparent that their attitude towards new things in general was one of tacit hostility. This is in keeping with their task orientation - their job is to meet production targets and new technclogy must be well-demonstrated in its potential to improve matters before it will be accepted. In addition to this, the production experience of Research and Development had not been particularly successful and there was general scepticism with regard to the abilities of this group.

(d) Relevant Outsiders: This refers to the political implications of the new project. As Pettigrew indicates (1974), radical innovation involves the creation of new resources and the control of existing ones; thus it will become a focus for political activity.

With these groups in mind, it is possible to look in more detail at the history of the project. Even at early stages of development, problems existed between the engineering and azo chemistry groups within Process Development. In part this was a skill conflict; the department had been formed out of the old research group and the tradition was one of applied chemistry. With the reorganisation in the sixties, a need for chemical engineering expertise on the site had been identified and the setting up of Process Development was partly a response to this. Resentment between the groups was heightened by the fact that (in a restrictive economic climate) chemical engineers could command higher salaries than chemists. Neither side had a high regard for the other's skills or for the need for the other's contribution; the attitude was, amongst the chemists, that 'we've managed for all these years without them, why do we need them now?'.

Coupled with this were some style problems; one of the key people in the azo area had a very high reputation for experience and successful problem-solving. He had been with the company for a long time and had thus acquired a wealth of knowledge about the idiosyncrasies of pigments and processes; clearly a central contributor to any team working on developing azo technology. Unfortunately, he was also regarded as very poor at communication. The chemical engineers involved reported great difficulty in working with the azo group as a result; as one of them put it, 'it's not that he's trying to hide anything - he'll tell you anything you want to know. The problem is that this is a new area for me - I'm no chemist - and I don't know the right questions to ask. He never volunteers any information and I don't know what to ask for specifically. We just seem to be working on two separate projects'.

Equally, the azo group were unhappy about the styles of the chemical engineers. Lack of knowledge of chemistry was a major criticism. One of the engineers was 'far too finicky. If he wants to do anything, he'll go right back to square one and work his way through methodically. That's probably a very good approach, but it takes too long. Besides, if he only bothered to come and ask us we could save him most of his time - we've tried half the things he's looking at and they won't work!'.

The departmental manager, himself a chemical engineer, was not yet fully integrated into the department; criticisms of his style and approach were also important problem areas (discussed elsewhere).

Against this background of conflicts and problems, the proposals for new technology were developed. Relations between the department and the rest of the site were not good at this time; perhaps because it was a newly emerging group. Consequently, reactions from production managers to the work being done were cool. Attempts were made to interest them, but it was not until the Swiss declared their interest that things began to move.

At the early stages of the first project team the political implications began to emerge. A letter from the Technical Director outlining his views on the project was received with hostility; comments about 'another case of politics messing things up' were frequent and this prompted the researcher to try and discover the underlying issue. Exhibit 20 presents the letter, from which it is not immediately apparent why this reaction should emerge.

EXHIBIT 20 : Letter from Technical Director to Initial Project Team

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Continuous Azo Process

Thank you for your proposed Terms of Reference for the project team.

I was very interested to read your summary and proposals, and there are one or two comments which I think are important to bear in mind.

1. In the advantages, you refer to the improved product quality, and I wonder whether you are setting your sights as high as eliminating batch blending.

2. We should undoubtedly be able to use smaller and simpler buildings and vessels, but you will of course need more sophisticated controls and infrastructure which may have a counter-balancing effect.

3. I hope you are right about the better working conditions and a cleaner plant, but I am not sure how much this depends on continuous azo processing or on other housekeeping factors.

4. You refer to very much larger output, and in the Terms of Reference you call for a definition of a range of products with annual sales totalling at least 600 tons. I am afraid that this might represent one flaw in your argument. It has been re-established in our recent strategy discussions that we wish to stay in the high technology, more profitable end of the classical pigment business and to avoid becoming commodity manufacturers. The implications are that we must continually improve our products, and although we would like to manufacture large quantities of highly profitable products, there will be the need to be flexible and to up-date our products when and as necessary. Large volume throughput - which is essential for low costs - must not be at the expense of flexibility. Furthermore, I believe that our future lies in the development of new forms of our pigments, which can present high quality in an easily usable form: this means that although we should aim to produce continuously, the finishing and isolation of the product may be where the flexibility must be incorporated.

I look forward to the planning discussions where we can ensure the full commitment of the Division to this work and make sure that the objectives are understood and agreed by all parties.

Most people asked indicated that there was a split between the Technical area (Research and Applications) and the manufacturing area (mainly Production), but including Process Development by virtue of the reorganisation). This was variously identified as a conflict in strategic objectives of these groups, a personal conflict between the relevant directors, a difference in orientation of the two groups etc. Later studies of this political rift suggest that it is probably a combination of all of these factors. However, in this particular case it seems likely that a conflict of strategic views was the reason. (A fuller study of the conflicting views at high level of the strategic directions for the company is given elsewhere).

In actual meetings of the early project team this issue was taken up, but it did not appear to reduce the potential co-operation between Research and Process Development; the representative from Research said that he would ensure that resources were allocated to facilitate any relevant background work which the team might feel was necessary. (In the event there was very little Research involvement in the project, but this appeared to be due to the nature of the tasks involved rather than any problems in securing co-operation).

Early meetings of the team were concerned with discussion of specific points, such as the actual location of the proposed plant within the pilot-plant complex; however the issue of costs was seen as being central to any further work. Unless they could be kept within the limits for a minor project the whole proposal would have to move to a different level of operation. This period was characterised by a number of individuals riding their particular 'hobby horses' - trying out ideas on the group. Since there was only a broad commitment to a pilot plant at this stage, all these ideas were admissible; they included fully automated control via microprocessor or computer, integrated feeding systems, etc. The main problem for the group to solve lay in trying to identify the potential financial advantage for the company; there was some doubt as to whether it would make any significant difference in terms of output, quality etc.; it was unlikely that, despite the technological attractiveness of such a project, the company would consider it worth the investment unless this could be demonstrated. (This was particularly true in view of the tight investment restrictions on the company).

A visit from the Swiss expert took place in September. He explained that his remit was to study how azo pigment production plant would look in 1985/6; the assumption that this would incorporate continuous technology as a matter of course was an indication of the level to which the Swiss were committed to this approach.

Although the systems developed at Basle involved a different control principle, it was felt that the two philosophies were not very different. (Later on it became apparent that this difference in approach was to cause difficulties).

By October a proposed layout was available and it is indicative of the commitment that team members felt at this stage that, after little discussion it was agreed that these should be costed; i.e. the layout was acceptable, providing that the costs were within the limits imposed by capital restrictions.

The costings revealed that the project would have to become a medium capital one and it became necessary to set up a new project team. This was significant because it involved others and effectively took the project outside the control of Process Development alone. However, both the project principal and the manager were from the original team.

The most important new factor to emerge at the first meeting of the new team was the possibility of getting continuous technology into the new azo plant. This brought the production issue into sharp focus; the project was no longer just an attempt to develop technology for possible future use by the company.

The prospect of integrating it into a production unit in the near future made it a much more significant piece of work. Equally, the production representatives were very sceptical; they did not consider their experience of incrementally new technology introduction to have been a success.

It was apparent that two sides were represented at meetings of this team; innovators and potential adopters. Much of the debate centred on the issue of instrumentation and control. In production the regular criticism of new processes had been that what worked in a clean laboratory or even on pilot plant would not necessarily work on the plant. Innovations had to be robust enough to survive under adverse conditions, simple enough to be operated by unskilled operators and reliable enough not to need maintenance beyond regular check-ups. Proposals such as those being advanced for the new azo process, involving highly sophisticated automatic control, were felt to be suspect and repeated reassurances were sought as to reliability. In some cases this led to design changes - for example, a request for a second supporting pH control loop to be installed because of production fears that pH control would be subject to regular failure under plant conditions. It is difficult to determine how far this reflected a genuine concern for plant reliability and how far it was production cynicism at the performance of anything new.

The meeting at which the project was abandoned involved a great deal of discussion but it appeared that the outcome had already been largely decided before the meeting itself. The reservations were expressed by one of the engineers responsible for capital investment evaluation and took the form of a circulated copied list of personal objections to the project's going any further. The principal objections were to the lack of evidence as to the potential reliability of performance of the completed plant- with investment likely to exceed £100,000 this was felt to be too big a risk to take.

Responses to this statement tended to be in agreement, and it was clear that people were not happy in their own minds about the possibility of success. Comments like 'we're not certain to what degree the plant will work - we know it won't fail, but.....', 'we're taking a very expensive route to carry out what are essentially trials of instruments and control systems' typified the mood of the meeting. It was clear that the risks involved were too great and there was no evidence of a champion willing to step forward and push the project through. As one of the team members put it, 'we have only had experience of incremental changes up to now - now we're proposing a radical process change which appears to be taking us further than anybody believes we can go'.

Only one member of the team was still strongly committed to the project - one of the Process Development engineers. Much of the meeting was taken up in trying to justify to him the reasons for not going forward. In general it was felt that reliability and costs were the major problems - it was basically a matter of judgement and no-one was prepared to take the chance. 'Taken singly, there are no insurmountable problems - but additively, I don't think we're ready yet' was one typical response.

At this point the various doubts that each individual had began to emerge and a range of alternative options were proposed. Scale-up, scale-down, simplify, use some existing plant etc. Opinion seemed divided as to the best strategy; the production and engineering people felt that more laboratory and small pilot-plant work should be done, whilst the Process Development side were unhappy about aspects of the proposal but reluctant to lose the opportunity. A joke was made about the strange situation in which the team found itself; it was one of the few in which management had already been convinced and were prepared to put up a considerable amount of money. This provoked the response that the risk should be taken but once again there was no support for this.

The project leader summarised the overall problem in the following way. 'The company won't go continuous for the sake of going continuous. There has to be an identifiable benefit - some way in which this process is better. The meeting has the responsibility to present a unified view of this issue to the management committee; this would seem to hinge on the balance between the risks and the advantages involved. Some kind of demonstration is the only way of getting an innovation of this kind accepted. Are there other alternatives which could be considered'.

By this time it was clear that only one person remained committed to the original proposal; the meeting closed with him remaining unconvinced and very unhappy. The formal decision taken had been to abandon the existing project and to explore further development of this and other options in the relevant areas.

Discussions with some of the members after the meeting enabled the researcher to identify some of the factors behind this apparent about-face on behalf of the innovators. In most cases they confessed to having had doubts for some time about going ahead too quickly on ground which was essentially uncertain. They did not feel that the department had sufficient of a reputation to carry this through on their own; as individuals they were concerned at being identified with a possible expensive failure.

The preferred strategy was to return to the development work and try and clear up the grey areas. In addition to this, there was an awareness of the Swiss interest in continuous work and people felt they would like to wait until the overall company objectives for continuous technology were made more explicit.

Shortly after this, the Swiss came over to visit and discuss investment plans. (One of the significant features which may help to explain the anomalously high level of influence the parent company has is that investment plans are scrutinised internally, in Switzerland). As a consequence of this discussion, attitudes became far more positive, and a definite decision to include continuous technology in the new azo plant was made. (It was suggested later that the discussion had been something of an ultimatum on behalf of the Swiss - 'either you go ahead with new technology in the new plant, or you don't get the money to go ahead at all!).

During the course of the project, the meetings held (formal and informal) by the head of process engineering in Process Development (the project manager) were monitored.

Details are given here:

Date	Time	With and Subject
8.10.76	30 mins.	Chief Engineer on the general background and the people involved.
11.10.76	20 mins.	P.D. Chemist } basis of
	30 mins.	Instrument Engineer } project aims,
	15 mins.	Head of Chemical Engineering } team, what's
	30 mins.	Project Engineer } already been
	5 mins. (phone)	Production Manager } done etc.
12.10.76	90 mins.	Formal meeting with whole team.
13.10.76	10 mins.	Production manager - briefly to confirm action on identifying target dates.
14.10.76	120 mins.	Instrument and Project Engineers - discussions on size of plant, general philosophy of design, engineering details, etc.

Date	Time	With and Subject
14.10.76	90 mins. + 30 mins.	Head of Chemical Engineering and Chief Engineer on above, securing general agreement.
15.10.76	20 mins.	Process Development chemists and engineers (3) discussion on possible use of computer/ microprocessor control.
	15 mins.	Project principal (senior Process Development chemist) to fill in on yesterday's talks on engineering.
	30 mins.	Project engineer to confirm sizes and arrangements.
	5 mins.	Instrument engineer to confirm sizes.
19.10.76	25 mins.	Production manager (azo units) to discuss flowsheet and general philosophy.
	20 mins.	Pilot plant manager to discuss siting of trial plant.

Date	Time	With and Subject
19.10.76	15 mins.	Process Development chemist and chemical engineer to discuss throughputs.
	20 mins.	Instrumentation engineer to discuss flowsheet.
20.10.76	30 mins.	Process Development chemical engineer to discuss transition problems.
	60 mins.	Azo product executive to discuss azo strategy and where project fits in.
21.10.76	30 mins.	Senior Process Development chemist to discuss patents and pilot plant reports on earlier work.
	15 mins.	Manufacturing director to discuss equipment acquisition (possible second-hand exchange on vessels).
22.10.76	60 mins.	Process Development chemical engineer to discuss flowsheet.

Date	Time	With and Subject
25.10.76	90 mins.	Instrument engineer to discuss contents of formal project proposal and to look at flowsheet.
	15 mins.	Project engineer to discuss costs.
	120 mins.	Formal meeting of team.
26.10.76	60 mins.	Instrument engineer and Process Development chemical engineer to discuss flowsheet.
	30 mins.	Project engineer to discuss costs.
27.10.76	20 mins.	Chief Engineer and head of chemical engineering to discuss time scales.
	30 mins.	Project engineer to discuss time scale and layout.
	10 mins.	Instrument engineer and Process Development chemical engineer to discuss time scale.

Date	Time	With and Subject
27.10.76	30 mins.	Instrument engineer and Process Development chemical engineer to discuss flowsheet.
28.10.76	30 mins.	Process Development Manager to discuss concept and ideas.
29.10.76	120 mins.	Process Development Manager, chemical engineer and senior azo chemist to discuss aims and work programme.
	30 mins.	Project Engineer to discuss layout.
1.11.76	60 mins.	Project engineer to discuss his problems and reservations.
	105 mins.	Formal Team Meeting.
	30 mins.	Process Development Manager with senior azo chemist (as project principal) to inform him of decision.

Date	Time	With and Subject
2.11.76	30 mins.	Chief engineer.
	30 mins.	Head of chemical engineering - both to discuss outcome of previous day's meeting and plan future.
	15 mins.	Process Development chemist and chemical engineer, Project Engineer to inform them of final state of affairs.
3.11.76	30 mins.	Process Development manager to discuss concept and views of Basle on subject.
4.11.76	150 mins.	Manufacturing director, Chief Engineer, Head of Chemical Engineering, Process Development Manager to discuss project generally.
	30 mins.	Process Development chemical engineer to hear his views and reservations.

Date	Time	With and Subject
5.11.76	20 mins.	As above to give information about yesterday's big meeting.
	30 mins.	Senior azo chemist to discuss yesterday and plan for future.
	60 mins.	Process Development manager to discuss project generally.

From this brief study some idea of the interaction patterns involved in a major innovation project can be built up. The high level of involvement with people of different groups, experience, discipline etc. highlights the need for good integration on project teams.

In addition to this data, interviews with the Process Development members involved revealed the following case histories and viewpoints.

(i) BJM, chemical engineer and later project manager. Currently representative of Process Development on the major project team for the new azo plant.

The idea had been around and tried out on several occasions but no viable system was developed until AH/CN (azo chemists in Process Development) came up with design A. This was the basic breakthrough, the enabling step which provided the suitable control system; a simple laboratory scale plant worked well on this process.

A second design B was developed parallel to this by BJM on chemical engineering lines, paying closer attention to reactor design etc. The two approaches were put together in the first internal team which worked on trying to evolve a compromise design for a pilot plant which would be cheap, quick and which would use existing equipment where possible.

(Basle, up to this time, were pushing for it to be done but without any strong line - their major input was of support).

The failure of the team to make progress coupled with changing circumstances led to the setting up of a formal project team. The aim was for a compromise, not only between designs A and B but also to please mechanical engineers, chemical engineers and production specialists; it ended up as a camel - the committee's attempt at designing a horse! Too big, too expensive and failed to give individuals what they wanted; consequently the team folded up and the project reverted to the Process Development internal team.

Up to this point, the idea of continuous azo technology had been attractive but no-one put any time commitment to it. Now Basle and senior directors in the UK (e.g. the Manufacturing director and Chief Engineer) began to push for its possible input to the new azo plant; this marked a radical transition from sceptic to believer for several UK individuals. It appeared as if Basle had put pressure on, having decided themselves to go ahead.

The visit of senior management from the parent company suggested the rumour that an ultimatum had been given; 'unless you introduce new technology you don't get any money for your new azo plant'. This is certainly in keeping with known views and would explain the sudden about-face of the sceptics.

The consequence for Process Development is that things are much better than before; the external support has meant that people outside the department are now doing jobs which are fundamentally the same as they were required to do on the original team. The difference is that they feel more involved- instead of a tentative 'shall we...?' there is strong pressure to get it done quickly.

Within Process Development there are still some problems associated with different approaches; the divergence of thinking has been widened by the arrival of a Swiss chemist to work on the project and integrate the Basle ideas. Nevertheless, there appear to be advantages to be gained from combining the three systems.

One interesting observation is the minimal involvement of the Research Department; apart from a small amount of early work on coupling, they have remained totally apart from a major piece of innovation. The suspicion is that this represents a conflict of strategy between the Technical and other directors.

The project team was an indictment of the system; 'if a project team starts from day one with grass roots it could succeed. In this case half the team were already thinking with closed minds on specific plant'. The strange thing is that attitudes now are so much changed despite the fact that many of the objectives raised earlier are still applicable.

CN (chemist) worked on early projects right through to present system.

1965 was the starting time, with various vague studies being made - these went on for several years. However his own full-time involvement began in 1972 and was triggered by an article on continuous diazotisation. (In retrospect he suggests that this may have already been policy since Basle had demonstrated interests and techniques in continuous technology over the previous three years. Most likely the article revived Paisley interest and helped overcome their scepticism about the Basle proposals for control systems).

By mid-1973 a laboratory process was demonstrated and work began on designing a pilot plant; this was under construction by the beginning of 1974. Work between then and 1976 was concerned with development and tightening up, and with moving to the new pilot plant. In May 1975, three members of the department went to Basle to lecture on continuous work.

Whilst working at another site (within the UK organisation) in January 1977, he noticed a Basle report comparing the Swiss and UK systems - a'travesty' as he described it. Understandably the Paisley chemists took exception since this report underestimated the UK work; 'it was selling the Basle approach by denigrating other approaches. Fortunately we got a reply in otherwise the influence could have led to a cancellation of the whole project'.

Basically there are three approaches to control, two developed in Basle and the third at Paisley. The Basle system combines two approaches and is very good for batchwise automatic control; thus their criticism of the Paisley system - 'not a general method'. However the Paisley system did not set out for general application of automated control - it was for the specific duty of a continuous plant.

Other criticisms such as cost, accuracy and reliability were also refuted; in a memo sent from Paisley the senior chemist involved commented, 'finally, we cannot understand the statement that the Paisley method will fail completely.....'. The major point at issue was that the Basle document was put out as an opinion - but the power of the parent company as such means that opinions committed to paper tend to assume the status of facts and/

/'gospel truths'.

The continuous coupling story was essentially simpler than the continuous diazotisation; it grew out of the earlier work and at first interest was shown in the Basle system. However in 1973 the control monitor was advertised in technical journals etc. and it was clear that it stood out as the answer to the problem. Various development projects resulted in a viable laboratory system and pilot plant construction is now in progress.

The turning point in his opinion for the whole project was in mid-1976 when Basle gave the go-ahead for the pilot plant. After that it became a question of when? rather than whether continuous technology would appear. Currently, there is Basle pressure to modify the control system to their approach - he feels that the parent company involvement is getting like the Russian 'advisors and aid' to a small African state - a covert takeover.

DM (chemical engineer). His involvement arose out of the early work at the 1976 meeting setting up the internal project team. In September 1976, a visit from Basle to co-ordinate activities revealed that they were further ahead in their work on computer control and automation. There were also two distinct approaches to control of the process; the attempt to push the Basle method seems to have failed at this point because everyone was already convinced of the superiority of the Paisley system.

From a personal point of view, he felt a lack of clear justification for the work; 'I felt for a long time that improvements in quality was the only real benefit we should be aiming for.....any others were likely to be peripheral. But others stressed consistency and cost as the key advantages'. In general, the only real alternative to continuous operation as the next generation of technology would be the Basle system of automated batch processing. The role of the pilot plant was thus particularly concerned with demonstrating the advantages of one system over another.

At the meeting of the full project team where the decision was taken not to go ahead with the proposed plant, DM was the only one to defend the proposed design. 'I was in agreement that we stop, but not for the reasons that most people had. My reason was the insufficient evidence of product quality improvement from the equipment to justify the investment.....we could've used alternative reactor designs..... most people felt that the list of problems circulated was the cause but there were other issues.....the important thing was that they all concurred on the general lack of evidence'.

He found himself asking the following questions;

' - why do we want continuous azo?
- should we not take risks to justify this?
- what do we need to know to specify a continuous plant?
- what is the probability of benefits being realised?
- what is the best strategy to obtain this information?'

and decided that the pilot plant proposed would be the most economical way of exploring these areas. For these reasons he grudgingly accepted the decision of the team.

His present work has involved extensive study and assembling of relevant literature and he sees himself as having a 'gatekeeper' role to play, 'consciously trying to stimulate comment and discussion on issues like mixing and design'. He has circulated his design flowsheets widely, inviting comment but has been disappointed with the feedback.

In addition, discussions with members of Research (including the Technical Director) provide an insight into the other side of this innovation proposal.

'Generally, the feeling is that the whole thing has swelled up to a disproportionate extent. The original interest and selling of the idea took place at a time when market trends and outlook were favourable. Now the engineers and production people are really wrapped up in building this plant - yes, it's a good design but is it what the business wants anymore? After all Azo 3B and project 5202 (the two major investments in plant extension) were both held up because of this same misjudgement of the market position and company expansion. The problems of overcapacity and wrong markets are essentially Manchester views but the general feeling is that the 1980s may be very different to the imagined set of events.

After all, the idea isn't new - Hoechst have a continuous plant in Germany and I.C.I. have a continuous dyestuffs plant in the UK. There is a view that questions are not being asked about this project; that Paisley have lost their objectivity in their enthusiasm.

Similarly, the Swiss input was certainly a strong influence but they too may be justifying investment on the basis of 'it's OK, it's a technological advance on old plant' - i.e., ignoring the market and other factors'.

Overall the study of this project illustrates clearly the difficulty of introducing radical innovation within this company. This is perhaps to be expected in view of the tradition of incremental and product innovation; there is a natural suspicion of radical changes in technology since this is a very new area in which trust must be placed in specialist groups whose role and reputation is not yet established clearly.

One limiting factor must undoubtedly be the absence of a 'champion' for the project; although many people were convinced of the value of the idea, no-one took it up with the passion necessary to steer it through the 'company obstacle-course'. The high level of inertia within the organisation is aptly illustrated by the often-expressed view - 'continuous azo? - great idea, but where are you going to put it? You can't put it on the Paisley site - it'd never work!' Whilst this view anticipated industrial relations problems implicit in the notion of automation, it was also a clear indication of the general reluctance to change technologies.

Equally significant was the role of the 'influential figure' - the 'machpromoter' in Witte's/Geschka's view. None of the key influential figures in the UK expressed a strong preference either way (the exception being the Technical Director who committed some reservations to paper): this ambivalence in practice meant a general lack of support for the project. By contrast, the Swiss influence (financial though it may have been) catalysed opinion and the number of proponents quickly snowballed, gathering up influential voices as it went.

Data from the short course and other observations support this view of the low-level of risk-taking which manifests itself within the organisational culture. This may have dysfunctional consequences in the long-term since 'incremental' (i.e. low-risk) thinking will limit planning for the plant after next to known and trusted configurations. Failure to anticipate adequately major technological changes likely to come in the longer-term future allied to a corporate reluctance to take risks may present severe problems in the 1980's.

(iv) Studies of Senior Management

As has already been explained, two management groups were of special interest and influence in the innovation process; Meeting 3 and the Technical Co-ordination Group. Data is presented here on both of these groups. This is followed by a discussion of their interaction over a specific issue, the fate of new products; this illustrates some of the key aspects of these groups.

Initially, however, it will be important to understand the central political issues operating at this level and bearing upon the innovation process. An attempt is made to introduce this theme here.

(a) 'Political' Issues

During the course of the research a number of references were made to various real or imagined political conflicts. Further investigation suggests that these are manifestations of different judgements and opinions expressed at high levels over a sustained period.

From an historical perspective it is important to appreciate the political climate of the company. According to most members of the division interviewed, there had been considerable political activity within the company under the previous managing director. Many felt that his whole philosophy of control depended upon 'divide and rule' tactics and that he believed in promoting conflict and in taking decisions in an autocratic fashion. By contrast the current managing director has a radically different style; he has repeatedly stressed his reluctance to indulge in 'paternalistic, parent/child' management (which had been the dominant ethos within the company). However the tradition of conflict does not appear to have declined very far and the essentially 'separated' style of the new managing director provides no direct instructions or decisions which might reduce the problem.

In the area of innovation the problems described frequently to the researcher tended to focus in particular on two key individuals; the manufacturing and technical directors. Part of this 'personification' of the political issues was undoubtedly due to their close personal relationship.

Because of their almost mythological status in the cultural history of the company from its beginnings everyone was familiar with information about their close and long-standing relationship begun when the were at University together. Just as well known was their extensive involvement with building up the company and their intimate knowledge, not only of the complex chemistry of organic pigments, but of the problems in manufacturing and marketing them, of managing people and strategy etc. On this basis it is likely that they would still have had enormous influence as informal leaders even without their formal positions of power.

Most people interpreted the conflict between these two as essentially a clash of personal styles; whilst this may well be a possibility, it is argued that more significant conflicts emerge between their different judgements, opinions and decisions on major issues such as strategy and structure. How much these positions were a consequence of the functional role and experience of these individuals and how much they were created by personal views is impossible to detect. It is not even possible to assume directly that either of them was aware of the role and political status which they had although it is likely that they were.

Dale and Spencer (1976) discuss similar 'mythologies' associated with key individuals and draw attention to the degree to which they are influential in shaping values, norms, beliefs and even ideologies in their spheres of influence. It is suggested that one source of conflict within organisations may be the incompatibility of two sets of beliefs etc. which reflect the original 'mythological' conflict. So, for example, the values and beliefs etc. which are at the heart of the conflict between a research chemist and a production manager will be essentially similar to those held by the technical and manufacturing directors. This is particularly ture in areas like structure and strategy but the level of personal influence is also clear from social values (which appear to be derived in the same fashion).

To illustrate this point further it will be useful to look at issues of strategy and structure which highlight the different approaches.

In terms of structure, the Technical area (Research, Applications and Technical Service) has a major responsibility for innovation within the company. Historically, however, development of new products had been carried out by groups working closely with the production units - often involving plant trials and other activities.

When the company was reorganised, a new department evolved to handle scale-up work and also to take responsibility for new technology introduction; this was Process Development. What is interesting is that line responsibility of this group is through the manufacturing, not the technical director - despite the fact that activities involved refer more to the technical area than manufacturing.

This anomaly of structure has been a major source of political unrest for some time within the company: conflicting views on innovation strategy in the two areas means that the group often give the appearance of working in direct competition. Because of the newly-emerged status of Process Development (relative to the rest of the site) there is a sense of insecurity which emerges at the frequent rumours of a 'takeover' by the technical area. The situation is analagous in some ways to a small state disputed over by two super-powers: a further complicating factor is that many of the older Process Development members used to work in the old development groups attached to manufacturing and thus share values, beliefs etc. in common with this area.

It is clear that the innovation strategy held by the two individuals differs significantly: in the manufacturing case the emphasis is on incremental modification of products to suit customer requirements (the traditional 'bread and butter' innovative work of the company) and on technology improvement aimed at reducing unit costs in production. Whilst the technical view would not contradict the value of this kind of work, there is a strong suggestion that ultimately this kind of 'tactical' innovation will result in a loss of market share. Because competition is fierce and from larger companies with resources to produce on larger (thus cheaper) plants on one hand and from smaller companies with flexibility to respond to customer needs more quickly on the other, there is a risk of being 'squeezed out' if a follower policy is pursued. Thus the company needs to innovate on a more fundamental level, and to develop a background of knowledge about the general mechanisms of pigment chemistry. (Exhibit 21 gives the basic elements of a presentation made by the Technical Director outlining Research and Development strategy; this makes some of the above more explicit).

EXHIBIT 21 : Research and Development Strategy Presentation

Overall Strategy

- research-based company
- specialities rather than commodities
- pigments as major product
- basic strategic objectives - rate of growth, profit improvement, new business

(i)	rate of growth is related to:	market growth share of market innovation opportunity maintaining viability
(ii)	profit improvement is related to:	efficiency of production slim organisation process cheapening rationalisation
(iii)	new business is related to:	more profitable markets new users new products innovative opportunities maintaining viability

Research and Development is concerned with:

- translating intangible concepts, ideas and theories into specifications, tangible products or processes
- innovative work more concerned with new things
- a high proportion of professional staff whose concern is longer term than day to day
- longer and more uncertain time scales

Specifically, the Research strategy is based on these assumptions

(i) centrally coordinated, it supports the worldwide strategy of the company

(ii) research effort of the overall company is split between the different divisions and carried out in several countries

(iii) pigments research is closely coordinated between Paisley and Basle and planned to support the worldwide pigments business

(iv) research in Paisley is primarily concerned with defence of classical pigments sector and with the search for new low-cost pigments and new physical forms

(v) Research and Development planned to be viable in size etc.

This gives rise to a product strategy based on these elements:-

(i) introduction of new products is vital to long-term survival

(ii) products introduced should meet market needs in industry and geographic areas selected by the business: these can be met by either products identified and specified in advance (need-pull) or by invention (knowledge-push)

(iii) innovative steps must be of reasonable size for product to reach market: this is against factors like dynamic environments, 'ageing' and competition

(iv) introduction of relatively expensive products should be avoided if possible - attempts made to strike a user advantage/cost balance and to plan for an uncertain environment using demand and price curves

(v) short term benefits should be sought from long-term targets, i.e. early exploitation leads to a chance of early profit improvement

(vi) waiting for ideal products and processes can take too long

(vii) within Research and Devleopment resources need to balance these factors:

- product, scientific and background effort
- innovative, defensive, " "
- new chemistry, existing products
- different industry users
- short, medium, long term

(viii) balance will vary from year to year and trends will reflect

- long term business strategies
- plant capacity with respect to investment
- " " " " " business cycles
- " " " " " limitations
- number of products which system can accommodate

The presentation made clear the range of activities in which Research were involved and the pressures acting on strategy formulation. Despite this, there were many contentious points: for example, the assumption of being 'a research-based company' is not universally held as fact. The overall stress on a long-term programme met with hostility from non-Research personnel present at the meeting - they were concerned that the group expand its 'planned' research activities and concentrate on satisfying the market. Knowledge-push innovation has not been a very successful route for Research in the past few years: many people contend that they've produced nothing for too long. By contrast, market-pull projects are sometimes short of resources despite a strong justification for their development: the argument is thus around the deployment of resources - a typical political theme.

Planning and execution

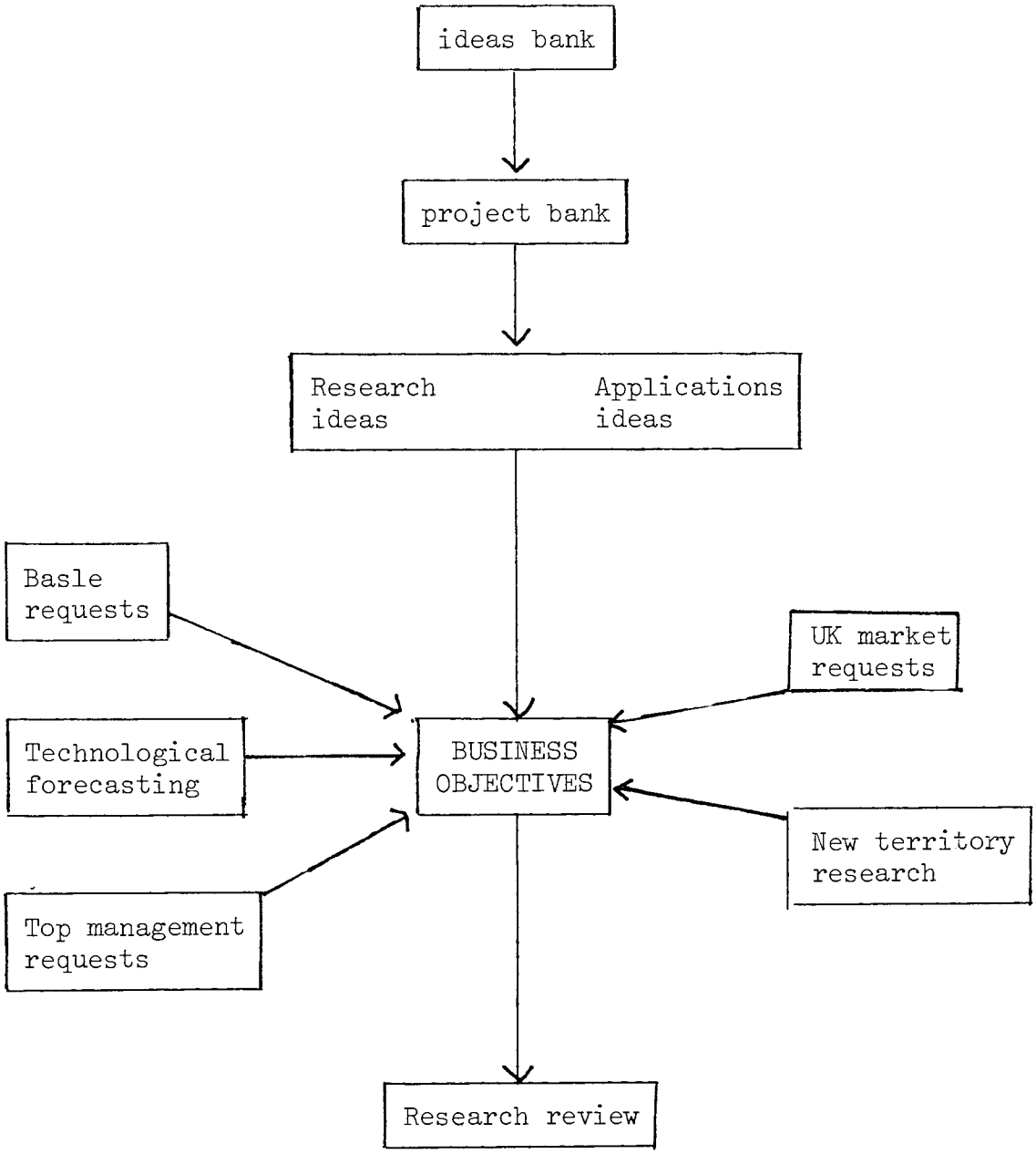
Product strategy	Scientific strategy	Background strategy (mostly university and consultancy)
New product development	Synthesis of new intermediates, pigments and additives	Pure research
Existing product defence		
New Forms	Physical and physico/chemistry studies	Pure research

PATENT COVERAGE OF ALL THESE

These activities are divided thus into planned and unplanned categories:

Product and target orientated projects	Scientific and means orientated projects
	Background work
Planned	'Unplanned'

The actual planning process involves a variety of inputs.



The research review is carried out annually and attempts to involve and satisfy as many people and interests as possible. Final meetings in Basle in the autumn finalise research programmes for the coming year.

The consequence of differing views on strategy and structure will be a conflict of opinion: this will not necessarily be a 'bad' thing. However, since it occurs at a very high level, it is likely to influence the overall thought and belief patterns of the majority of the organisation. If the conflict is not openly admitted and adequately resolved, the commitment of different groups to corporate objectives may not be total. A mirroring of the conflict at lower levels in the organisation can be expected and the repetition of standard political themes is likely to take place associated with a variety of issues.

(b) Meeting 3 Studies

In the latter part of the first year of the study the research focus moved beyond the Process Development department. The suggestion was made that the project could usefully look at the strategic management of the innovation process, and an invitation to attend a Meeting 3 was extended.

Altogether three meetings were observed, all held at Manchester and lasting all day. The researcher was present essentially as a 'fly on the wall' observer and studies were non-participant in nature. Techniques such as simple process and content analysis were used to try and make the best use of the opportunity.

Coupled with these studies was data collected over time from other individuals which helped to define the external relationship Meeting 3 bore to the rest of the organisation.

(i) Historical Data

Meeting 3 was originally a large meeting involving chemists, technicians and all those working on projects which had to be handed over to Process Development from Research. As the name suggests this takes place at phase three level in the progression system for new products.

This arrangement was rather impractical since it involved so many people and often got bogged down in details which were not the concern of the meeting. An alternative 'streamlined' version was set up which involved the Technical, Manufacturing and Marketing directors and members of the Product Management group.

The task of this group is to interpret policy and lay down guidelines: input to the Meeting comes from a variety of sources. Product Management work closely with their Swiss counterparts and help to formulate strategic plans which are put before the Management Committee.
This group lays down policy and strategy for the UK company which can be interpreted by Meeting 3 for new product strategy.

In practice all members of Meeting 3 (except the Product Executives) are also members of the Management Committee so that their activities will have a significant influence on new product policy.

The group meets monthly, usually in Manchester for a whole day: it is chaired by the head of Product Management. In addition to the regular membership described above, two of the meetings observed were also attended by a representative from the T.C.G.

(ii) Field Observations

From a simple observational viewpoint, it was apparent that the meeting was dominated by key individuals. In terms of status,; the product executives were junior to the Management Committee members so that this partially accounted for their inhibition; however the high level of formality at the meeting meant that this was not a strong constraining factor.

What was clear from an early stage was the dominant conflict of viewpoints between the Technical and Manufacturing areas: although the Marketing Director was involved in the meeting, his input appeared largely to consist of factual information rather than opinion. Ostensibly the meeting was controlled through the chair by Product Management, but in the meetings actually observed this role was very weakly played.

The conflict is easier to understand if we view Meeting 3 as one of the major 'battlefields' on which strategy is thrashed out. Arguably policy is made at the Management Committee, but there is still room for influence at Meeting 3 in its interpretation.

The differing views of the Technical and Manufacturing directors on strategy have already been discussed: it should be stressed again that, whilst these include personal views, they also represent the major strategic division common to the whole company. Provided such conflict is open and decisions arrived at through healthy discussion are adhered to and supported by all involved, this will be a very positive forum for strategic decision-making. The suggestion is, however, that this is not the case and that the meeting suffers from unresolved conflicts and lack of commitment by all its members to decisions.

An early example of this occurred at the first meeting studied; under discussion was the problem of Research/Process Development co-operation. The statment was made that '.....I don't feel that the attitudes are right - there are psychological problems involved in arriving at a fundamental acceptance of what the work should be - there appears to be a conflict of objectives between the departmental managers - between individual workers the situation is not a problem and the implication is that this is a high-level problem'.

The discussion which followed this suggested that the 'high-level' problem did not stop at departmental manager level but extended to their superiors, i.e. the directors involved at Meeting 3.

In this instance (and in many other cases) the role of Product Management is interesting. As the chairman suggested, their ability to take a broader view should mean that they can make a contribution towards improving integration and flexible relationships between two viewpoints e.g. on the issue of Research/ Process Development work. However the power of Product Management was never strong enough to intrude on the fundamental conflict - perhaps because they are a staff rather than a line group.

In addition to this element of internal conflict, it was apparent that the group was unhappy about its relationship to the organisation in Basle. There was a general feeling that truly joint decisions between the two were needed, and that Meeting 3 had a major responsibility to <u>persuade</u> Basle thinking. (This confirms the view of Meeting 3 as a policy and information <u>junction</u> rather than a source).

A number of other problems and concerns were discussed; typically these included:

- concern about the additive effects of marginal (contingency) decision-making in the face of an uncertain and dynamic environment.

- concern for care in minuting the meeting as opposed to reporting the whole discussion ...'bearing in mind the audience'.

- concern about the apparent ease with which rumours evolved, often from a chance remark taken out of context.

- concern for the need to plan for psychological reactions to certain decisions and their implications.

- concern for the correct balance in withdrawing or shelving product and initiating new ones.

- concern about the overall strategy - the need to make decisions and stick to them, even if personal commitment to a particular line is absent.

- concern about communication problems e.g. a report on a Process Development project: 'they do a lot of good work but then they find out something different has been done by production control laboratories'. General worries about coordination.

- concern about costing of development projects, 'still carried out on too informal a basis at present', need for formal documentation, ground rules, comparative bases etc.

- concern over encroachment on Meeting 3 territory e.g. by logistics.

- concern about Research and Development mechanism - feasibility study before final development and risk being late? or straight into final development and risk having no market? 'Do we need more restraint on the Research and Development operation?'

- concern over Production laboratories carrying out their own 'Research and Development programmes: duplication of effort, lack of shared information etc.

- concern about the growing 'follower' status of innovation within a company that had the reputation at one time of leading the market in new ideas. The question of how many 'long shot' projects to pursue, and its resultant resource allocation decisions.

- concern about integrating other elements in the environment - e.g. agreements with competitors and the necessity for maintaining goodwill in these areas.

- concern about Basle lack of confidence in Paisley ability to produce and market successfully.

- concern about the T.C.G. appearing to cut corners in the Werdegang - how to override them without reducing their autonomy. General problems with relationships between the groups - e.g. minutes with accusatory clauses like 'we are still waiting for a Meeting 3 decision on this one.....'

- concern that Meeting 3 are handling too high a level of detail.

- concern over problems of 'departmentalisation'

- concern over 'incoherent policy', 'incompatible objectives', misinterpretation of the outside world, etc.

(iii) Process analysis

In addition to simple observation of the meeting, attempts were made to analyse various elements of interaction involved. (This method, originated by Bales (1951) is described more fully in the methodology section). Categories such as information giving and seeking, opinion giving and seeking etc. are 'scored' for each individual and for the whole group over measured elements of time. In this way the character of the meeting, irrespective of its content, can be assessed.

Simple analysis supports the general observation that the meeting was dominated by certain individuals: the overall number of contributions were largely made by the Technical director, the Manufacturing director and the chairman. Whilst the last-named could be expected to be extensively involved in view of his role, the dominance of the others is interesting.

Looking more closely at the type of contribution we find that opinion giving is again dominated by the Technical director, with the Manufacturing director second in the ranking. Information giving is much more the province of Product Management and this is reflected in the high scores of the Product executives and the chairman. Similarly the highest scores for information seeking were held by the Technical and Marketing directors: this supports the view that the meeting functions as an information junction between the business (as represented by Marketing and Product Management) and the technical elements.

Of further interest in this connection is the role played by representatives of the T.C.G. On several occasions a member of T.C.G. attended Meeting 3, presumably in an attempt to bridge the gap between the two groups. In terms of their contribution to group process they were very significant, scoring highly on information giving and seeking and opinion giving. (This suggests that there is an information flow limitation on the existing channels and that personal representation provides a necessary extra channel for this).

Overall there are limitations to process analysis: but the findings reported here provide support for overall observations about the meeting.

(iv) Role analysis

Another observational aid is that of role analysis (e.g. Benne and Sheats 1948), discussed in the methodology section. In the case of the marketing studied, a number of roles emerged.

(a) 'Provoker'

This role was taken up strongly by one of the product executives (and appears to be a strong personality function since he plays this role outside of the meeting as well). It is characterised by a strongly challenging attitude interjected throughout the discussions, sometimes openly, sometimes sotto voce. Flippant and direct commentary, a disregard for status or formality (despite the fact that his superior was also at the meeting), this role had both a positive and a negative aspect. At its best it allowed a high level of honesty, refusing to gloss over points which needed discussing, even if they were sensitive issues. At its worst it was annoying and disruptive and provoked hostility amonst other members of the meeting.

(b) 'Substitute Chairman'

This role emerged as a reflection on both the weakness of the nominated chairman and the strength of character of the Technical director who assumed the role. This was essentially concerned with content rather than process, i.e. those activities related to how long an issue was discussed, when a decision was to be arrived at and when to proceed to the next item on the agenda. Since the agenda consisted largely of a number of projects whose progress was under review, this provided an opportunity for covertly exercising influence on the direction of these.

(c) 'Chairman'

This formal role was, as indicated above, filled rather weakly: there was no sense of control from the chair with regard to the direction and content of the meeting. However as far as the other process of the meeting was concerned this was an effective role: support and maintenance, smoothing of conflict and hostility etc. were all well-provided and this helped in keeping a balance about the meeting.

(v) Content Analysis

Another attempt to broaden the overall observational picture, again described in the methodology section. This analysis is most revealing in the range of subjects discussed: in addition to strategic and policy issues which one would expect, there seems to be a high level of 'local' detail discussed. Chemical reaction sequences, suggestions for optimisation, equipment problems etc. are clearly the responsibility of operational groups and not a senior policy group.

The reason for this is likely to be that all members of Meeting 3 have spent a long time in the industry and have extensive operational experience in a number of fields. Thus they will find it difficult not to get interested and involved in problems of this kind: however it restricts the efficiency of the meeting and upsets other groups who feel that their autonomy is threatened. The criticism that 'Meeting 3 handle too much detail' was often raised elsewhere: this seems to be justified in part.

Inevitably the character of this meeting changes over time: for example, the original chairman changed jobs and his successor is, by all accounts, much more forceful and controlling. The relationship between Meeting 3 and T.C.G. has been the subject of extensive dialogue and the terms of reference of the latter have been rewritten: implicit in this change of role is a similar one for Meeting 3.

(c) T.C.G. Studies

(1) Archival data

The T.C.G. was set up in October, 1975 as an attempt to bring about closer coordination of functional groups. Amongst early discussion of objectives for this group, the following factors emerged in correspondence:-

(i) In order to cut down the time needed for getting products on to the market it would be acceptable to members of the company that the interfaces between departments would be a little less rigid than hitherto. Nevertheless the departmental managers concerned have the final responsibility for the work done in their departments.

(ii) We will make a specific and concerted attempt within and between our departments to foster informal cooperation and interchange of ideas at all levels. We aim to do this whenever possible without teams or committees but we do not underestimate the difficulties in overcoming traditional protective

/attitudes at some levels of management.

(iii) We are collectively most unhappy about the present system of arriving at research projects. The scheme (idea, product, market justification, product specification, allocation of priorities, project) at present sometimes take place out of sequence, the original data (the idea) are not always thought out precisely or accurately enough and the whole takes too long. Moreover the Research targets are rarely brought up to date subsequently. While we intend to do what we can to improve matters, the solution is largely in other people's hands.

In another document, they emphatically reject the notion that 'the group exists to overcome a lack of communication between departments'. They argued, rather 'that we exist to achieve a collective sense of direction and purpose in our group and to maintain this at all levels in our departments'.

A later meeting in December reiterated the view that the group had begun well: 'while it is still a little early to say that our style of operation has been fully established, there is a welcome sense of pulling together in one direction which we will do our best to maintain.....'.

The issue raised in (iii) above was a central topic: in particular the group was concerned about the quality and frequency of market information being fed to the research process. They were trying to get action taken at higher levels to influence the process to improve things - 'otherwise, no matter how effective T.C.G. is in speeding up the events culminating in the manufacture of launch stock, we will achieve nothing whatever of value. We will just get the wrong products onto the range more quickly'.

Another problem identified in a meeting in February 1976 was the rearrangement of Meeting 3. Previously this had involved chemists and personnel working on projects in an often chaotic meeting aimed at overviewing the handover of products between Research and Process Development. This had become 'streamlined' and now involved senior management only: the fear was that the earlier

/involvement might be missed. The T.C.G. commented that they had been well aware of this problem and had 'devoted a great deal of though and effort to avoiding inadequate communication and involvement within our departments. In general we are satisfied that this is being achieved - indeed the feedback is that any slight deficiency there may be in this area is a small price to pay for no longer having to attend the old-style Meeting 3 which many chemists found to be a distinctly demotivating chore'.

In April 1976, the group reported on its progress since its inception. Their main conclusions were:

'(i) it has not been difficult to establish a sense of purpose and direction in the T.C.G., though we have at times been hampered by absence of policy.

(ii) T.C.G. exists primarily to speed the progress of new products, particularly in Phases 4 and 5 through to launch. There have been one or two hiccups but in the main we have shown that the proper compromises can be arrived at/

and we feel confident for the future that emerging products..... will move forward equally rapidly'.

(iii) 'T.C.G. is also charged with speeding up the progress of new products in Research. We have concluded that this is not an easy task but the identification of problem areas within Phase 3 will enable this function to be at least partially fulfilled.

(iv) 'T.C.G. is also commissioned to examine market justifications for new products and to feed in ideas of its own.... at present changes in policy or clarification of it take place by a variety of informal routes, which is highly undesirable. T.C.G. has been singularly unsuccessful in feeding in ideas of its own..... There seems still to be a useful area in which short-term improvements to existing products could be made, outside the research programme, in order to improve either our profitability or market share, if Marketing could identify points of deficiency and provide the justification'.

(v) 'As far as Meeting 3 is concerned, we believe it would help if this body concerned itself solely with:

(a) officially recording progression through the phases

(b) clarifying policy.

It should not, in our opinion, be making technical assessments nor should it become involved in detail or even with how results should be achieved...

If Meeting 3 can establish itself formally as the sole policy-making body there will be less tendency at all levels to take each little verbal comment as representing the lates 'policy'. This is particularly the case with visitors from Basle. We would strongly support an increase in the status of Meeting 3 in this respect with less dependence on Basle policy'.

Later correspondence between the groups acknowledge the definition of role for Meeting 3 as policy-makers: this represented a resolution of part of the conflict. Meeting 3 felt that 'it should be the prime role of Meeting 3 to act as the filter for the initiation of projects.....'

Further apparent resolution of conflict between the groups emerged in a report in July 1976. Whilst continuing to be unhappy about the lack of a bridge between the groups, favourable comment was made on a memo from one of the members of Meeting 3 giving his views on the T.C.G. Included in this memo was the following: 'Personally I believe that the T.C.G. has made a number of significant improvements in the course of its first six months and I would catalogue these as follows:

(a) a breaking down of barriers with a resultant improvement in progression of products between the departments represented by the T.C.G. members.

(b) a united plea for better information and justification for Research projects. Hitherto individual departmental complaints tended to be interpreted as interfacial problems rather than a recognition of a common basic deficiency.

In May 1976, the report included a further reference to the gap with Meeting 3. 'The most recent Meeting 3 minutes suggest a more decisive style for that meeting, which we welcome. It is also to be applauded that there appears to be much more concern with policy and less with detail. We are still concerned about the lack of a bridge between T.C.G. and Meeting 3, which will not be satisfactorily resolved by the proposed periodic get-together'.

Very similar comments were made in June 1976: '...the T.C.G. still feels that too much detail is discussed at Meeting 3 and that this in many cases could be quickly disposed of if one of the T.C.G. members was present. Equally it is difficult when policy is communicated by Meeting 3 to get the full flavour from minutes.. Similarly...the T.C.G. minutes may leave Meeting 3 confused at times.....There seem to be two difficult problems:

(a) to provide a bridge, preferably human, between the two meetings.

(b) to ensure that matters we raise receive due attention and response.

(c) A necessary goad to the Management Committee for providing a clearer idea of policy and strategy'.

In discussion the following month with the chairman of Meeting 3 concerning the possible representation of the T.C.G., it was commented that the group's role had altered '...with the change in the economic climate, in that there is no longer such a pressing urgency to launch new products'.

Insofar as definition of role was possible, this was well summed up in September 1976: 'There is broad agreement that Meeting 3, broadly speaking, sets the policy and the T.C.G. provides a facility for carrying it out. The T.C.G. does not take decisions or accept responsibility for action: these are line management functions'.

Late in 1977, arising partly out of the 'Fate of new products' discussion, revised terms of reference for the T.C.G. were drawn up to better fit it to the contingencies it faced.

'The T.C.G. was originally formed in 1975 during a deep recession. Its major objective at that time was to expedite the rapid introduction of new products to full-scale manufacture and sale, by bringing together the appropriate functions in a common forum: the original terms of reference.....explain how we seek efficiency improvement and the commitment to common divisional objectives through the development of lateral relationships while retaining vertical loyalties.

Although the business environment has altered and our strategy and plans more clearly define our objectives, the need for rapid progression of new products is as urgent as ever: the necessity to press for reduction of departmental interfacial difficulties as real as ever. The original terms of reference related primarily to new products emanating mainly from Research and Development projects in the classic market requirement sense. It must be recognised however that increasingly we are faced with requirements associated with process changes and improvements, 'ecological' projects, rationalisation projects associated with new plant and product range structuring and others: all on top of the new product projects.

At the same time we have a limited technical resource but one of much experience and diversity ranging from speculative research to factory control. The matching of this resource to that which is essential in our technical programme is of great importance: we cannot afford duplications, inefficiencies or irrelevant work.

It is suggested that the original terms of reference of the T.C.G. largely hold good but that their remit be widened to ensure that the total technical resource is indeed deployed and interacts in the most effective manner to attain our overall objectives and that renewed emphasis is placed on the need to expose and solve problems affecting progress'.

The debate as to the future role of T.C.G. was continuing at the conclusion of the research.

(2) Field Observations

Thanks to extensive co-operation from all those involved, the researcher was able to carry out a wide range of observations with the T.C.G.: these included direct observation, process analysis, content analysis, role analysis etc. as well as discussion and interview with members of the group on subsequent occasions.

The first observation was that the group was far more defensive towards the researcher than Meeting 3 had been: it was suggested that only after some discussion had it been decided to allow the observation to take place. Arguably this higher level of insecurity arose out of the ambiguous and vague identity which the group felt it possessed. Over time line managers had become more and more isolated, and thus the T.C.G. was a welcome forum at which they could exchange views and discuss issues, express opinions etc. behind closed doors and with their peers in the organisation. However the actual role and task of the group was unclear, so there could have been suspicion that the researcher would:

(a) conclude the group was ineffective since it wasn't clear about its task and

(b) conclude that the group was fraught with problems, conflicts, personality clashes etc. which were in fact only artefacts of an essentially open and frank meeting.

(These observations are suggested to account for the different climate perceived at T.C.G. in comparison with Meeting 3).

Once again, there appeared to be a dominant conflict in the group, between the Research and Process Development managers. This is interesting since in line management responsibility these two mirror the Meeting 3 split between the Technical and Manufacturing directors. Another similarity with Meeting 3 was the relatively non-aligned nature of the other groups represented. The chair was held by the manager of Quality Control (the Chief Colourist) whose concern was more with production testing (although Research and Development testing on the Paisley site was carried out in his area; this arrangement was rationalised in 1977, and Research and Development testing came under the more logical wing of Applications.)

In every case the hostility was veiled behind a cloak of formality; the chairman did much to preserve this formal, atmosphere by effective control using 'smoothing' tactics. (The long-term effectiveness of 'smoothing' as a conflict resolution strategy is generally felt to be limited (e.g. Blake and Mouton, 1964, Filley, 1977). However, it is argued that this appears to be the dominant and most sophisticated method used on the Paisley site; perhaps there is a cultural reticence about using confrontation or forcing tactics?).

Once again, the group suffered from external integration problems. Relationships with Basle were often brought into question, particularly over the planning cycle for Research and Development projects. There was concern felt about 'strings being pulled from Basle' on ways and means as well as on policy: 'how you achieve your goals is surely a matter for your judgement - not Basle's decision!'

As far as strategy was concerned, it was apparent that the group would have liked to make a greater input. '<u>We</u> are responsible for the next boom or slump - that's the real Research and Development problem'; however, the response was to wait for strategic guidance from those responsible, and to blame them if this was ineffective. A mood of cynicism seemed to underlie views on this issue - essentially similar to the views expressed at lower levels, e.g. 'you can't beat the system. The company doesn't know or care where it's going and it keeps getting it wrong. Nothing you can do will make a difference'. As one of the T.C.G. members put it, referring to a recent management seminar, 'Cally sent people away with nothing except perhaps enthusiasm, in their bellies'. The view was that the responsibility for resolving the issues raised was delegated to them as managers - but taking the initiative was difficult with a system as limiting as that which governed them. Coupled with this was an open acknowledgement of the low levels of trust between individuals and groups which acted as a further inhibiting factor.

The dominant concern of the group appeared to be that, whilst they were charged with the responsibility of arranging and co-ordinating the ways and means of the Research and Development projects they were paralysed by a lack of faith in the strategic framework in which these were taking place. For example, the suggestion of a failure rate over 50% on projects which had already had a feasibility study carried out from all possible angles - 'at that stage, it's ridiculous!'

Arising out of this feeling was the survey on 'The Fate of New Products', an attempt to locate the causes, technological or otherwise of failure - and to see if there was a dominant pattern. (This issue is discussed elsewhere).

In general, the meeting had a very strong informal function in providing a forum where the individuals could 'let off steam' and gain support for otherwise isolated viewpoints.

This was borne out by the relatively high incidence of discussion 'off the record'; in this way sensitive and political issues could at least get an airing; often this activity reflected strong criticism of individuals or the system -'our dirty washing' as one member put it. The relevance of discussions of this kind to the task of the group was questionable, but it had a strong value in binding the members into a closer relationship; thus it bore strongly on group identity.

Another operation in the group was 'testing the water'; an attempt to try out opinion on certain issues related to general co-operation between departments (i.e. not confined to the innovation process).

Overall the meeting was not dissimilar from Meeting 3; characterised by a dominant internal conflict and a range of concerns all associated with elements of external integration. A number of changes have taken place since this study was undertaken, largely in response to external criticism, personnel shifts and changes in the relationship to Meeting 3.

Criticism of T.C.G. suggested that it was too isolated (examples of this comment can be found elsewhere in this report) and worked from too weak an information base. This has partly been overcome by adopting a policy of 'calling witnesses' and involving the technical personnel actually working on projects for the portion of the meeting where their projects are under discussion. Contact with Meeting 3 has been improved by occasional visits of T.C.G. personnel to that meeting and by having the Product executives attend both meetings.

This has not been such a successful experiment in view of suspicion and mistrust on the part of the T.C.G., and because of the personal style of one of the executives involved. However, it these differences can be resolved, it will improve the meeting's effectiveness since the quality of information input is much improved.

The changes in terms of reference have already been discussed; they reflect a change in the role and identity of the T.C.G. In many ways the carrying out and circulating of the new products survey has defined more strongly the kind of critical input which the group can make.

In addition to this unified approach, changes in the personnel of the group have brought about closer integration.

The group has contracted and now involves only the Production, Research, Applications and Process Development managers as major representatives plus the Product Executives. The new Research manager appears to have less of a personality clash with the Process Development manager, and there is a growing element of integration in their political/ strategic aims. This arises out of the growing acknowledgement of the need to cut down on speculative research and improve product development work, and also out of the extensive interchange of philosophies carried out in working group B, a senior management group set up to investigate innovation problems.

Examples of the issues discussed by this group included:-

- concern about strategy - is it right?
  - do we make enough input?
  - what is the business about?
  - whose responsibility is it to ask questions of that sort?

- concern about market and environmental dynamics - 'the product field where the winds of change blow ever more frequently'

- concern about role and responsibility of the group - 'is it our function to comment on things happening which we are not happy about?'

- concern about mismatch between policy, strategy and the real world - 'performance in past on the research programme has been poor because by the time the projects are finished they are no longer required'.

- concern about high rates of failure, low cost effectiveness of Research and Development work.

- concern about limiting innovativeness by too great an awareness of cost and competition constraints.

- concern about timidity of company - 'is it the Swiss elements? Build the best watches and cuckoo clocks, then get knocked out by electronic watches?'

- concern about different interpretations, interests, priorities of groups involved

- concern about attitudes of other groups.

- concern about relationship with Meeting 3 and criticism that there is a gap in communication flow, that they are taking decisions from a weak information base etc. - e.g.'the people who wrote this minute weren't aware of all the facts'. Problems of politics at that level - 'more politics than real life sometimes! ' Criticism that there is too much detail discussed - 'whether we get the properties by stirring in, boiling in nitric acid or whatever is none of their (product Management) business - their role is to specify the properties required!' Concern about 'mysterious' decision-making - and lack of clear guidance on other issues. Decision making too slow.

- concern that Meeting 3 minutes are essentially a political document to be sent to Basle.

- concern about resource deployment vs relative advantage balance in new projects - e.g. is it worth tying up production plant for a given project?

- concern about presenting a 'united front' to outsiders, e.g. Basle - refers to earlier criticism of fragmented and duplicated effort.

- concern about handover between departments.

- concern about lack of confidence and faith in Marketing/Product Management.

(3) Role Analysis

As with the Meeting 3 studies a number of key roles emerged.

(i) 'The Lawgiver': this role was characterised by strong information giving: the quality of information was essentially irrefutable and concrete - 'tablets of stone'. This role was played most often by the Applications Manager and this is in keeping with his contributions about the business aspects of the innovation process: he alone had direct knowledge of what the world outside wanted. Also he was closer to senior management (since they were housed down in Manchester) so he could also pass on opinion etc. with some measure of credibility.

(ii) The Chairman: Unlike Meeting 3, the chair at the T.C.G. was quite strong and firm, the chairman seeing his position as central, neutral and largely objective. He had a clear conception of the identity and role of the group and was very careful in his ordering of the minutes to reflect the group as a unified if dissident collection of managers.

The process of the meeting was not neglected: support and smoothing were often evident and there was considerable reinforcement of the 'behind closed doors' element to encourage open and frank discussion. He believed strongly 'in the ability of this team to transfer information efficiently, exchange views and sort out problems, whilst leaving the actual decision-making to the linemanagers in question'.

(iii) "The Sceptic": this role was filled by the Production manager: essentially he occupied a detached position in the meeting, only interjecting where the content involved production directly. His attitude towards change appears ambivalent: whilst personally appearing open-minded and enthusiastic, he plays the role of sceptic, cautious and conservative - 'you'll never get away with that here!'. In this he may well be reflecting the long tradition of Production cynical of any change that they did not introduce.

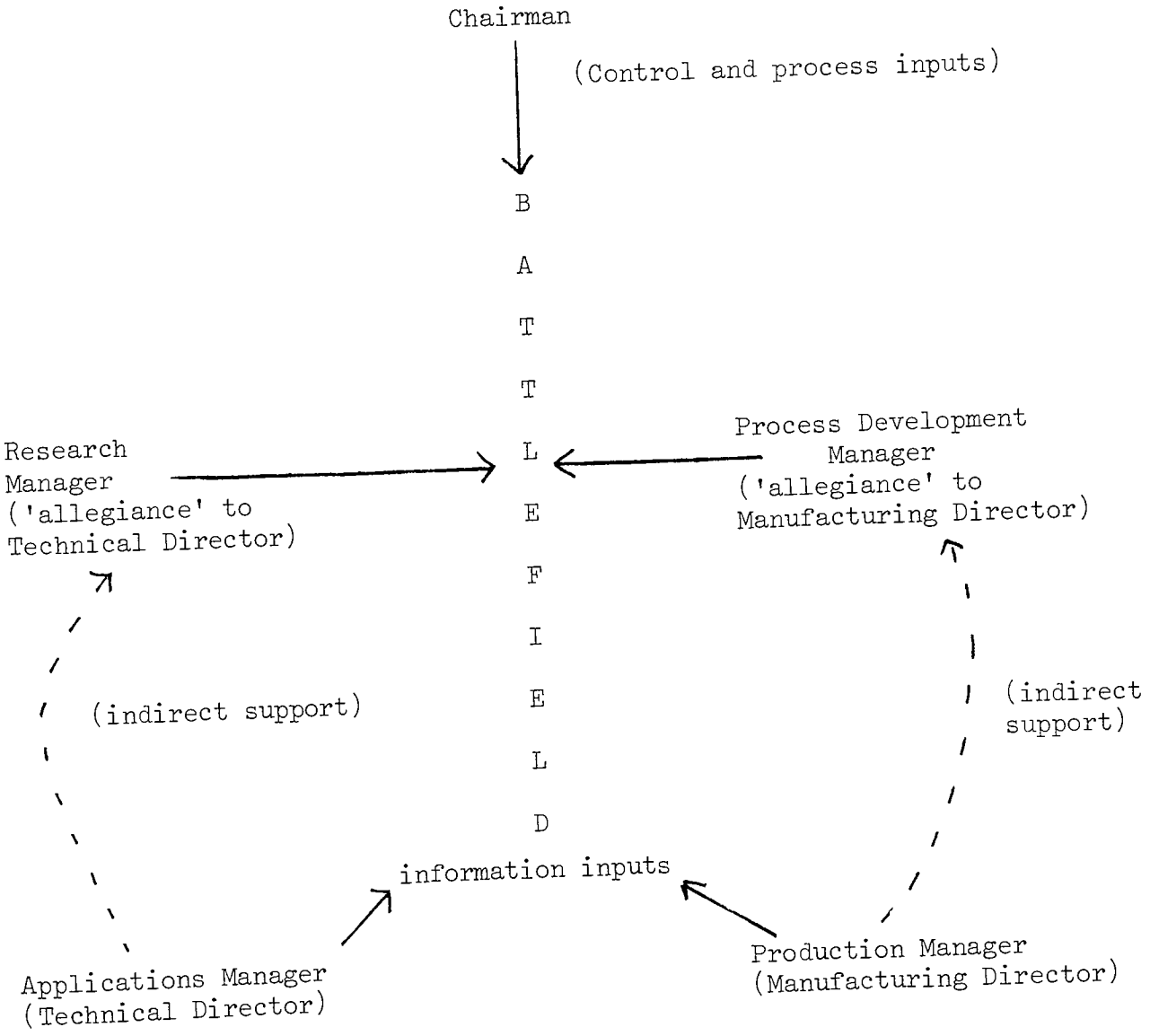
(4) Process Analysis:

In terms of overall involvement in the meeting the chairman is predictabily the most dominant scorer. Contributions from other members seem equally distributed except for the Production manager whose involvement is considerably less. His contributions seem largely confined to information giving: the dominant contributor in this field however is the Applications manager. Information seeking shows little differentiation in scores except for the chairman's: it is to be expected that he will need to collect information since his role is outside of the normal innovation process channels.

Opinion giving is another area where there is relatively little differentiation: the low scores of the Production manager could be remarked. In general this suggests that the meeting has achieved at least a level of openness where opinions can be safely advanced.

In terms of supporting and maintaining activities scores were surprisingly low: the chairman's score alone stood out, as would be expected. This confirms an observed perception that the meeting exists in a state of dynamic tension, finely balanced and controlled from the chair.

Diagrammatic representation of meeting process



As with the Meeting 3 observations, the involvement of representatives from groups outside the T.C.G. changed the balance, particularly of information flow. Both the product executives and the operational chemists, project heads etc. had a large input in information: this suggests that criticisms of a limited information base in its earlier form may have some substance to them.

(d) The Fate of New Products

Faced with what was felt to be too wide a range of problems in the introduction of new products, the members of the T.C.G. conducted a survey in which they identified what they thought were some of the reasons. In June, 1977 they published their report, sending a copy to Meeting 3. Predictably enough, in view of the many criticisms which were directed towards members of Meeting 3 (especially Product Management) a reply was sent giving the other side of the story.

An attempt is made here to present the major arguments offered by both sides.

(i) The T.C.G. study; 'A study of the progression of new products in Pigments Division during the past 2-3 years'.

The introduction to the study explains the motivation behind it; 'it was felt that this report was necessary because of the very strong awareness of wasted effort in the progression of new products. While normal problems are inherent in any Research and Development organisation, we have attemtped to highlight areas of special difficulty and delay'.

In the experience of the researcher the awareness of wasted effort was very real; many chemists in Research and Process Development had expressed the view that 'it's not worth bothering - this company doesn't know what the hell it's doing - every time we put all our efforts into getting a new product out, it gets shot down. Politics, lack of strategy, bad judgement - we never even get to know the reasons why some products are cancelled. It's like banging your head against a brick wall - after a while you stop bothering'.

The study itself presented a survey of some two dozen pigments and commented that only one had 'passed smoothly from being a gleam in the inventor's eye to being successfully manufactured on a full plant scale without any complications. 'In every other case it was apparent that difficulties of various kinds had prolonged the time for them to reach the market or even the plant.

In general terms the survey identified the following general problem areas:

- faulty product st rategy (no clear idea of long term company objectives)

- inadequate analysis of the market or panic reaction to a purely temporary market situation

- excessively long response time to market changes

- basic product deficiency

- basic process deficiency

- product testing deficiencies

It was also stressed that these categories were interdependent - e.g. a major fault in product evaluation or market strategy must have an effect on the suitability of the product or on the time taken to develop it. Importantly, the report went on to say that this list of factors oversimplified the real situation; other influences were acting as well. Examples offered included lack of commitment, inadequate project definition, slow, cumbersome decision-making and a general reluctance to take risks.

They summarised the two factors exerting the most widespread effects as:

- the need to improve the quality of the business input into the Research and Development programme and maintain it throughout the year.

- the need to improve the selection and general acceptance of project and product priorities.

Recommendations were along the following lines:

- to improve the situation by better circulation of project and market justifications, and by closer scrutiny of these ('they should be scrutinised as critically as are capital investment proposals of a corresponding magnitude'). This scrutiny should cover these aspects:

  - show how the product fits into the newly-formulated product strategies

  - identify market gaps/needs/opportunities and indicate cost and profitability potential

- include a consolidated estimate of technical feasibility within a stated time-scale, based on systematic assessments by the relevant departments

- if and where possible, indicate the likely manufacturing implications, including the possible need for new investment

- improve project control by having, in addition to departmental mechanisms for overseeing the progress of a new product, a formal project audit. This would involve participation of all concerned including the Swiss business input. This audit 'should not just be critical of the performance of products emerging from a given project but review the whole viability of the project in the light of the most recent commercial information, project progress and resource allocation. It should re-confirm commitment to the project in question'.

The report also contained the individual case histories of several products and identified problems associated with each. Amongst the list of difficulties, the following emerge:

- no justified product, no strategy

- lack of understanding of the market situation-misjudgement of potential

- product perpetuated on a stop-go basis, no-one able to come to a decision

- emotional attachment to a specific business strategy

- technical and testing problems, impossible to achieve ideal combination of properties. Phase three standard a compromise

- fluid market situation

- panic reaction to appearance of competition product-incorrect assessment of market impact of this

- lack of firm decision-making product remains too long in limbo.

- inability or unwillingness to make a decision about less-than-perfect products

- slow and spasmodic gathering of applicational information

- lack of support

- Research/Process Development interface problems

- raw material supply and quality problems

- project lacked support of the whole company

- change of direction on an apparently ad hoc basis

- technical inadequacy

- aimed at wrong market

- confused strategy

- lack of decision-making over many years

- continued support for product in the face of negative information

- too long in development

- insufficient analysis and control at the phase 4/5 stage

- lack of confidence

- lack of access to the true market situation

- lack of access to the evaluation procedures used by the European marketing force

- critical assessment at phase 3/4 lacking

- panic reaction

- lack of market intelligence

- lack of strategy in certain areas of business

- 'we appear to collide with market changes rather than anticipate trends'

- misleading information base

- right decisions made but too slowly

- lack of information dissemination within the company

- policy confused

- product developed quickly but got lost in changing strategy

- duplication of effort between Research and Process Development

- poor planning

- rate of scale-up too slow due to unforeseen technical difficulties

- products stopped too late - should never have been started

- too low priority afforded

- misjudgement of plant capacity and equipment availability

- testing variations

- complete lack of strategy and guidance

- orientation towards single customers only

In general, the histories presented a view of events which, whilst acknowledging the problems of operating in a dynamic and competitive market, suggested that there were or had been deficiencies in the whole approach to planning. There were repeated references to technical difficulties and many failures were accepted as being due to problems in this sphere; however the major criticim was the lack of clear decisions as to whether projects in difficulty should have been allowed to continue.

The report concluded 'of the twenty or so products examined, only two have reached the market place and attained any appreciable success. A further two were overtaken by competition before reaching production and were then shelved, while all the others have been rejected or modified in some way before reaching the market-place.'

Whilst accepting that some of the 'blame' lay in their own departmental areas and needed better co-ordination and control, they suggested that'the most improvement is possible in the initial stages of identifying the project in terms of market requirements. If this stage is carried out correctly and adequately, and if any market changes necessitating updating of the project are efficiently and rapidly communicated to the Research and Development department, the chances of success are much greater'.

Naturally this document stirred things up at Meeting 3 whence it was addressed; it was discussed on several occasions. In October a reply was sent to the T.C.G. outlining the results of these meetings.

The first criticism offered was of the time period chosen; Meeting 3 felt that recent years should be considered unsatisfactory for these reasons;

- 'As an aftermath of the merger and as a result of the unpredictable economic climate, there was uncertainty about the long-term business strategy. Research and Development planning was therefore unable to keep up with the changing business objectives during the period 1971 - 1976.

- the changes in business objectives were in some cases a shorter time-scale than those required to bring Research and Development projects to a successful conclusion; this has also applied to the last two years when changes to the programme have been running parallel with the development of a business strategy.

- the 1976 Research and Development programme was finalised in an environment of business recession when volume to improve profitability dominated our thinking

- the Research and Development programme has been too broad for the resources allocated by the business in relation to the time scales expected'.

They suggested that the current dearth of new products should be considered against this background. In planning future Research and Development programmes they were of the opinion that the following parameters should form the basis:

- business strategy
- marketing tactics
- defence of existing business
- innovation
- resources available
- chance of success
- research strategy (balance of background work and project work)
- toxicological aspects
- investment programme (short and long term)
- management abilities (decision making)

In addition they stressed two other factors; determination to succeed and discipline to adhere to the programme.

Having set out these basic ideas, they went on to respond to specific criticisms.

On the planning and selection process, they agreed that changes in direction of the business strategy during the past few years were largely responsible for the failure of new products. In particular they drew attention to 'the Division's romance with the European Publication Gravure market'; the change in strategy involved here had led to the conclusion of Research and Development work in this area in a responsible manner. Unfortunately this had been a painful detachment. They admitted that, even after the strategy became clear in this respect, management had continued to be 'dazzled by the volume potential for new products in this sector'. They had been further influenced by the belief that 'a clean surgical cut of the relevant Research and Development projects would do great damage to morale in the affected departments'. Thus a conscious decision had been taken to progress the work to a point where it could be written up and the products shelved for possible future introduction.

To the chemists it was apparent that this picture did not come across; instead they felt it represented poor management. Consequently morale was further eroded. Lessons learned from this experience were;

to change direction in business can have a major effect on Research and Development success

- Research and Development programmes need stability for success; sudden tactical changes should be avoided as much as possible

- resulting changes in the Research and Development programme associated with a change of business strategy must be carefully planned and anticipated well in advance. Where there is no benefit to be obtained from continuing related Research and Development work, it should be stopped right away.

On the subject of priorities for Research and Development they stressed that 'a correct balance of priorities within the Research and Development programme in the context of the Business strategy must be obtained. 'Two examples of failure to achieve this balance were quoted; corrrect balance of priorities should depend on;

- defence of existing business

- resources available

- chance of success

- innovation

- potential profits

It was accepted that poor balance of priorities over the past few years had led to poor technical defence of existing business.

The problem of market input to the Research and Development programme was also discussed. The diverse and growing nature of markets placed limits on the amount of information available. In particular, knowledge would be highest in areas of well-established markets and would fall off rapidly in the new areas; for the major growth markets (i.e. Europe, except W.Germany) the market intelligence learning cycle had only just begun. This was further complicated by the fact that markets were constantly changing, thus making the planning task very difficult. Trend identification was hard; 'from past experience, it is recognised that basically it is too late to call for action to combat a market change when it is already well underway; good planning requires us to identify trends and potential needs much earlier'. Whilst the criticism that past decisions had not necessarily been based on a balanced judgement, it was suggested that it was equally possible that the Technical structure was too inflexible to react quickly to change. (i.e. returning that ball in part to the T.C.G.'s court.

Whilst admitting that 'too often justifications have not been thought out well enough or have been made on too optimistic a basis', they went on to criticise the input made by Research and Process Development, in particular;

'- what are their strategies?

- do these strategies correlate with the business strategy?

- do they sell innovation well?

Having considered the planning elements, they went on to discuss issues related to the execution/fulfilment of the programme. This was principally concerned with a reiteration of the operating philosophy, i.e. that ultimate responsibility lay with line management. It was their task to 'ensure that the programme objectives are pursued. Any significant deviation should be notified to Meeting 3 for consideration in relation to the planned project'.

One of the mechanisms available to line management to help them in this task was the T.C.G.; new terms of reference were being drafted but the group's major responsibility was to smooth the passage of products through the Werdegang. The role of Meeting 3 was also clarified; it was basically a sub-committee of the divisional Management Committee and provided a parallel forum to the Swiss equivalent. 'Within the framework of the divisional and business strategy and planned objectives this group informs the T.C.G. and line management on matters of policy affecting the Research and Development

/projects and new products. It progresses in the formal sense the passage of new products through the Produkte Werdegang.' '... the PKK (Swiss equivalent) and Meeting 3 are the technical bodies representing management commitment to the business strategy and should in no way hinder the progress of new products'.

The role of Product Management was also made explicit; they were responsible from a neutral standpoint for ensuring departmental action to correlate with the achievement of the business objectives. Comments in the T.C.G. document in respect of a more positive role for this group were fully accepted.

On progress of products they commented that 'once the Research and Development project is under way, there should not be an abdication by Applications, Product Management and Marketing regarding feed-in on further technical and commercial information. The input by these bodies plus the output by Research and Development should be a dynamic flow not static. Many of the problems over the last years can be laid at this door'. The idea of a formal project audit was accepted; it was felt that this would also provide a means for alerting management to any innovative products which might need 'selling' within the company before progress along the phase system could be made.

Risk-taking and decision-making were also considered; 'one point that is worth highlighting is the need for individuals to take decisions in their own area of responsibility and not to abdicate this to committees.'

The reply concludes with an analysis of the T.C.G. criticisms, and identifies these areas of action needs;

'- more effort to keep input flowing is needed
- continue attempts at closer liaison with Basle through Applications, Marketing and Product Management
- continue divisional management support to the T.C.G. to help solve problems
- a commitment to improve decision-making and risk-taking needed by all concerned. Get rid of red tape; don't allow the committee system to slow progress.'

Analysis of these two documents suggests first of all that they reflect the same feelings of dissatisfaction as have already been discovered at other levels in the organisation. <u>The basic message is that, faced with a highly complex and dynamic market situation, the company need high levels of integration to cope successfully</u>.

All the problem symptoms, lack of information flows between groups, interfacial difficulties, lack of adequate contact with Basle marketing, lack of strategy etc. can be viewed as posing problems for integration. For example, a formally declared (and adhered to with discipline) strategy provides an integrating device at the level of securing commitment by all concerned to common objectives. Where individual judgement is required it can be used with reference to the overall stated aims and objectives of the organisation as defined in the strategy.

Looking at the responses made by Meeting 3 to the T.C.G. document, it can be seen that they are very strong in their reinforcement of the systematic rules and procedures for the innovation process. Clarification of roles, redefinition of the rules and regulations etc. are all attempts to emphasise existing integrating methods. (We have already seen that one way in which organisations can control variety is by instituting rules and procedures).

However, we can also see that the product innovation process faces a large number of difficulties resulting from its inherent complexity. Arguably, there is no one agency to blame (although this issue took on some of the characteristics of a political 'football'): the 'blame' such as there is, belongs to the system itself and its complexity.

The fact that this interchange of views took place without excessive acrimony on either side is encouraging; the proposals put forward more so. Lawrence and Lorsch (1969) in their study of companies innovating new products in the plastics industry (essentially a similar situation with a highly complex and dynamic market), conclude that integration is critically related to performance. Further, that the type of integrating mechanism used is related to performance as well. In the case under discussion, a number of integrating mechanisms are proposed in addition to mechanistic devices such as rules, roles and procedures: these include the T.C.G. and Product Management as active groups with responsibility for 'ensuring departmental action to correlate with the achievement of the business objectives'.

How far this interchange will improve matters is difficult to predict. Certainly it illustrated well the gap between levels of strategic and operational groups (Meeting 3 and T.C.G. respectively) and suggested that one important integration could result from the closing of this gap. Attempts at reciprocal representation at the two meetings aroused initial hostility and mistrust: issues of status and confidentiality were used to try and block these moves. Nevertheless at some stage a bridge must be built if there is to be any lasting improvement in the product innovation process.

Similarly the relationship of these two levels to the actual operational world of the chemist involved in Research and Development work needs to be re-examined. Whilst few people disputed the need for a streamlined Meeting 3 to replace the chaotic review meeting which everyone attended, the general feeling was that the present system left them uninformed on progress, uninvolved in making inputs to decision-making and rarely supported, encouraged or commiserated with as a consequence of the fate of their project. Once again the call is for a closer bridging of the gap: this takes place already on an informal level via the product executives from the Product Management group. As one member of Process Development described it, 'he's (the product executive) our window on the world outside': this role of integrating the business with the technical activities should not be underestimated.

(v) Production Studies

(a) General Introduction

The production of pigment at Paisley is carried out by a number of units; there are significant differences between these. During the study the researcher was able to visit all major units on several occasions and to participate in plant trials on some of them.

The oldest plants are two azo units which also include a small plant for the manufacture of metal complex pigments. Conditions are very poor within these units simply because they are worn out: most of the processes are highly labour intensive and there is an excellent record of quality production. This is a source of pride to those involved: that despite the poor working conditions, they can still produce even the most demanding products to a high quality standard.

The third azo plant is much newer and larger and involves more automated technology. Full-scale trials of continuous filtration and drying take place alongside more traditional handling methods.

There is a wide difference between the phthalocyanine units; the first is very old and was scheduled for withdrawal when the investment freeze came on. It is only used for crude manufacture and for some old standards made using acid pasting technology. The second unit is more advanced and includes some milling provision for manufacture of pigment. However the third plant is of most interest since it is the most automated of all the production units with semi-continuous operation, automatic control of feeding etc. All phthalocyanine units suffer from being very dirty and unpleasant since blue pigment dust coats everything: working conditions are further reduced by high noise levels, coming mainly from the milling operation.

The final unit studied was the paste elaborations plant; this is essentially a finishing plant and much cleaner. In particular it has a strong reputation for safety.

Each individual unit was characterised by particular factors - people, tasks etc. but there were also general elements common to all units. For the purposes of this analysis the common elements will be considered, in the interface between Process Development and Production as a whole.

Innovation is naturally unpopular in Production - at least insofar as it intrudes upon the normal routine of high pressure activity aimed at achieving programmed targets. Indications of the nature of the task in production can be gleaned from 'typical day' accounts given in Exhibit 22: these illustrate the pressure of work involved.

EXHIBIT 22 : Activity Samples - 'typical day studies'

(1) Plant Manager: Begin day by looking at log to find out what's happended on shift and what the state of the plant is. After brief office work, take samples from oven drying batches to the control laboratories and to analytical laboratories for testing: collect any results available from previous tests. When process men are back from break, go back to plant to watch the critical stages of the process (has arranged the making schedule so that this activity occurs at the time most convenient to him for supervising it): would give a hand but union pressures prevent this. Having seen the batch through the difficult phase, back to office for paperwork, records, batchcards, ordering raw materials, logistics data etc. Back to plant to check all OK. Then to the paint laboratories (products are almost all for this market) to discuss what's happening and what changes might be needed to produce blendable stock. Collect results etc. Back to plant to cover while operators take lunch break, then own lunch break. Back to plant to check general running and prepare for shift handover: fill in log and leave instructions for backshift team. Coffee break, more paperwork. Back to plant, see backshift men and that they understand what's going on and what's to be done - ensure resources available for this! Check on shooting (discharging) the batch: take samples to paint laboratory (for 40 hour tests). Check on log sheets, changes in parameters, keep them informed about yields, other analyses etc.

In addition to this, often doubles up in one of the other units if short-staffed. Has developed some flexibility in operations system in that intermediates can be madeup to two days in a advance of the corresponding batch; thus if a batch of intermediate is failed on analysis, there is a second one available. This minimises hold-up problems and ensures that test data on special peculiarities of batches are available: means that he has more time to supervise critical stages in the making process.

(2) Plant Manager: Begin by checking shift chemist's log to find out what's happened overnight on site and supervisor's log to find out what's happened on the unit itself. Walk around unit with supervisors to discuss problems etc. Pick out issues like safety and housekeeping. Check logs in supervisor's office - 'communication' and 'shift' logs kept on 24 hour basis listing priorities etc. Make out plans and priorities, leave ways and means to supervisors to sort out. Visit paint laboratories for advance samples testing and to check off incoming samples. See technical administrator and give him a copy of day's programme, priorities etc. Visit quality control laboratories with log and check off samples so they know what's coming through: collect samples and results from previous tests

(2) cont'd.

Rest of day is less structured; typically spent on problems and meetings. After lunch, check off morning's results from quality control and get an idea of progress. Meet day shift supervisor and back shift supervisor and check handover of shifts: reiterate and update priorities. Fill in logs etc. and other paperwork. Inform (usually informally) the production manager.

In addition to structured periods, a number of activities fill up the other time. In one typical week:-

- see personnel about new supervisor
- contact production manager about overtime calculation
- sort out mail forwarding
- interview new supervisor
- complete assessments
- contact logistics about drums
- discuss containerisation
- meeting with representative from another company
- see technical administrator about next week's programme
- attend meeting
- see other candidates for supervisor's job
- draft minutes of containers meeting
- draft minutes of other meeting
- see process operator about his contributions to suggestion scheme
- check raw material storage arrangements (following major warehouse fire)
- see supervisors about new shift proposals
- see Process Development about new colour
- see superior about IR problems
- finalise action on raw material storage
- problems on colour dispersion
- job evaluation - see shop stewards about IR problems

(3) Plant Technician: Begin by checking the back and night shift work and raw material stocks for batches to be made (all computer controlled information, available on special sheets). A quick tour of the plants to see what's actually going on and that the operators have no problems. Back to office for paperwork until coffee: often has to sort out individual administration problems, e.g. shift allocations etc. for operators. Back to plant to check progress then visit various test laboratories with samples: collect results and information for future batches. Meet maintenance engineer in office and discuss maintenance problems and priorities. Back to plant to check and cover over operator's lunch; own lunch break then back to plant. Paperwork in office and checking on plant until coffee break; then back to test laboratories. Supervise transition of shifts and brief supervisors on what is being/is to be made.

These brief accounts indicate the high level of pressure under which production personnel operate. Their activities are essentially fragmented and orientated towards solving any short-term exceptional problems whilst maintaining the basically self-regulating control system of rules and procedures. Innovation, being uncertain and longer-term in its orientation, will be an activity in direct conflict with this.

(b) Production Studies

All major production units involved in the transfer of new technology were examined using a combination of research methods including interviews, questionnaires, critical incident studies, assessments etc. These measures are described more fully in the methodology section. The results of this study were published together with a discussion of their implications in the sixth quarterly report.

Essentially the study focussed upon interfaces in the transfer of new products and technology between Production and Process Development. A number of problems were identified and it became apparent that these were largely connected with the different orientations of the two areas. An attempt at presenting a 'two-world' model of the interface showing that many of the criticisms were common to both areas was introduced. Samples of this presentation appear in Exhibit 23.

In general the problem of different interests, allegiances, pressures etc. lay behind the issues raised: once again a need for integration is implied. Examples of the effect of good and bad integration on transfer of technology can be seen in critical incident data on best and worst transfers (Exhibit 24).

EXHIBIT 23 : The 'two-world' model

Section A - The Production View

In general terms, the production view of innovation is that by the time an idea has passed through the system and arrived on the plant, it is a largely controllable activity. Much of the original uncertainty has been eliminated but at the same time, the pressure on the new product or process is considerably greater. Whilst the risks are lower than on the laboratory bench (in terms of identifying and exploiting a new idea), the stakes are much higher - large batch-sizes, demands on resources, effective down-time from normal production scheduling etc. The major contribution which could be made in this area is fast, effective and co-operative problem-solving combining the resources of experience and technical skills with a basic commitment to introducing new ideas.

Overall, the need for innovation is clearly understood. Whether to develop new markets, maintain existing ones, compete with rising resource costs, maintain and improve levels of safety, or whatever, the fundamental requirement is that the company adapt and change to keep pace with the outside world. The blocks and barriers to innovation are thus seen not as being a resistance to change but rather as a series of defects and faults in the system whereby change is introduced. It is particularly in the grey area of behavioural variables that problems arise; the feeling is that if the correct balance of trust, confidence, co-operation etc. were achieved, the collective technical skills and experience of all those involved would be capable of anticipating and solving most innovation problems.

The tasks of production and development are largely different, and this basic difference is reflected in a variety of ways - the structure of the department, the pressures and constraints, the type of activities involved etc. So the development of specific viewpoints by members of a production group will reflect the overall atmosphere of the production world - an example might be the common belief that 'production is where the work gets done and the profits made. If we didn't get colour out of the door at the end of the day, there'd be no money for luxuries like research and development'. Figure (1) lists some typical aspects of the Production world and contrasts them with the Process Development world; from this it is easy to see why both sides of this interface feel (even if they find it hard to describe) that there is a gap between them.

The separation between the two worlds is enhanced by a geographical and an historical split; in simple terms, the fact that the buildings are separated means that there is correspondingly less chance of a production man getting to know - and thus understand - the world of a process development man. Historically, much product development work was actually carried out in the production blocks and, whatever the positive benefits of altering this arrangement, the setting up of separate research and development functions has broadened the gulf between the production and the innovation areas.

With this 'two world' idea as a model, it may be easier to understand the building up of attitudes which tend to resist transfer of new ideas across this interface. A typical sequence of events may help to illustrate these further:

'Process Development bring across a new idea with little or no explanation or forward communication, so that Production have no real knowledge of what it involves, what its relevance is in terms of an overall innovation strategy, what the important parameters not specified on the process card are - and what happens when they are exceeded, what the history of development was, who is responsible for it, etc. Thus from the beginning there is a mixture of frustration and annoyance at being treated as a convenient service function rather than as an essential, contributing link in the innovation chain. Inevitably, this operation has meant rescheduling important production batches and allocating scarce labour and material resources to accommodate Process Development, so that there is a strong underlying sense of disruption over and above that normally imposed by the high level of pressures and constraints under which Production operates. If the Process Development team fail to appreciate this, or if they make too heavy demands during the transfer or trial, it is likely that the production people will feel a strong resentment towards them for adopting such an arrogant attitude.

It may be that the new process has not been fully scaled-up in pre-production work so that more valuable time and resources are wasted in solving problems which could have been anticipated on the pilot plant or by earlier consultation with experienced production men.

The result of this type of transfer is that the process may fail or at least require extensive modification, and as a result, the respect and confidence of the Production team involved will be lost. This will reflect not only on those directly responsible, but on the Research and Development function as a whole, thus setting up a poor reputation. Costs, in terms of money and time, have to be made up by Production and thus general dissatisfaction with Research and Development is compounded with a sense of having been used in an expensive, poorly planned exercise which has been thrust on them and which has failed.

Over time, the repetition of this kind of event breeds strong feelings on the subject, e.g. 'innovation is forced on us from outside by incompetents - we could do far better ourselves'.

Lack of contact increases, departments become less trusting and the system grows less effective. However, the need to continue innovating means that there is a constant pressure to carry out this activity under increasingly resistant conditions'.

It should be stressed that the above is a fictional representation, but as such, it does describe views held on the subject by Production people. Actual sources of friction include those described in detail in Table (1).

Despite this gloomy and critical picture, the process of innovation does take place and is often a relatively smooth and effective transaction. The value of identifying the problems involved is that it defers the search for a solution until the problems have been adequately defined and understood. In many cases, effective solutions have already been implemented, and there are many other potentially

FIGURE 1

The Production World	The Process Development World
short-term problem horizon	long-term problem horizon
dirty, unpleasant conditions	clean conditioned environment
pressures from:-	pressures from:-
industrial relations equipment raw materials labour and resources	meeting applicational demands - quality properties etc. meeting production demands - quantity, robustness, flexibility etc.
need to meet production targets and tight schedules	high uncertainty
little room for experiment	high experimentation
responsible for the present	responsible for the future
formal, orderly structure	loose, organic structure

Section B - The Process Development View

As a comparative newcomer to the site, the problem for Process Development has been to gradually build up an identity within the innovation process. Indeed, much of the early work of this investigation was concerned with the way in which this group developed its awareness of the role(s) it had to play and the contribution which it could make.

Essentially, Process Development can be seen as a bridging function between the highly innovative and inventive activities involved in the identification and specification of new ideas on the one side, and the problem-solving activities associated with the commercial manufacture and exploitation of those ideas on the other. The innovative output of this group is a mixture of 'home-grown' ideas, such as in the Process Engineering sphere and 'developing' ideas which pass through the phase system from Research to production via a Process Development stage.

Inevitably occupying such a central position in the overall innovation framework means that there has to be a high level of contact and co-ordination between Process Development and other areas. People working in this group have to be flexible and adaptable to others' needs, and aware of the pressures and constraints which operate in other groups.

The interface with Production is particularly important since there is such a wide potential gap between the two worlds. Taking new ideas on to the plant requires that they are technically sound and proven and that they are responsibly and carefully handed over as part of a co-operative exercise with Production people. Whilst Process Development accept this 'selling role' as their responsibility, there are a number of areas and issues about which people feel unhappy and which, in time, set up blocks and barriers to smooth innovation.

The pressures under which members of this group work, whilst being of a less tangible nature than those affecting Production, are no less real. Trying to progress from a laboratory-tested idea to a fully scaled-up product or process which retains the applicational properties required, which is robust and flexible enough to cope with being produced in large quantities and on equipment far removed from laboratory limits on control etc., is no simple task. So the criticism which Production sometimes put forward that 'Process Development are incompetent - they can't even bring a properly worked-out process onto the plant' etc. is not applicable - once again the need is for an understanding by one group of the difficulties and pressures confronting the other.

As with the Production view, it may help to put the Process Development case into fictional form: a typical transfer might be seen in the following way.

'After considerable and careful development work on a new product or process, including pilot plant scale-up etc., it becomes necessary to test this out on full-scale plant trials prior to handover to Production. Despite advance warning of the transfer, and circulation of the necessary background information, there is little or no response from Production. Invitations to attend planning meetings or pilot plant trials are extended, informal contact and forward selling is attempted, but people in Production never have time to spare for these activities.

When asked for comments, Production specify only their basic requirements to assist them in fitting in the trial - not for information about the process in general. Their attitude throughout the trial is one of sullen assistance rather than full co-operation, and it is often necessary to go over their heads to get something done. If anything goes wrong on the trial, or if there is an equipment fault or problem, the blame is laid at Process Development's door - in this way, a bad reputation is quickly built up on unfair premises. Even long after handover, when Production may be making their own day-to-day modifications, the blame for bad design or bad processes etc. is attributed to Process Development who become scapegoats for the whole uncertain business of innovation. Over time, attitudes of mistrust develop and Production are seen as unco-operative and inflexible people who will do anything rather than have their routine broken into. Inevitably this leads to more formal arrangements, use of senior management to force co-operation and an overall attitude which regards Production as a service function for the innovation process rather than as a joint contributor'.

Once again, the above represents an extreme view, but it does contain many of the basic sources of discontent and misunderstanding.

The following pages list some examples of problem statements regarding this interface.

Problems at the Process Development/Production interface as seen by:

	Production	Process Development
(a)	Communication	
	- not enough information available.	- 'people never read the reports we send them'.
	- no consultation beforehand to find out the production view.	- no one available for meetings or planning sessions - 'people are always too busy'.
	- no follow-up to monitor progress etc.	
	- no information as to why an innovation is coming on to the plant.	- 'they always complain about our giving them no information but they never tell us what they want'.
	- no background details.	
	- no circulation of relevant documents outside of the bare essentials.	
	- lack of information on parameters and their limits etc.	
	- need for more information to meet other contingencies - details of the 'what happens if.....? type, to make batches for blending requirements etc.	
	- 'to our level there's not enough feedback as to what Process Development are doing'.	- little or no feedback on planning and co-ordinating decisions.
	- T.C.G., Meeting III and other co-ordinating people do not circulate their minutes.	- 'high level co-ordination is often irrelevant at the technical level'.

	Production	Process Development
(a)	Communication cont'd.	
	- objectives unclear or poorly communicated.	- these groups (T.C.G., Meeing III) operate in a world of their own - they try and co-ordinate and decide on technical matters without adequate communication with those who are directly involved.
	- confidentiality restricts access to important information.	
	- 'too many memos, not enough face-to-face contact'.	- lack of informal contact - 'people rely too much on the formal channels, which are inadequate'.
	- insufficient communication channels, particularly informal contacts.	- 'meetings get used as battle-grounds and minutes become scoresheets to see who's winning!'
	- one-way communication 'we always have to go to them'.	- need for more personal contact and informal communication.
	- 'some people 'talk' too much but never get the job done!'.	
	- personality clashes.	- personality clashes.
	- information provided too late.	
	- need for regular contact and continuity.	- no-one at certain levels to relate to.

Problems at the Process Development/Production interface as seen by:

	Production	Process Development
(b)	Planning and Execution	
	- need for more joint planning before the transfer.	- need for more joint planning.
	- need for follow-up meetings, possibly to include provision for re-appraisal and process or design modificaiton.	- need for more pre- and post-transfer consultation.
	- need for lower level co-ordinating e.g. a T.C.G. for plant managers and chemists.	- need for co-ordinating groups at lower levels, directly involving the people concerned.
	- 'all these groups - T.C.G., Meeting III and so on - they're so distant from us we never know what they're <u>for</u> much less what they're doing.	- 'T.C.G. and Meeting III are too remote - they can't possibly know what's going on from a short briefing session once a month.
	- 'project teams never involve supervisors or technicians who may have valuable knowledge and experience to contribute'.	- 'not enough stress on 'oiling the wheels'.
	- need for more formalised handover arrangements.	- inflexibility in co-operation means that it is necessary to refer the problem to senior management - 'using sledgehammer tactics to solve simple problems'.
	- bad planning - 'goal posts are often shifted several times' - 'we never know what we're aiming for'.	- 'Production control what happens but we get left to carry the can'.
	- transfers tend to get 'hurried through'.	

	Production	Process Development
(b)	Planning and Execution cont'd.	
	- 'the process should adapt to fit the plant not the other way around'.	- 'Production vary scheduling and equipment so we never know what we're using or when we're going to be able to use it!'
	- not enough Process Development time spent on plant - not enough coming and going by Process Development.	
	- Process Development attitudes are arrogant, 'they regard Production as a convenient service function'.	- Production attitude is one of 'sullen assistance'.
	- basic lack of mutual interest.	- scepticism and lack of faith in new processes and equipment.
	- 'they (Process Development) always assume that innovation only takes place in one direction, from them to us. We've got a contribution to make too'.	- inability to consider new ideas on their merits. - 'they offer so little help, you could waste all day waiting for them unless you stir things up!'
	- lack of involvement - 'involvement works within Production and brings benefits. Interaction with our control laboratories often helps solve problems'.	- lack of trust in any other group except Production - the 'clique'.
	- need for commitment but no opportunity to contribute.	
	- no willingness to adapt.	
	- lack of understanding of Production problems.	

Production	Process Development
(b) Planning and Execution cont'd.	
- 'need for a more realistic appreciation of pressures and priorites in Production, more detailed specification of parameters in new processes etc. We haven't time to play around with variables'.	- 'we're under pressure too'.
- expecting the impossible.	- 'they expect the impossible - and when we fail they never let us forget it'.
- playing about on the plant.	- 'we get used as scapegoats for all kinds of problems on the plant'.
- lack of clear objectives.	
- wasting time on scale-up problems because of moving straight from laboratory to plant.	
- 'Process Development people lack Production experience but are not prepared to learn'.	- too much emphasis on technical skills, not enough on the human side of innovation.

EXHIBIT 24 : 'Best and Worst Transfers' - critical incident data

(i) Production Manager

Best - 'the chemist in charge of handover had prepared the ground thoroughly - i.e. some time before the first trial batches were made on the plant under Process Development supervision, he had provided a copy of the process and a resume of laboratory work and pilot plant work. He also made himself available for discussion of the process.

After the first run on the plant he tabulated the results vs. parameter changes and compiled a short report on the run. He then discussed this fully with production personnel, seeking our advice where applicable.

During the next run and subsequently the handover run, production personnel were fully involved in the manufacture and in obtaining results of the batches produced. Even after the handover had been compelted, he continued for some time to show interest in the manufacture of the standard.

All in all it was a very smooth, speedy handover and maximum co-operation was obtained between production and process development people'.

Worst - 'In this case there was practically no communication before Process Development people appeared on the plant. It was necessary to request a making card (instructions for the process) only days before the run.

During the first plant trials, it was as if part of the plant had been transferred to Process Development for a few days. They did not try to inform us of their intentions nor did they seek our help to deal with plant problems. The result was that these trials were disastrous, producing an extremely sub-standard batch and another which was a mixed coupling.

In subsequent trials and in handover run, the level of co-operation between both groups was minimal and communications from Process Development were non-existent. They didn't even bother to give us a copy of the test results.

It would be true to say that we were never very happy about taking over this standard (product) but we were under pressure to accept quickly. The first year's production was hardly a great success and even yet we don't manufacture this standard with any confidence.

It would be easy to state that the answer lies in the differing personalities of the chemists involved but this would be an oversimplification. The system certainly doesn't lend itself to smooth transitions.

(ii) Production Manager

Best (1) (new plant)	- 'good communications - plant operated well - only minor modifications needed - plant under Production control
Best (2) (process modifications)	- good liaison - good communications - good give and take of ideas between Production and Process Development
Worst (1) (product)	- money wasted on plant modifications - labour wastage - process wrongly carried out - modifications subsequently scrapped
Worst (2) (product)	- plant occupied (to detriment of Production) - poor communication - transfer system between Production plants not working
Worst (3) (Process technology)	- very expensive - automated - but still not operational two years later - does not work as designed - unsafe as to design - no instructions as yet after two years

(iii) Process Development Technician

'Easiest' (1): '-very simple process - all ingredients high speed stirred in a vat - paste collected - vague memories of a stirrer motor burning out but a 'minor' detail in an otherwise successful transfer.

Easiest (2) - very little change involved from a previously acceptable standard.

Easiest (3) - as above, incremental change.

Best (1) - due to the viscosity of the paste the product was extremely difficult to process -lot of 'down time' - lot of pipework changed, stripped, cleaned etc. - lot of harsh words - finally however an excellent product - great sense of achievement (not shared by production personnel).

Best (2) - transfer of products to different kind of mill - outstanding success - lots of extra strength - slight processing difficulties - from a production point of view initially an ideal process - for quality control a nightmare - settling/separation problems on storage - a solution was eventually found and accepted - the solution created its own problems from a production point of view, i.e. greatly increased standardisation times - work is still being carried out by us to remedy the situation - production interest and hence assistance is currently very good but had the same interest and assistance been shown six months ago, the problem may well have already been solved.

Worst (1) - a relatively simple process involving fluidising presscake, shear milling followed by thickening - several batches ended up solid - manual stirring with large wooden poles was tried by Research personnel - this was occasionally successful, at other times the poles snapped - definite complaints from production personnel following these trials - a deservedly so from the process point of view, but not from any increased work-load on their part.

Comments: As far as this plant is concerned the word 'transfer' is often a misnomer - as new processes are often only slight modifications in a formulation and the equipment is the same. (The arrival of a new piece of equipment sparks a flash of interest but even then often only from a spectator point of view). One is left on one's own until perhaps 3 trials have successfully been carried out (with little or no active interest from production personnel - quality control and stock controllers often taking a more active interest than 'shop floor' staff) and the product is considered transferred.

The arrival of a new plant chemist could awaken interest from other people as he shows an interest in products and processes taken over to his unit. Transfers in this plant would be made easier if someone would go onto the floor with Process Development people to mutually solve problems which arise'.

(iv) Process Supervisor

Best - '- ' introduced this trial to the plant. He gave information regarding competitors, launching of competing product etc. He injected a sense of urgency into the operation and was, in my opinion, very successful.

Worst - from the outset it has never been clear who carried the responsibility for this plant. '-' in the early stages said that the machine would be run on shifts by Process Development. When the trials started, this was modified to one man (day shift) and one man who covered the plant till about 21.00. I feel that opinions have not been sought from Production regarding either operating instructions or methods of training. This has caused friction'.

(v) Plant Technician

Best (1) - 'period of discussion between Process Development and production personnel illustrating type of product involved - problems experienced in laboratory and pilot plant discussed - production personnel able to advise on likely problems on main plant. Discussions included history of product and specific uses. This type of discussion thrashed out the problem of solids content on this particular product and helped solve it.

Best (2) - Process Development personnel became involved in all aspects of production on this standard, i.e. full coverage throughout shifts - people tend to think production work on dayshift basis only in this area. Good points and bad points on each specific batch were communicated back to production management on a daily basis.

Best (3) - Hourly-paid personnel were also made aware of the problems involved, not only process side (this seems to be the 'be all and end all' in a handover run) - as far as most people are concerned, everything can go wrong only in process, not in pressing or drying - this belief has been proved wrong in many cases in the past.

Best (4) - Feedback on results on this standard was excellent. On two separate runs carried out by Process Development a document reviewing problems, results, aims etc. for next run was prepared and forwarded to production personnel for comment.

Best (5) - Final handover run was again fully covered by Process Development personnel who maintained an interest throughout while manufacture was carried out by production personnel.

Best (6) - Process Development personnel passed on relevant information on certain aspects of this standard which could be attributed to improving other standards.

Hence little or no problems have been experienced by production personnel during subsequent runs of this product.

Worst (1) - Little or no discussion on product to be made - only stipulation made regarding particular makes of raw materials.

Worst (2) - first and second runs of standards carried out with little or no communication on problems confronted.

Worst (3) - no feedback on results achieved.

Worst (4) - hourly-paid personnel did not become involved in all aspects of the product. Process Development a secret society?

Worst (5) - Convenience a priority for Process Development people - i.e. coverage on majority of handover on dayshift basis: only in some cases were people available for shift work - as a result valuable plant was left idle on occasions until next day shift.

Worst (6) - Handover seemed imperative to Process Development personnel who, perhaps due to pressure from above, seemed anxious to be rid of product.

Worst (7) - Certain important features on two standards with regard to the process details were not communicated to production personnel. As a result off-shade batches were produced. Production laboratory work solved these problems.

Worst (8) - Little or no follow-up during final handover run.

Worst (9) - One particular product handed over to Production had no standard to be tested against - confusion reigned!

Worst (10) - Problems on these standards were all communicated by Process Development people after Production people had experienced them - not before!'

Other problem issues are discussed in the organisational mapping questionnaire (Exhibit 25).

Exhibit 26 presents the work preference questionnaire which measures need for achievement; arguably this can be related to propensity to innovate.

Overall there are a number of indicators suggesting that integration - both vertical and lateral - is the prime source of problems. This theme will be taken up again later.

EXHIBIT 25 : Organisational mapping questionnaire

This instrument was intended as a 'mapping' device to explore problem areas: issues of significance included:

- objectives (1c, 1d, 1a)
- Research and Development policy (1h, 1r, 6b, 6c)
- non-technological problems (1i, 6e)
- structure (2b, 2j, 2k)
- hierarchical integration (2l, 2m)
- information flow (3h, 3j, 3l, 3n)
- intergroup co-operation (5a, 5m)
- group task definition (5e)
- informal structure (5h, 5i, 5j, 5n)

As with Process Development, there is strong emphasis on the informal organisation: most Production units work as tight teams under pressure, so that the level of interpersonal dependence will be high. Integration problems, in addition to vertical and other group issues, involve a high level of dissatisfaction with the relationship with Basle.

Information flow represents another issue in which there is unhappiness; the feeling is that each unit is isolated from the wider organisational world and has little clear idea of objectives, Research and Development policy etc. beyond their immediate area.

Once again, problems are predominantly non-technological in nature.

Organisational Mapping Questionnaire

Section (1) Objectives

In the context of this department, how far do you feel that:-

(a) the objectives have been realistically planned?

(b) the objectives have been effectively communicated?

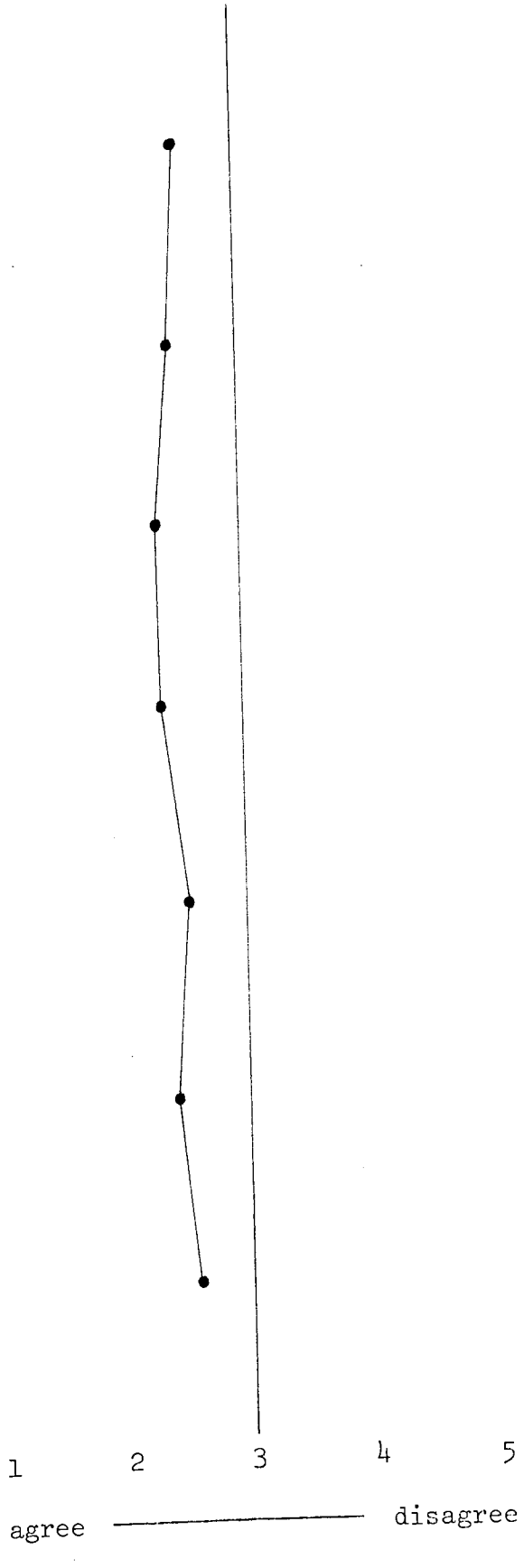
(c) the objectives have been clearly understood?

(d) the objectives have been successfully achieved?

(e) the objectives have been flexibly defined so as to be sensitive to changes outside the department?

(f) the objectives have been planned to make effective use of departmental resources (e.g. people equipment, etc.)?

(g) there is a high level of involvement in the development of a departmental strategy to meet these objectives?



In the context of this department, how far do you feel that:-

(h) there is a clear statement of formal R. & D. policy?

(i) the major obstacles to the fulfilment of these objectives arise from non-technological factors?

(j) the major obstacles to the fulfilment of these objectives arise from outside the department?

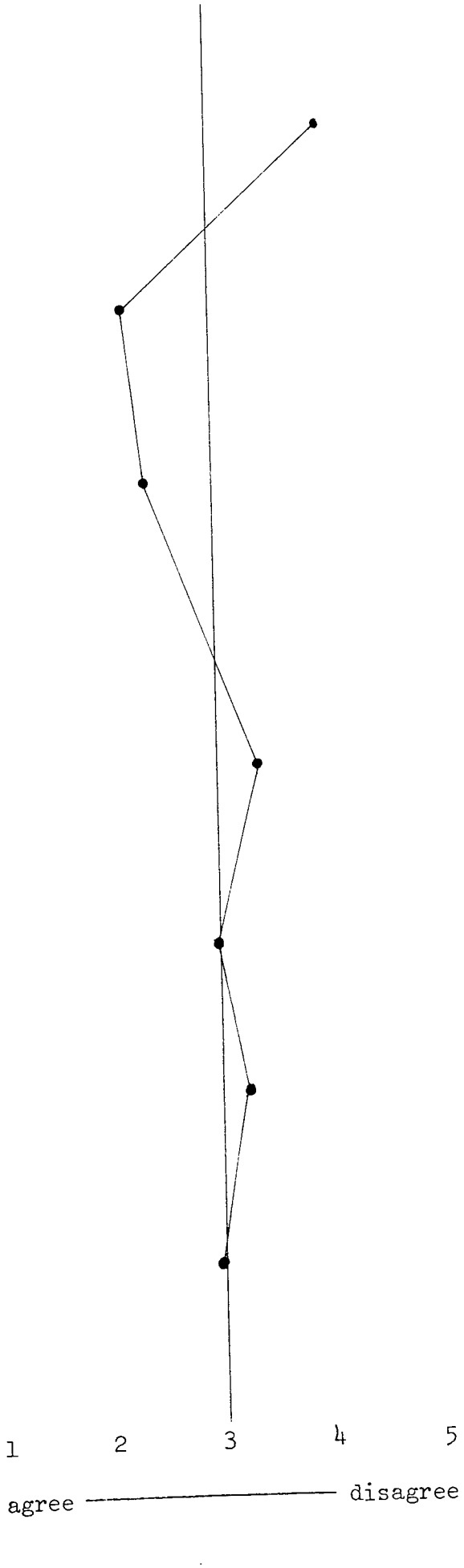
In the context of the Pigments Division organisation, how far do you feel that:-

(k) the objectives have been realistically planned?

(l) the objectives have been effectively communicated?

(m) the objectives have been clearly understood?

(n) the objectives have been successfully achieved?



Section (1) Objectives cont'd

In the context of the Pigments Division organisation, how far do you feel that:-

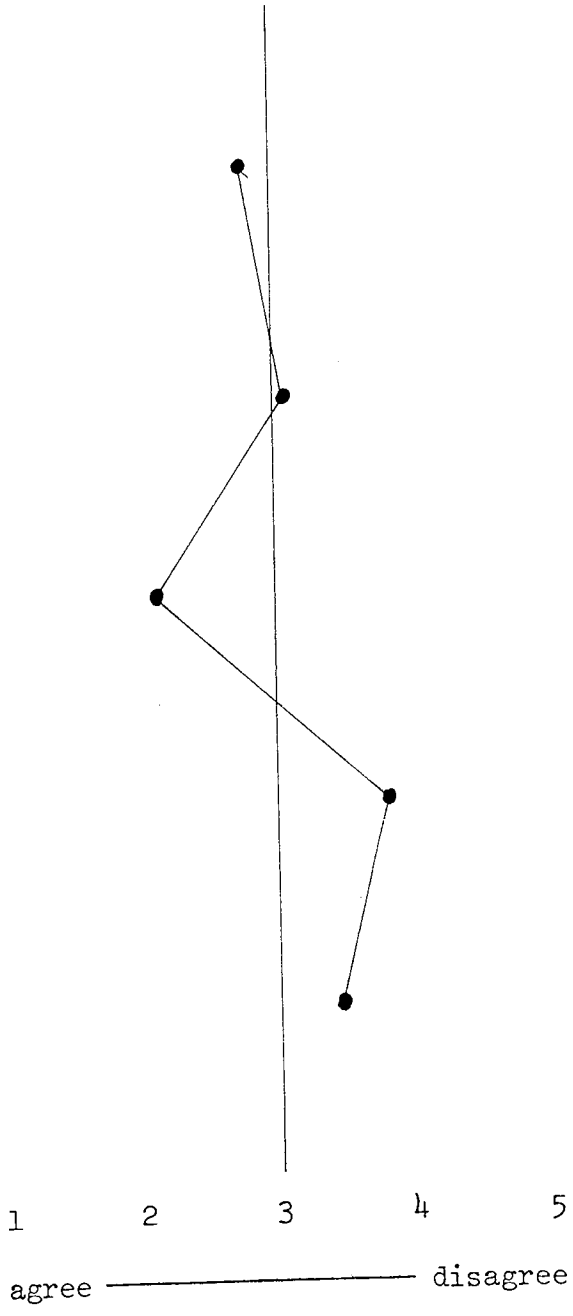
(o) the objectives have been flexibly defined so as to be sensitive to changes within the organisation?

(p) the objectives have been flexibly defined so as to be sensitive to changes outside the organisation?

(q) the objectives are too strongly influenced by Basle?

(r) there is a clear statement of formal R. & D. policy?

(s) there is a clear understanding of the role of R. & D. in the organisation of Pigments Division?



Section (2) Structural Factors

In the context of this department, how far do you feel that:-

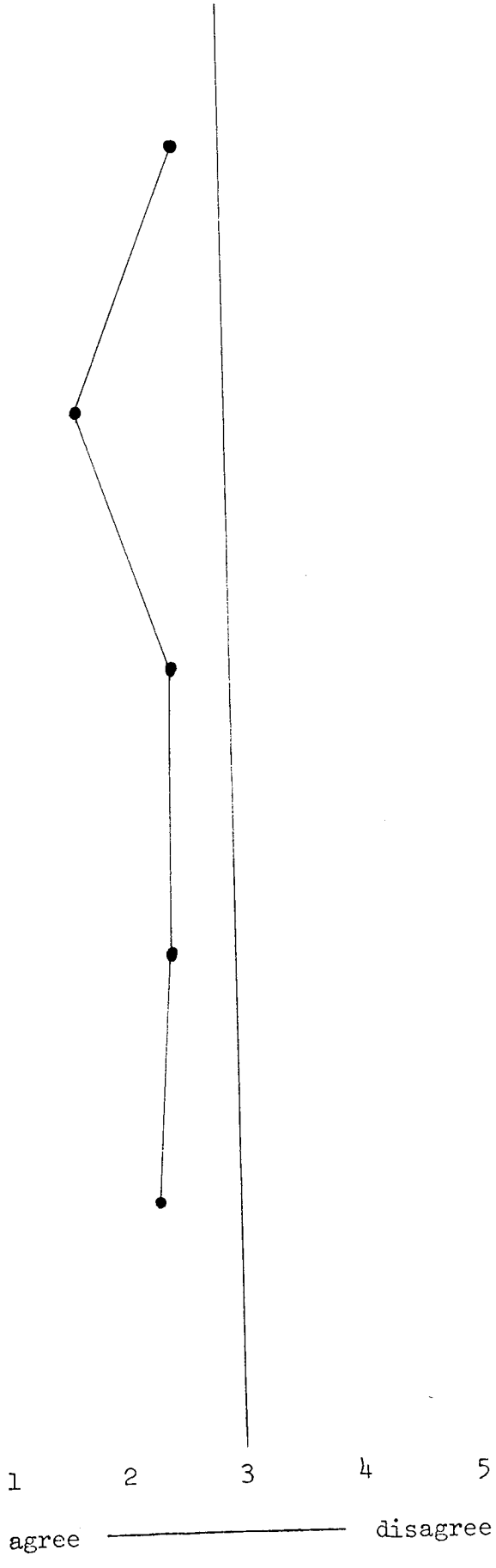
(a) the existing structure makes effective use of available resources (e.g. people, equipment, etc.)?

(b) the existing structure permits the use of individual initiative?

(c) the existing structure allows for greater delegation of responsibility?

(d) the existing structure permits each member of the department to make a significant contribution to, and to feel involved in, the life and work of the department as a whole?

(e) the existing structure is well adapted to the function the department has to perform?



Section (2) Structural Factors cont'd

In the context of the Pigments Division organisation, how far do you feel that:-

(f) the existing structure permits each individual to feel involved in and able to contribute to the life and work of the organisation?

(g) the existing structure allows for delegation of responsibility?

(h) the existing structure is flexibly defined to respond to changes in the outside world?

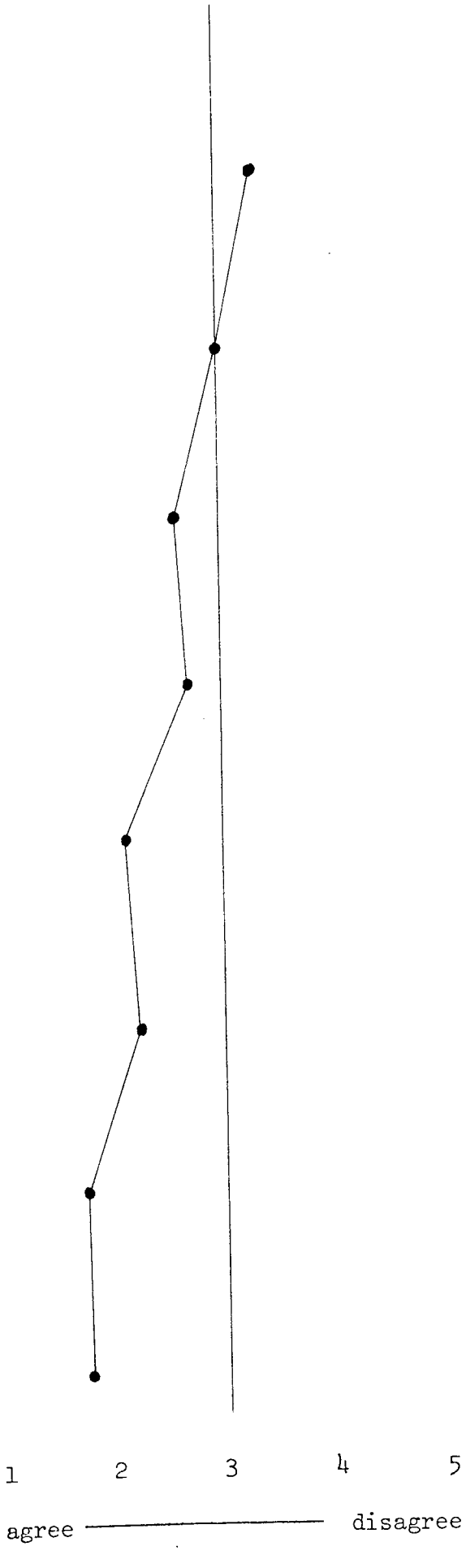
(i) the existing structure can quickly adapt to changes in the world outside?

(j) the existing structure is too far dominated by Basle?

(k) the existing structure is too rigidly defined to permit adequate contact between groups and departments?

(l) there is a gap between different levels in the management hierarchy?

(m) there is a distortion of perception across this gap?



Section (3) Communication

In the context of this department, how far do you feel that:-

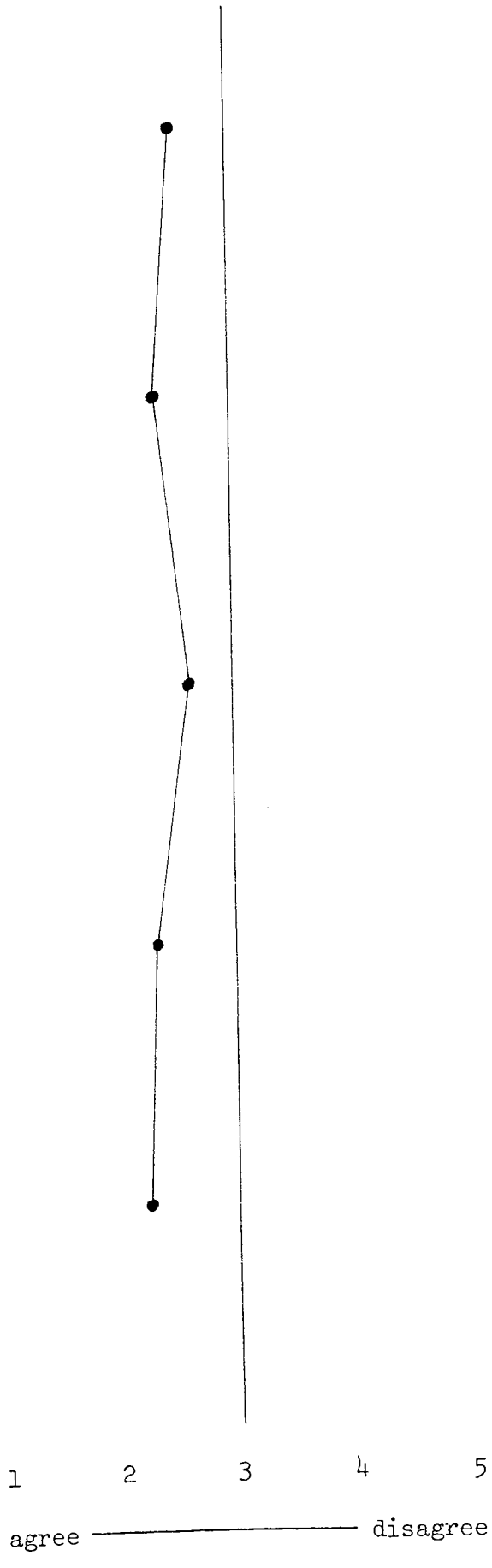
(a) information is effectively communicated?

(b) information is selectively 'filtered' before being communicated?

(c) information is communicated in a timely fashion, so that a sense of involvement and awareness is generated?

(d) information is more completely and openly communicated, i.e. that 'the whole story' gets passed on, by the informal network than by the formal one?

(e) information is more effectively communicated, and in a more rapid fashion by the informal network than by the formal?

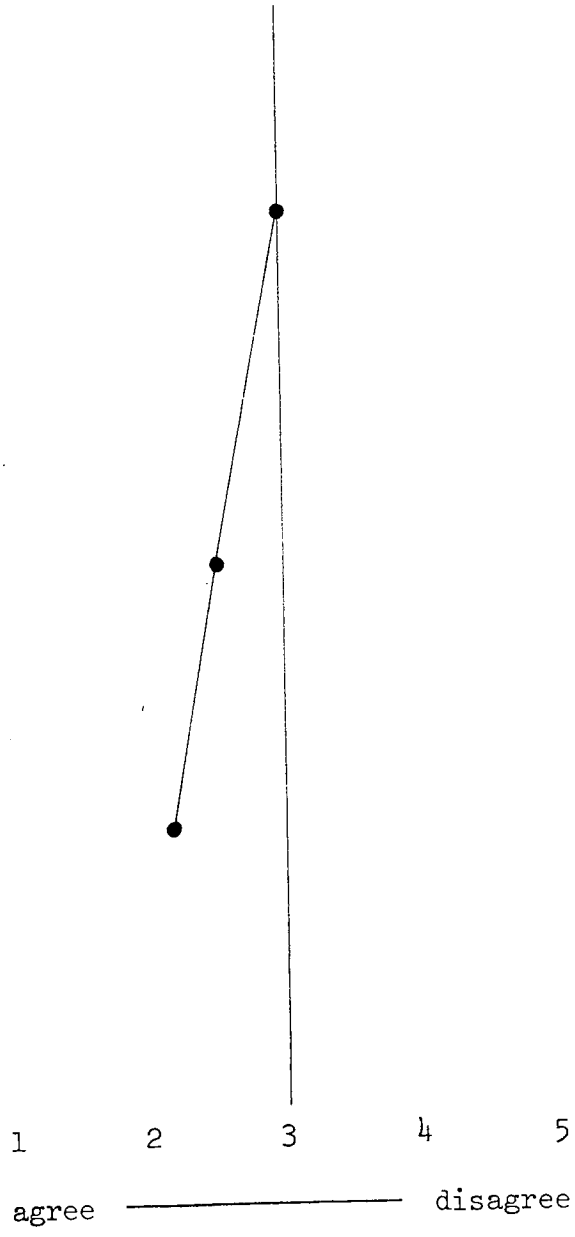


In the context of this department, how far do you feel that:-

(f) the informal communication network is better adapted to keeping people informed and thus fostering a feeling of involvement and awareness?

(g) the informal communication network represents a distorting factor which contributes little to and may in fact inhibit the passage of correct information?

(h) the informal communication network reaches a much wider 'audience' with a much greater variety of information than does the formal?



In the context of the Pigments Division organisation, how far do you feel that:-

(i) information is effectively communicated?

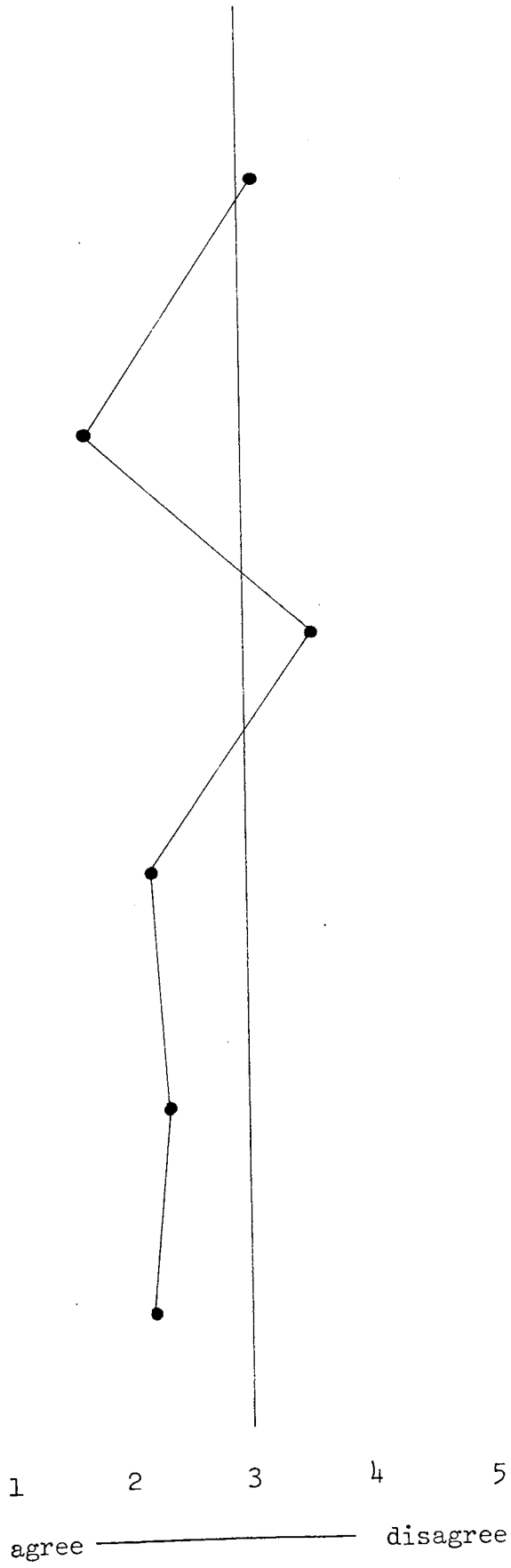
(j) information is passed on a selective 'need to know' basis rather than on a completely open 'telling the whole story' basis?

(k) information is communicated in a timely fashion such that a feeling of awareness and involvement is generated?

(l) information is more effectively communicated, and in a more rapid fashion by informal channels rather than by formal ones?

(m) the informal communication network represents a distorting factor which contributes little to, and may in fact inhibit, the passage of correct information?

(n) the informal communication network reaches a much wider 'audience' with a much greater variety of information than does the formal?



Section (4) Job-related factors

In the context of this department, how far do you feel that:-

(a) jobs are accurately defined?

(b) jobs permit a high degree of self-fulfilment?

(c) jobs offer a realistic opportunity for career development?

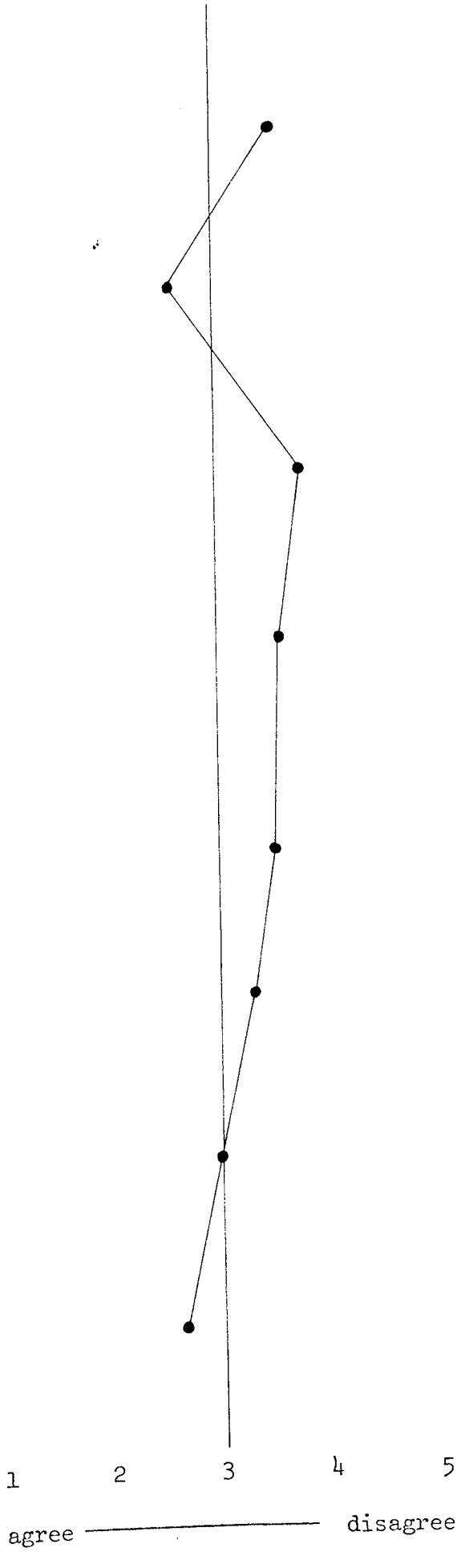
(d) the assessment procedures in use are effective indicators of performance?

(e) existing job descriptions offer the opportunity to contribute to the department as a whole?

(f) the assessment procedures are carried out in a uniform fashion?

(g) the assessment procedures permit an objective analysis of performance?

(h) promotions represent a meaningful change in job characteristics rather than an automatic 'step up the ladder'?



Section (5) Group-related factors

In the context of this department, how far do you feel that:-

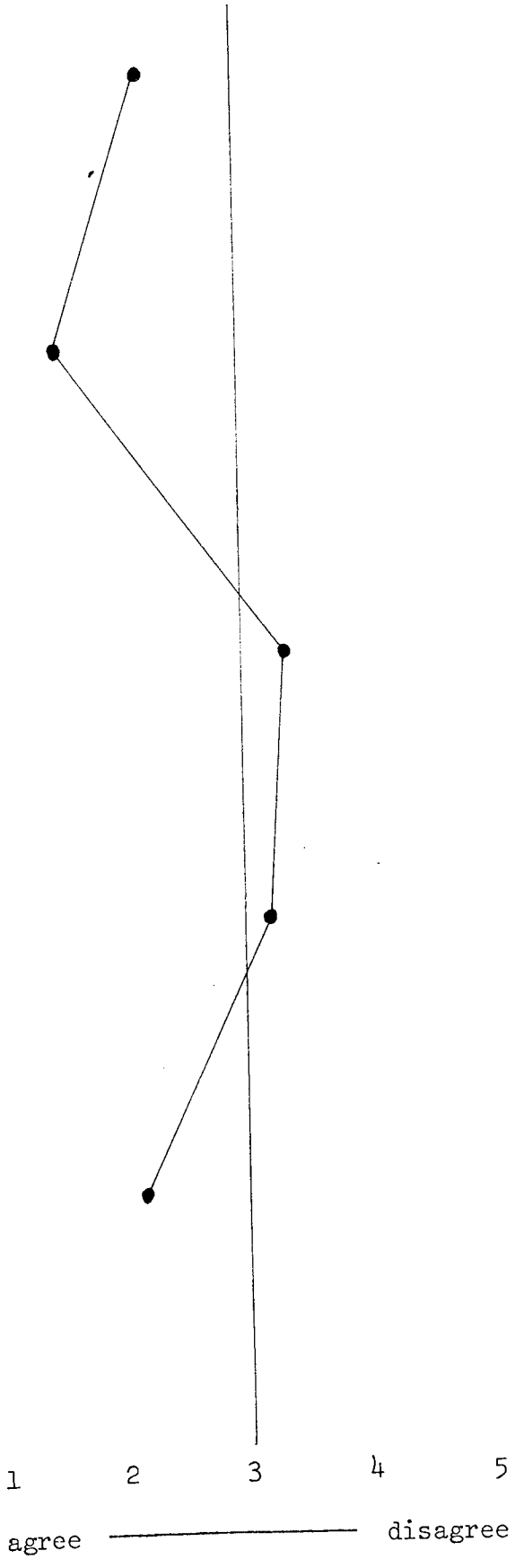
(a) there is good cooperation between groups?

(b) there is good cooperation amongst individuals within groups?

(c) there is a belief that conflicts and disputes can only be resolved in a win/lose fashion rather than by a compromise acceptable to both sides?

(d) there is good mutual understanding between groups and a clear appreciation of the problems and difficulties involved in other areas?

(e) there is a clear definition of the task(s) which the group has to fulfil?



Section (5) Group-related factors cont'd.

In the context of this department, how far do you feel that:-

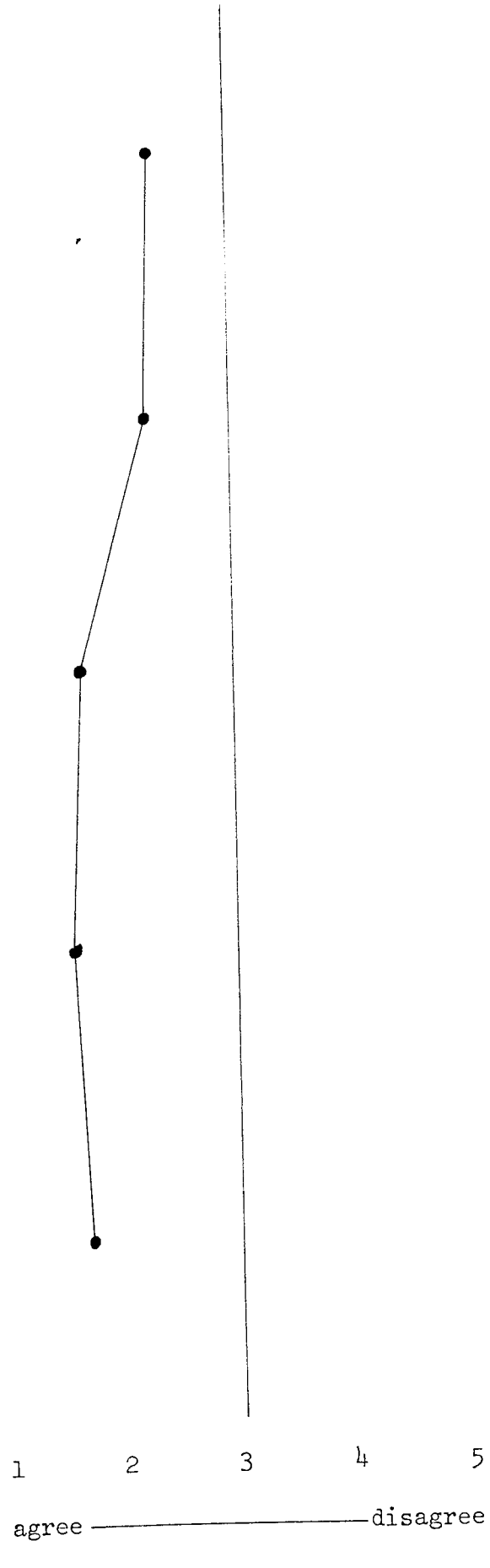
(f) there is a clear definition of the role the group has to play in the department?

(g) the clear understanding of role and task of the group leads to a sense of involvement, awareness and cooperation?

(h) that informal relationships help to strengthen a group from within?

(i) that informal relationships help to avoid confrontation situations between groups?

(j) that informal relationships help to foster a greater self-awareness and improve interaction with others both within and between groups?



Section (5) Group-related factors cont'd

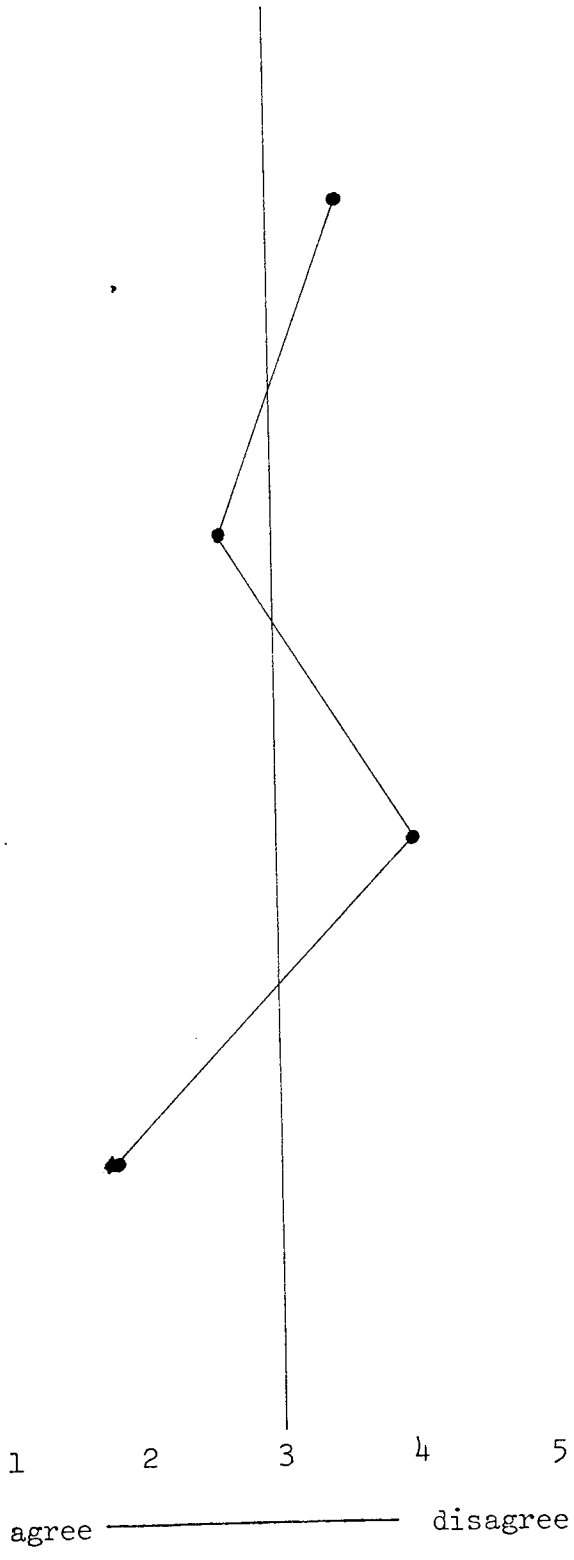
In the context of the Pigments Division organisation, how far do you feel that:-

(k) there is good cooperation between groups?

(l) there is a belief that conflicts and disputes can only be resolved in a win/lose fashion rather than by a compromise acceptable to both sides?

(m) there is good mutual understanding between groups and a clear appreciation of the problems and difficulties involved in other areas?

(n) that informal relationships help to foster a greater self-awareness and improve interaction with others both within and between groups?



Section (6) Innovation

In the context of the Pigments Division organisation, how far do you feel that:-

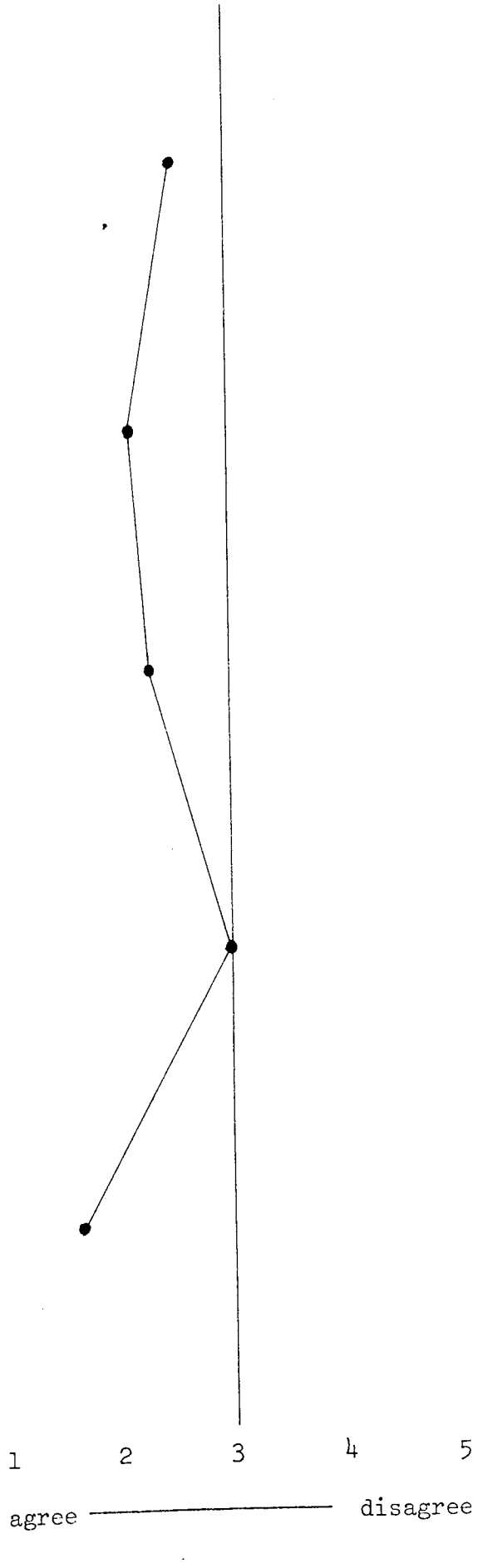
(a) attitudes towards innovation are too conservative?

(b) emphasis is placed on systematic work within procedure rather than on speculative, more radical work?

(c) the overall policy could be described as safe and sure?

(d) major departures from this policy would only result in major problems?

(e) the major barriers to innovation are not in the production of good ideas but in the process of carrying these into practice?



Section (6) Innovation cont'd.

In the context of the Pigments Division organisation, how far do you feel that:-

(f) these problems are not so much a function of the system itself as the personalities and behavioural factors involved?

(g) that the 'streamlining' of Meeting III has led to a 'gap' between functional departments in the innovative process and the R. & D. policy interpretation as performed by Meeting III.

(h) that the setting up of the T.C.G. has helped towards closing this gap by providing a link between functional departments and Meeting III?

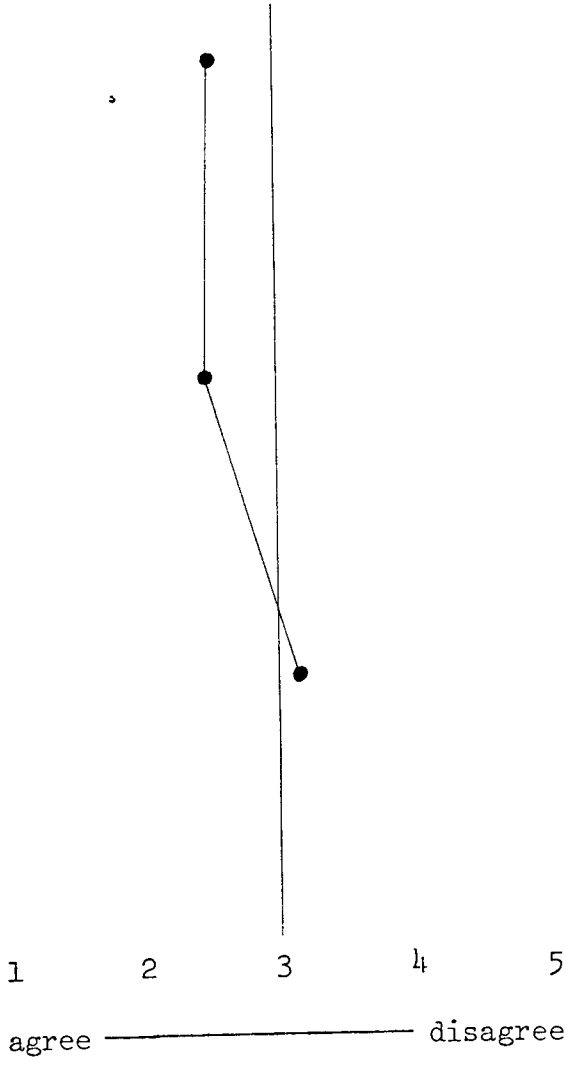


EXHIBIT 26 : Work preference questionnaire

This instrument is described in the methodology chapter: it consists of a series of paired statements about ideal boss and organisation. One choice is high in achievement orientation so a simple scoring procedure can be applied.

In terms of average score, Production and Applications were lowest at 53%. Some writers argue that achievement orientation correlates with propensity for risk-taking; on this assumption, one would anticipate lower scores from areas involved in routine activities like production.

Of more value are the scores for individual questions; these show strong feeling on statements related to:

- group identification (q8, q19)
- motivation rather than 'hygiene' seeking (q10)
- job content and satisfaction (q12, 13, 23)
- independence (q15, q17)
- support (q20)

These are largely similar to responses in Process Development and suggest the same degree of 'professional' orientation towards the job; arguably this is a major characteristic of technical specialists. Of particular significance is the strong group orientation in this area; many non-production people level criticism at the tight clique which exists, but it is obviously of prime importance to those involved.

Work Preference Questionnaire

Would your ideal organisation be one...

1. Where a person's promotion is unpredictable and depends largely on his own good performance.

Where a person can see exactly how his career will progress after certain periods of time.

2. That regards special benefits, such as attractive bonuses, free pension schemes and a company car, as the prime incentive to remain in the job.

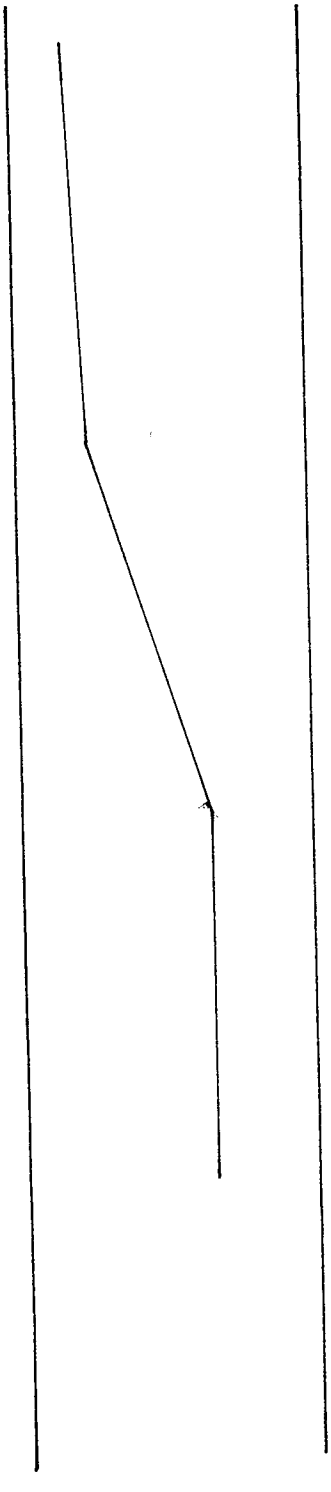
That concentrates on tempting new employees with interesting work, although it is not able to pay as much as other organisations providing less interesting work.

3. Where it is emphasised that the 'job comes first', therefore afterwork pleasures should take secondary importance.

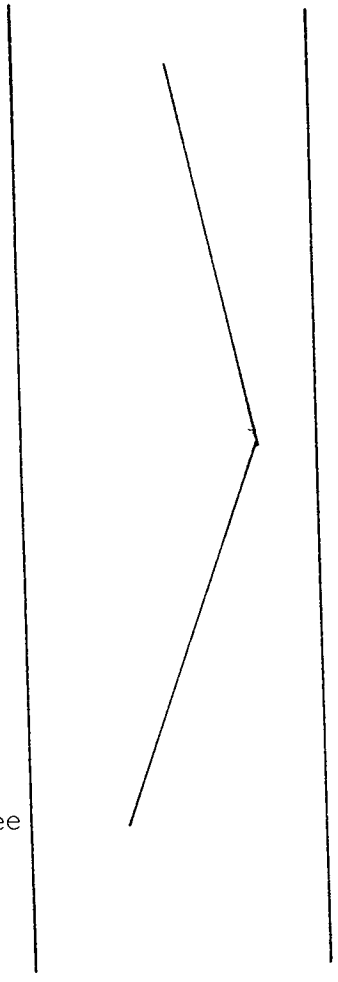
Where it is very difficult to carry on work over a weekend period should someone so desire.

4. Where the few changes in tasks that occur allow people to perform one type of work with considerable care and proficiency.

Where there is constant pressure to complete a task well in a short period of time and to then become involved with another task.



5. Where there is a general attitude that, even if the working conditions are poor, much can be compensated by interesting work.		Where little that is favourable can be said about the work itself but where the attitude of management towards its employees' welfare is first class.
6. That gives people jobs that can very likely be done well.		That gives people work which is not so difficult that they would have to rely on luck to do a good job nor so easy that they are bound to succeed.
7. Where it is expected that leisure time will be sacrificed if work pressure is great.		Where it is felt that working late is undesirable because eventually strain will be experienced in normal working hours.
8. That believes that if a person concentrates primarily on working in a warm close fashion with his co-workers, good work must follow.		That regards the successful completion of an employee's assignment as more important than the feelings of that person's co-workers.

9. That expects individuals to help the organisation by fulfilling their own personal goals.		That expects its employees to strongly identify with the organisation rather than think of themselves as individuals apart.
10. Where good working companions and generous holidays are provided to make up for the tedious nature of the work.		Where there is more concern with employees' satisfaction with the actual work that they do than with their general conditions of work.
11. Where each employee is solely responsible for most of the work that he performs.		Where several people are always responsible for, and take the credit for, a particular piece of work.

Would your ideal boss be someone.....

12. Who gives his employees work that they feel sure of doing well without too much effort.

Who gives people work requiring quite a lot of struggling to master.

13. Who insists on finding out how worthwhile his employees see their work but neglects looking into the enjoyment that they get from their work.

Who regards the pleasure that his employees get from their work as more important than the actual worthwhileness of the work.

14. Who emphasises the importance of the work group's responsibility for its decisions rather than particular individuals in the group taking the responsibility.

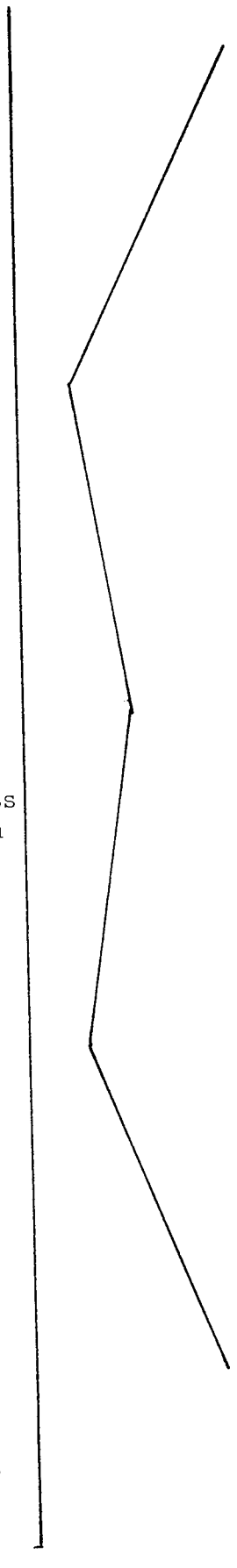
Who relies on a particularly efficient individual in a work group to control the group's activities.

15. Who expects to be consulted only for very exceptional work problems.

Who encourages employees to follow set procedures in their work.

16. Who attempts to provide attractive work for his employees even if it is not of great value to them.

Who would not give people work that they could view as of little value even though it may be highly attractive to them.



17. Who gives his employees general guidelines on which to base their own decisions about how to proceed with their work.

Who gives clear, very comprehensive instructions on how employees should carry out their work.

18. Who finds that for group morale it is better to try to preserve good co-worker relationships that may be spoiled by letting people keep working at a task to their own satisfaction.

Who feels that a certain degree of bad feeling amongst employees is worth tolerating if they are very much involved with their work.

19. Who looks for future employees who will be able to work independently of others.

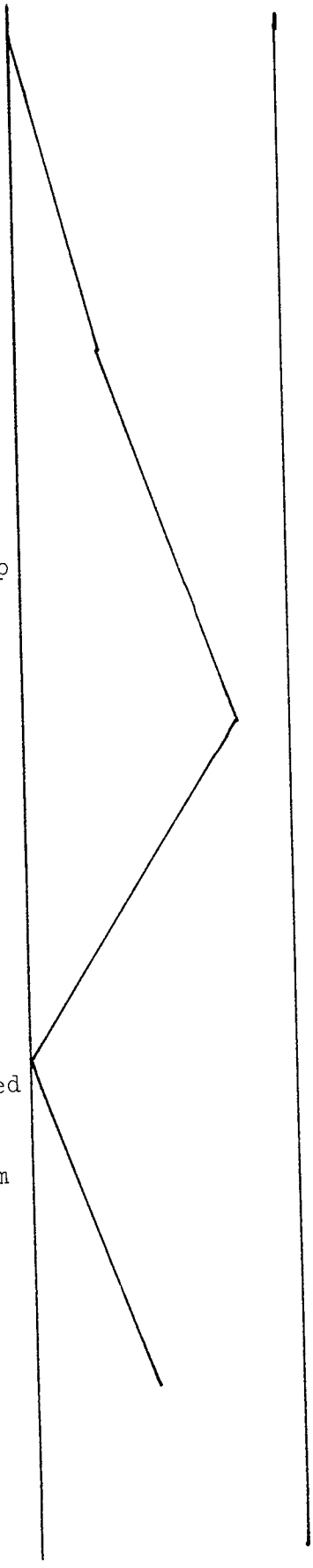
Who looks for future employees who will primarily be good at getting on well with other employees.

20. Who would rather employees consulted him with work difficulties than struggle with them themselves.

Who will not interfere with work for which employees have responsibility.

21. Who expects an individual's work rate to remain relatively uninfluenced by his colleagues.

Who relies on the group as a whole to produce a given amount of work expecting the group to influence an individual's quantity of work done.



22.	Who views good employee relations as being most important and incompatible with competitiveness.		Who insists on individuals trying to achieve a better performance rating than their co-workers.
23.	Who gives employees work where they need to write fairly detailed arguments about problem solutions.		Who gives employees work that involves very little written reporting or problem discussions.
24.	Who feels that working late should be avoided.		Who encourages working late in order to meet a deadline.

(vi) Research Studies

(a) General Introduction

The Research department (housed in a new and spacious block on the Paisley site) is concerned with early stages of the innovation process and with providing a strong knowledge base from which to exploit this. Research strategy has already been discussed in general terms; the groups which carried this out are:

(i) a physical chemistry group exploring the mechanism of pigments - optics, surface chemistry etc. This group also provides a comprehensive range of physical measurement techniques as a service.

(ii) an analytical services group offering a range of laboratory testing facilities to the whole site.

(iii) a new chemistry group aimed at looking for radically new forms and routes towards pigment manufacture.

(iv) a systems research group, also involved in developing new forms and systems for pigment use.

(v) a products research group working on identification and development of new products.

In 1977 following several changes and resignations and in the face of strong pressure from other sectors of the company, the Research department was restructured to reflect better the contingencies it operated in. This reshuffle involved shifting emphasis away from the fundamental and background work (physical and new synthetic chemistry) and deploying more resources into new product development.

A radical change in management also took place in 1977. The original research manager was a professional manager rather than a technical specialist. His style was strongly autocratic though separated and he inspired respect as a representative in terms of his management rather than his technical skills. His successor, by contrast, was very highly regarded for his technical ability and had been filling an internal consultant role within the department: his appointment met with approval and high expectation. This was because people felt he was familiar with their problems and that he would be capable of representing their interests correctly at higher levels - for example

/at T.C.G.

In general the problem issues raised in the following statements reflect the difficult situation of Research and Development in any organisation. There is a strong expectation of products arriving on a regular basis: it becomes very difficult to defend any failure to do so. Much is attributed to the political skills of the Technical Director in keeping Research and Development in such a strong position for so long - despite the fact that very few new products have found their way onto the product range in the market-place.

Research problems centre largely on two issues, one internal and one external. In the internal case it is largely a problem of motivating people in a job which demands high levels of commitment, tolerance of uncertainty, faith in long term strategy etc. as well as requiring individual creativity. This can be achieved, according to the prescriptive theorists, by providing climates and conditions emphasising freedom, autonomy, high rewards for creative contributions etc. (e.g. as recommended in Pelz and Andrews (1965) study). The problem in practice is that other constraints are also acting to restrict these climates.

This highlights the fundamental integration problem in the innovation process, viz. that conditions best suited to invention activities are not compatible with those best suited to development activities. In the first, high levels of individual freedom are indicated; in the second, high levels of control. Simple separation of these activities (as in siting Research at a different geographical location) is unlikely to solve the problem.

The second major issue derives from this and is concerned with integrating Research into the overall organisation. Whether on a strategic, structural or operational level, this is always going to pose problems, since it involves attempting to reconcile two different principles, one of stability, and one of change. There will always be pressure on Research to produce and criticism for its non-productive nature: the operation is of the nature of a strategic gamble and the element of risk is never absent. However, the dynamics of the relationship between innovative and operational units will mean that some periods of extreme pressure and some of 'prosperity' (slack) will exist. It is suggested that currently there is particularly high pressure facing research. The state of the market, the maturity of the technology - a range of factors limit the possibilities of coming up with any radically new options: the alternatives are incremental projects aimed at product modification/

/and process development. Under present conditions the latter course is proving far more successful and research plans are moving away from the long-term and towards this medium/short-term approach; how temporary this state of affairs is depends largely on strategic judgement. For this reason, research strategy is a major political issue.

In practical terms, however, there are major problems with the integration of research with other groups. Examples of problem statements in this area are given in Exhibit 27. Exhibit 28 gives the results of the organisational mapping questionnaire and Exhibit 29 the work preference questionnaire.

Once again, common themes can be seen to emerge: it is argued that the concept of integration is central to these.

(a) Objectives, Planning, Role etc.

- 'we feel under pressure from outside the department to produce - 'we're well aware that it looks as though we haven't delivered the goods in the past few years, but this is because the goalposts are always changing. We usually hit the targets set us - it's just that we only find out too late that the target has been moved'.

- 'the creative idea generation process is OK, we have sufficient freedom and there are a minimum number of problems associated with this area - the difficulties arise at the level of exploiting the new ideas. As far as the Research operation goes, this really is a problem of input - get that right and the rest will follow through. Unless the company requirements are clear and it is apparent that the exercise will be worth the effort, there will be problems as before'.

- 'lack of faith in strategies - 'despite the existence of them, I doubt the likelihood of either of the present ones surviving'.

- 'the unease about product innovation in the long-term depends on a stable strategy to cope with it - but every time we come up with a short term strategy filled with a lot of hot air! Often it turns out to be a lot of froth about one customer requirement rather than a reasoned picture of what the whole market needs and will need'.

- 'there's always an after-the-fact rationalisation for why products fail, but these excuses hide the real problem - lack of realistic strategy'.

- 'the production view of Research as non-productive is essentially a cliche since it takes no account of the number of new products which bite the dust due to goal posts being moved'.

- 'most of the planning input fails to use fact as a base for decision making - the process depends on judgement, politics, inadequate briefing, personal hobby-horses etc.'.

- 'we sometimes dramatically get the balance wrong between offensive and defensive projects.....we don't know how to control that balance.....there's a lack of risk-taking even when in a favourable position and then we'll take risks when the dominant need is to retrench!'

- 'what is needed is a greater Research input to the preparation of specifications, so that planners are aware of what can be done'.

(a) Objectives, Planning, Role etc. cont'd.

- 'lack of forward thinking or real planning'.

- 'failure on the part of planners to appreciate that a finite time is needed before Research can achieve any goals set'.

- 'The company is too big to adapt quickly, but too small to take advantage of large company economics, diversification etc. - so we lose out both ways'.

- 'Since Product Management don't have a full enough understanding of the Research and Development world, they throw everything into drawing up a specification in the unrealistic hope of getting the best of all worlds - and then blame us for failing to deliver! They don't give a clear indication of major and minor variables - this often leads to confused priorities and misdirected efforts'.

- 'what they say they want at time A is not what they want at time B - but there is no real provision for updating our awareness of what they do want'.

- 'The company get their money's worth out of Research - they could get more by taking more calculated risks rather than by pulling the shutters down on projects even due to minor faults'.

- 'From the Research point of view, there is, or has been, evidence of bad planning of technical objectives'.

'.....they keep saying that this is a research-based company but it seems as if they're only interested in improving existing products'.

- 'too many levels of bureaucracy slow things down.....'

- 'main inhibitor is having to go through the management for everything'.

(b) Relationships with Other Departments

- 'the role of Research is currently a farce - we're regarded as squatters on a production site!'

- 'Research is too insular, cut off from the rest of the site - no wonder production are so sceptical'.

- 'basic lack of interdepartmental trust - the need would be for high level management to try and instill a better climate, but the incidence of politics is highest at this level - they need to put their own house in order first!'

(b) Relationships with Other Departments cont'd.

- 'if we work in isolation, it's our own fault because we don't go out and talk - we need to build up a reputation, by being seen to solve real problems'.

- 'basic Research problem is not being seen to deliver the goods as far as the site is concerned'.

- 'the fundamental problem in relationships between Research and Process Development is the split into two empires - the managers have different allegiances and responsibilities and the gap begins there'.

- 'Product failures are cast back at Research as an excuse for the inefficiency of other groups like Marketing and Product Management who have a basic inability to get the specifications right'.

- 'with respect to the Research/Process Development interface, there is a basic need for continuity, particularly since there is currently different line management for each group and they must have different objectives'.

- 'need for confidence in other groups - e.g. we feel that Marketing aren't too sure what the market is all about'.

- 'Research must by its nature be introverted, so it's difficult to get a broader view and easy to get locked in an ivory tower'.

- 'at chemist level, there is no division at all between Research and Process Development - there's nothing to lose in being frank and open'.

- 'most Research chemists agree that Production have a fair critical point based on the facts available to them - to them it seems as if there have been no new products since 5GT!'

- 'there's a feeling that it's about time Research began to justify itself - we're all pretty well aware of the need to make profitable products'.

- 'the Swiss connection complicates the issue quite badly - Basle appear not to appreciate the Paisley problems - also serving two masters makes Research somewhat schizophrenic; Basle want scientific excellence whereas the UK Division wants products!'

(b) Relationships with Other Departments cont'd.

- 'the interface (with Process Development) is based on the Research fear that their product would be arbitrarily changed - most chemists would accept the need for changing on technical grounds but the belief was the Process Development would 'fiddle about' just to put their stamp on it!'

- 'Paisley have a lack of confidence in Wythenshawe's ability to fulfil the role of interpreting the business world's needs for them'

- 'in my opinion, it's a very bad thing that senior management is down at Wythenshawe - a kind of absentee landlord. It would be so much better if they were all on the one site'.

- 'Wythenshawe is another world.....'

- 'if you want sophisticated products you've got to have a sophisticated plant to put them on'.

- 'there's far too little contact between chemists and people going out to find what the customer wants'.

- 'the public image has put emphasis on the wrong things up till now, i.e. on fundamental work - synthetic and physical chemistry - which doesn't represent the major commitment'.

- 'there's much to fault in Marketing and the contact with them via Applications and Product Management'.

- 'there's a major problem in that markets are getting more uncertain and yet we depend on Basle for so much in this area - and the current relationships are nowhere near good enough'.

- 'Basle are a source of great mistrust - they only seem to allow one-way traffic of information, us to them - they're very parental in the way they control things - you always hear 'Basle wouldn't allow.....' or 'Basle are pulling the strings - my hands are tied.....' - at times I don't feel I'm working for the same company'.

(c) Testing

- 'is all this testing really necessary?'

- 'they (Applications) feel it's not their job to help products along - it's their job to test a product to its limit!'

- 'Because Applications are far away they don't have the same sense of urgency as we do - yet they are responsible for assessing Research work'.

- 'too many disparities between Paisley and Wythenshawe testing'.

- 'there's a serious problem in turnround times in testing which delays progress and stagnates innovation - reduces the chances of success since people cut down on the ground they cover to ease the pressure on resources'.

- 'if the company invest in Research, they need to include evaluation testing as a major resource'.

- 'testing should be centralised rather than the current differential screening arrangement'.

- increasing tendency for not only the target to move (as we've come to expect!) but also the method of assessing performance changes'.

- 'problems of Applications being so isolated and duplication (and differences) in testing at Paisley and Wythenshawe.

- 'delays in getting results, particularly applicational reports'.

- 'specifications inadequate - we never get enough information when we start a project'.

- 'differences in testing between Wythenshawe and Paisley - somtimes they even use different methods and we can't understand what the final results really mean'.

(d) Communication and Information Flow

- 'No matter how conscientious about communicating effectively people are, things get left out, misinterpreted, the sense gets changed etc. as you move along the chain'.

- 'it's all very well to have good communication of information, but wrong emphasis can lead to a tidal wave of misunderstanding'.

- 'not enough contact with Wythenshawe - problems of access and communication'.

- 'we always find Wythenshawe is too far away - and not just geographically'.

- 'too long a communication chain gives rise to distorted information flow because of emphasis changing, dilution, refining, misinterpretation etc.'.

- 'communication between departments - being able to interpret and understand the other side correctly - these are the central problems'.

- 'too many people work on the assumption that information is a commodity to be guarded at all costs'.

- 'unstable information base - lack of updating and common availability of information'.

- 'need for improved contact between departments - including long term commitments to maintain and update information.

- 'one of the basic problems is the lack of valid feedback which arrives at higher levels through the system - without criticism from below or force from above, change potential does not exist'.

- 'technical information fails to reach the chemists and those engaged on the actual work itself - there's too many people between us'.

- 'if we ask specific questions, we do get answers - but there's no continuous feed-in of information'.

(e) Morale

- 'people work to the best of their abilities but so often they come up with answers to the wrong questions - therefore they feel their efforts wasted and misdirected and there is growing frustration and loss of confidence in those responsible for direction'.

- 'strong demotivation from consistently failing products'.

(e) Morale cont'd.

- 'our view of the market position is of a company with a number of 'tried and true' products whose position is being eroded, rather like ducks waiting to be shot'.

- 'evidence for growing disenchantment is in the quality of the people leaving'.

- 'this used to be a good company but I feel like moving on - the notion of loyalty has gone sour'.

- 'the high incidence of people leaving and the apparent indifference of the company to the loss of significant people for reasons of deep dissatisfaction.....'

- 'I'm thinking of leaving - I feel I've got many untapped resources which would not be realised here'.

- 'the Paisley view is that people are simply units to fill technological roles'.

- 'problems of loss of identity through size.....'

- 'lack of belief in the real promotional potential of the technical ladder'.

- 'Our researchers have a lack of robustness - they are too sensitive to failure'.

- 'too much politics - people afraid to speak their minds'.

- 'lack of confidence or trust in other groups - misinterpretation and misunderstanding of what people want'.

- 'problems within the division - people think that the company is not doing enough.....'

- 'too much ambiguity about roles - who's responsible for control of line and technical functions - the Research Associate thing is nonsense because nobody has ever clearly defined how it's supposed to work - and it doesn't take account of personal style of conflicts, clashes of judgement and things like that - you could almost believe someone was working on the principle of 'divide and rule'!'

- 'there's a general lack of supportfor good ideas'.

- 'it's ridiculous to put such strict controls on spending and training and on new projects when so much money is wasted elsewhere'.

- 'the company appoint men who are technically good to be managers - the assumption is that the ability to make a pigment automatically makes them skilled at handling people - we lack professional managers'.

(f) Co-ordination and Management

- 'the T.C.G. are far too removed from the nitty-grityy'.

- 'they (T.C.G.) don't provide the type of information you need to get your product through'.

- 'decision making at T.C.G. and similar level appears based on superficial knowledge and lack of facts - it's a deficiency in the system which doesn't allow for the best communication - thus quality of decision-making decreases due to lack of depth'.

- 'there's too much point-scoring and one-sided decision-making - this comes out on reading the T.C.G. minutes - facts are not used - they create rather than solve problems'.

- 'too many committees at the wrong level - too much power concentrated in too few individuals'.

- 'T.C.G. failed to blaze a trail in the need for effective and ongoing co-ordination of inputs - they handle too much detail, are not sure what their objectives are'.

- 'the old system gave a better sense of involvement, but decisions never got made - now the T.C.G. has solved this but the quality of decision-making suffers because of the briefing system. Responsibility for this is two-way - it puts the onus on all concerned to make it work'.

- T.C.G. is all politics - any help to the products is purely accidental!

- 'power and control too centralised - and those who have it are inept at human resource management'.

- 'as far as the T.C.G. goes, I don't think that the individuals involved are able to contribute in a technical sense'.

- 'T.C.G. are just a rubber stamping group - when I look at the minutes I wonder how they get some of their information - it doesn't appear to be an open or frank meeting and a lot of things are left unsaid - reputations are at stake so the project suffers'.

(g) Innovation

- 'lack of continuity due to pressures of day-to-day work, testing etc. inhibit successful speculative innovation'.

- 'the company, or at least it's senior decision-making elements have an aversion to using routes/processes/ technology which are radical or capital intensive, despite their potential'.

- '.....prejudice against innovators.....'

- 'too many products get cancelled because they are put under the spotlight too early'.

- 'too much time spent on patents, cuts down innovating time - the argument is not so much about the utility of patents as about whose responsibility this should be'.

- 'this company has put so many products on the shelf that it must be groaning under the weight!'

- 'the company is too slow to do anything new - it's become a lumbering giant'.

- 'the mix between fundamental and 'practical' work is basically wrong'.

- 'difficulty of getting a decision made - company has become too large - they have a 'no risk' approach to most things, following rather than leading - even if we've already got the ideas, let someone else get there first'.

- 'the system looks for ways of saying no'.

- 'we are too reticent about the market - we only ever back sure winners'.

- 'taken together, this obstacle course (of systems, standards, procedures and committees) is a daunting prospect for any innovation'.

- 'in relation to maturing technology, it becomes increasingly difficult to be really innovative'.

-'too much short-term thinking - not enough taking the long-term view'.

EXHIBIT 27 : Organisational mapping questionnaire

This instrument was intended as a 'mapping' device to identify problem areas. Items of particular interest were:

- definition of objectives (1e)
- non-technological problems (1i, 6e)
- role of Research and Development (1s)
- individual involvement (2f)
- structure (2k)
- hierarchical integration (2l, 2m, 6g)
- information flow (3j)
- intragroup co-operation (5b)
- group task/role definition (5e, 5f)
- informal structure (5h, 5i, 5j, 5n)
- intergroup co-operation (5l, 5m)
- attitudes to innovation (6a)
- Research and Development policy (6b, 6c, 6d)

Emerging again is a high level of informal group orientation, as with Process Development and Production. There is a natural unhappiness about the overall understanding of the role and policy of Research and Development on site and this reflects in their responses. Arguably this is related to more general integration problems which include vertical and functional group issues.

Within the group there is a feeling that the structure may be too rigid to allow for the full and flexible use of individuals.

Overall problems are again seen as largely non-technological in nature.

Organisational Mapping Questionnaire

Section (1) Objectives

In the context of this department, how far do you feel that:-

(a) the objectives have been realistically planned?

(b) the objectives have been effectively communicated?

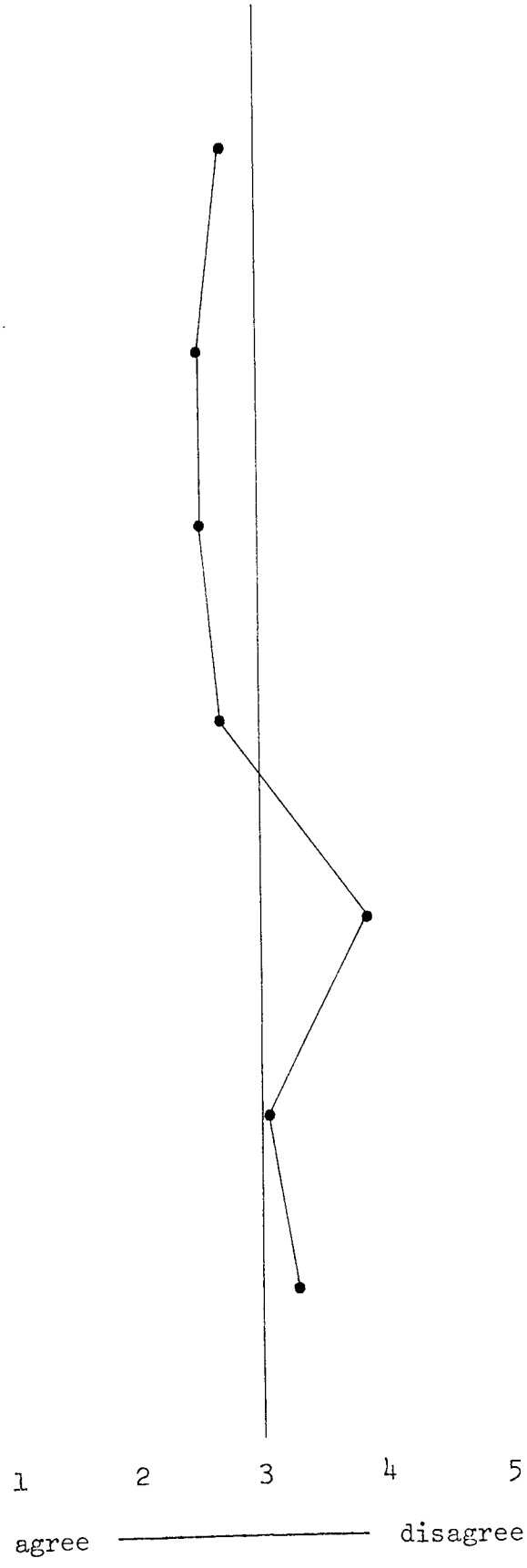
(c) the objectives have been clearly understood?

(d) the objectives have been successfully achieved?

(e) the objectives have been flexibly defined so as to be sensitive to changes outside the department?

(f) the objectives have been planned to make effective use of departmental resources (e.g. people equipment, etc.)?

(g) there is a high level of involvement in the development of a departmental strategy to meet these objectives?



In the context of this department, how far do you feel that:-

(h) there is a clear statement of formal R. & D. policy?

(i) the major obstacles to the fulfilment of these objectives arise from non-technological factors?

(j) the major obstacles to the fulfilment of these objectives arise from outside the department?

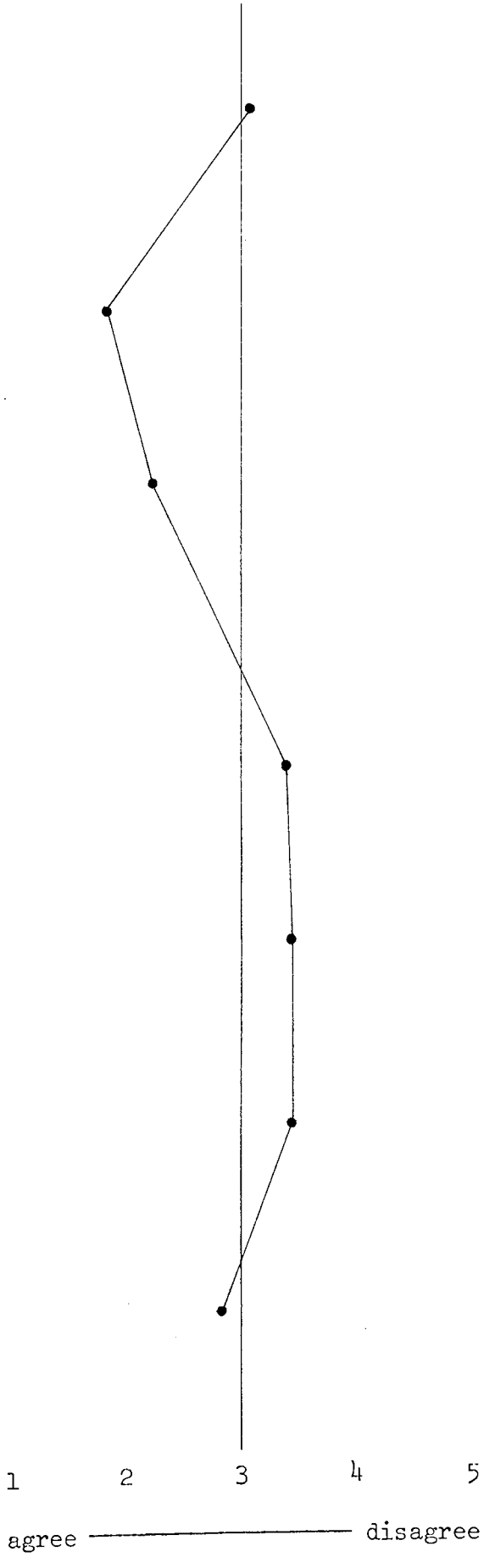
In the context of the Pigments Division organisation, how far do you feel that:-

(k) the objectives have been realistically planned?

(l) the objectives have been effectively communicated?

(m) the objectives have been clearly understood?

(n) the objectives have been successfully achieved?



Section (1) Objectives cont'd

In the context of the Pigments Division organisation, how far do you feel that:-

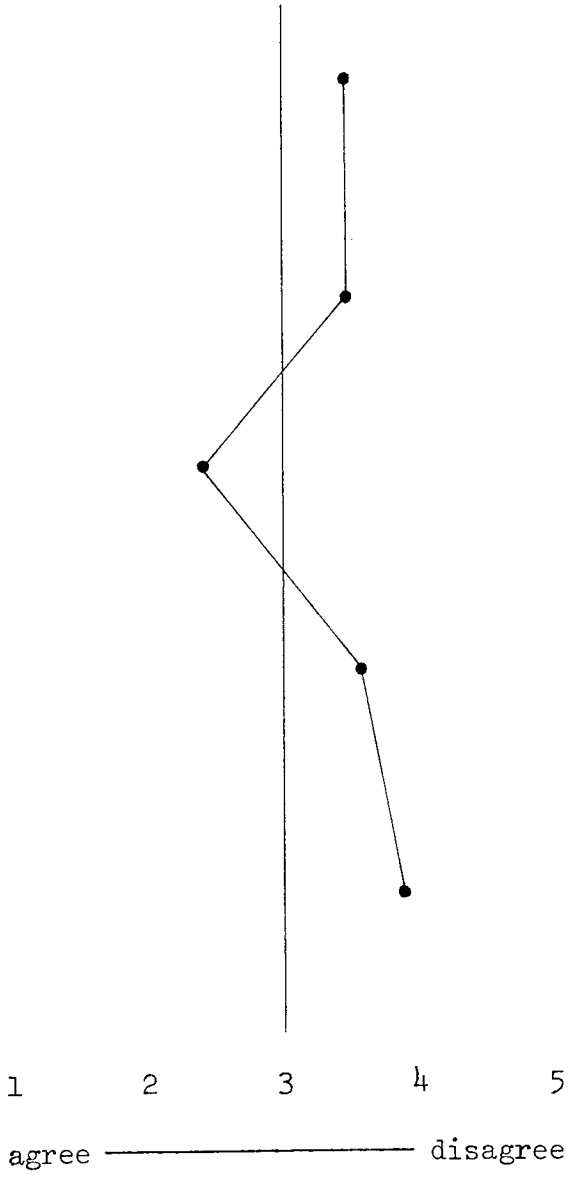
(o) the objectives have been flexibly defined so as to be sensitive to changes within the organisation?

(p) the objectives have been flexibly defined so as to be sensitive to changes outside the organisation?

(q) the objectives are too strongly influenced by Basle?

(r) there is a clear statement of formal R. & D. policy?

(s) there is a clear understanding of the role of R. & D. in the organisation of Pigments Division?



Section (2) Structural Factors

In the context of this department, how far do you feel that:-

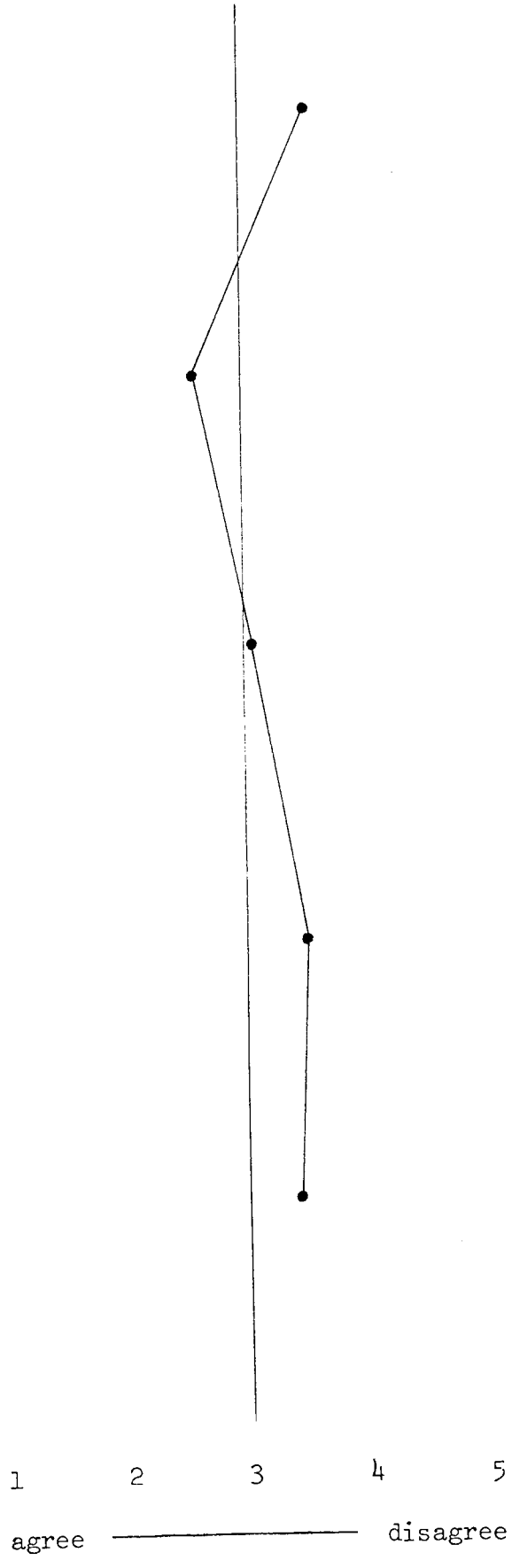
(a) the existing structure makes effective use of available resources (e.g. people, equipment, etc.)?

(b) the existing structure permits the use of individual initiative?

(c) the existing structure allows for greater delegation of responsibility?

(d) the existing structure permits each member of the department to make a significant contribution to, and to feel involved in, the life and work of the department as a whole?

(e) the existing structure is well adapted to the function the department has to perform?



Section (2) Structural Factors cont'd

In the context of the Pigments Division organisation, how far do you feel that:-

(f) the existing structure permits each individual to feel involved in and able to contribute to the life and work of the organisation?

(g) the existing structure allows for delegation of responsibility?

(h) the existing structure is flexibly defined to respond to changes in the outside world?

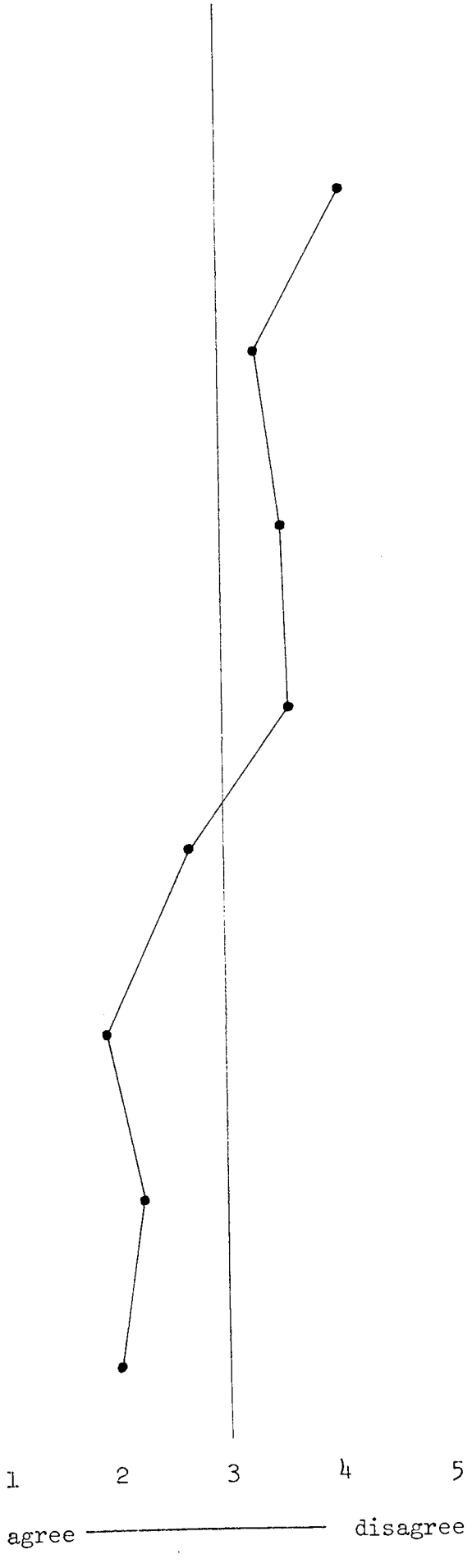
(i) the existing structure can quickly adapt to changes in the world outside?

(j) the existing structure is too far dominated by Basle?

(k) the existing structure is too rigidly defined to permit adequate contact between groups and departments?

(l) there is a gap between different levels in the management hierarchy?

(m) there is a distortion of perception across this gap?



Section (3) Communication

In the context of this department, how far do you feel that:-

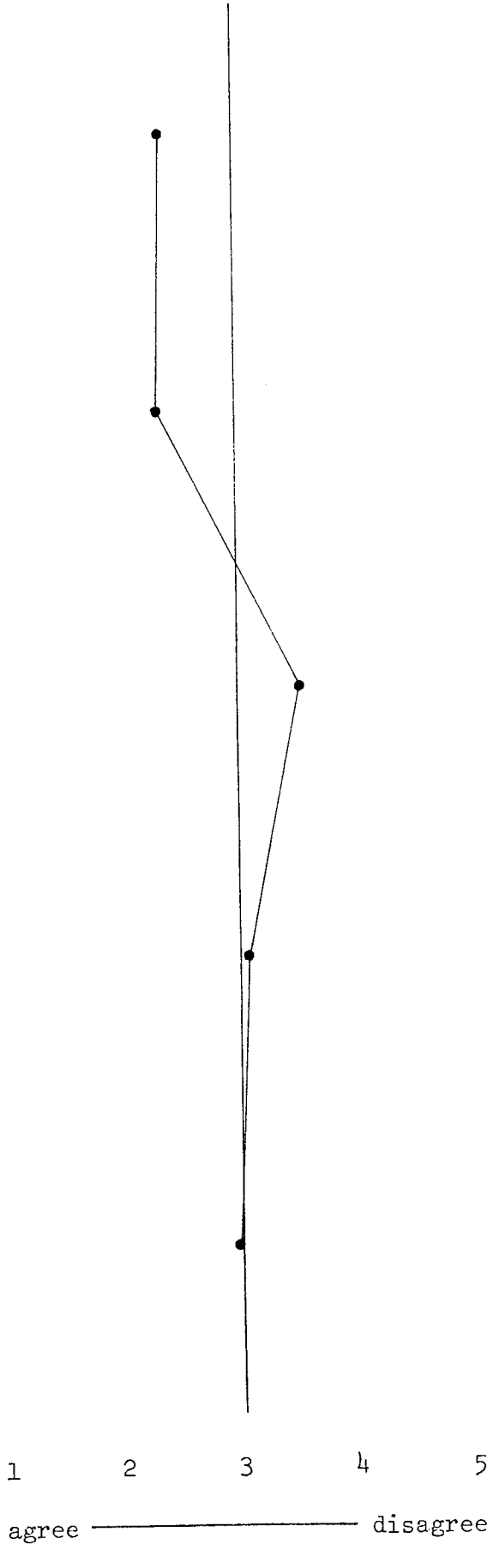
(a) information is effectively communicated?

(b) information is selectively 'filtered' before being communicated?

(c) information is communicated in a timely fashion, so that a sense of involvement and awareness is generated?

(d) information is more completely and openly communicated, i.e. that 'the whole story' gets passed on, by the informal network than by the formal one?

(e) information is more effectively communicated, and in a more rapid fashion by the informal network than by the formal?



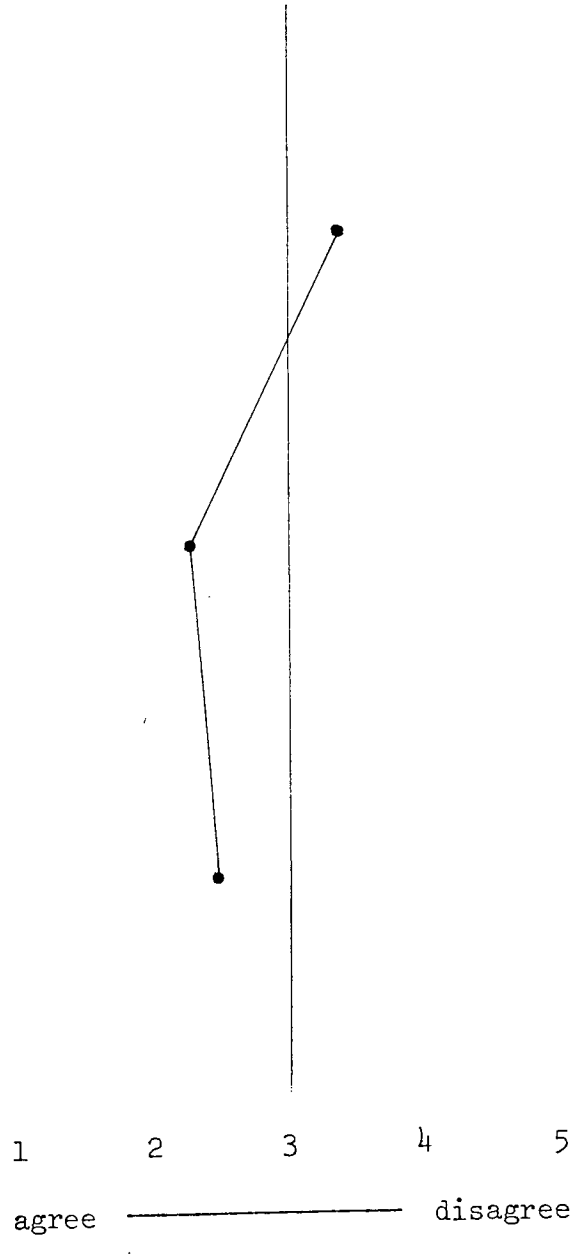
Section (3) Communication cont'd

In the context of this department, how far do you feel that:-

(f) the informal communication network is better adapted to keeping people informed and thus fostering a feeling of involvement and awareness?

(g) the informal communication network represents a distorting factor which contributes little to and may in fact inhibit the passage of correct information?

(h) the informal communication network reaches a much wider 'audience' with a much greater variety of information than does the formal?



Section (3) Communication cont'd

In the context of the Pigments Division organisation, how far do you feel that:-

(i) information is effectively communicated?

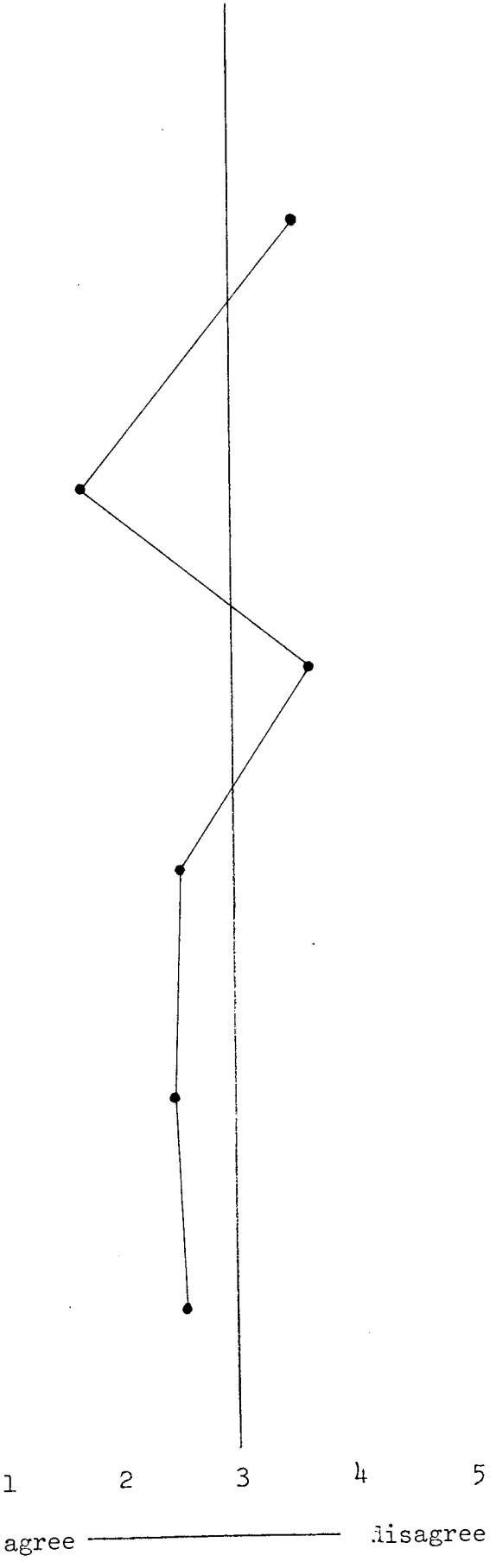
(j) information is passed on a selective 'need to know' basis rather than on a completely open 'telling the whole story' basis?

(k) information is communicated in a timely fashion such that a feeling of awareness and involvement is generated?

(l) information is more effectively communicated, and in a more rapid fashion by informal channels rather than by formal ones?

(m) the informal communication network represents a distorting factor which contributes little to, and may in fact inhibit, the passage of correct information?

(n) the informal communication network reaches a much wider 'audience' with a much greater variety of information than does the formal?



Section (4) Job-related factors

In the context of this department, how far do you feel that:-

(a) jobs are accurately defined?

(b) jobs permit a high degree of self-fulfilment?

(c) jobs offer a realistic opportunity for career development?

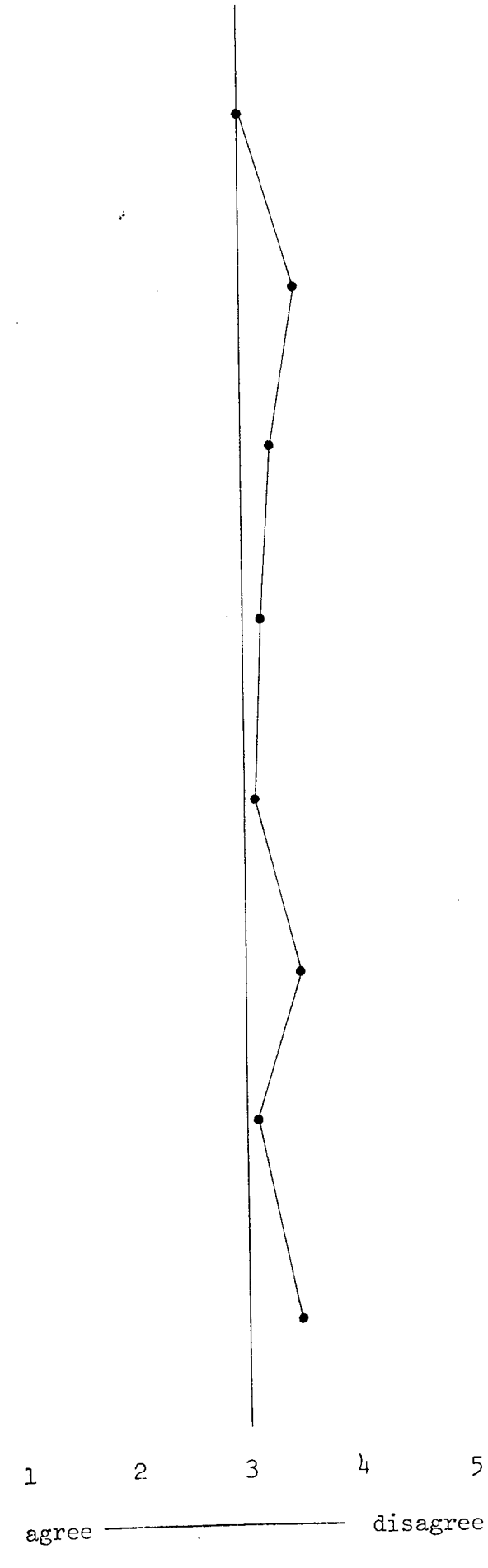
(d) the assessment procedures in use are effective indicators of performance?

(e) existing job descriptions offer the opportunity to contribute to the department as a whole?

(f) the assessment procedures are carried out in a uniform fashion?

(g) the assessment procedures permit an objective analysis of performance?

(h) promotions represent a meaningful change in job characteristics rather than an automatic 'step up the ladder'?



Section (5) Group-related factors

In the context of this department, how far do you feel that:-

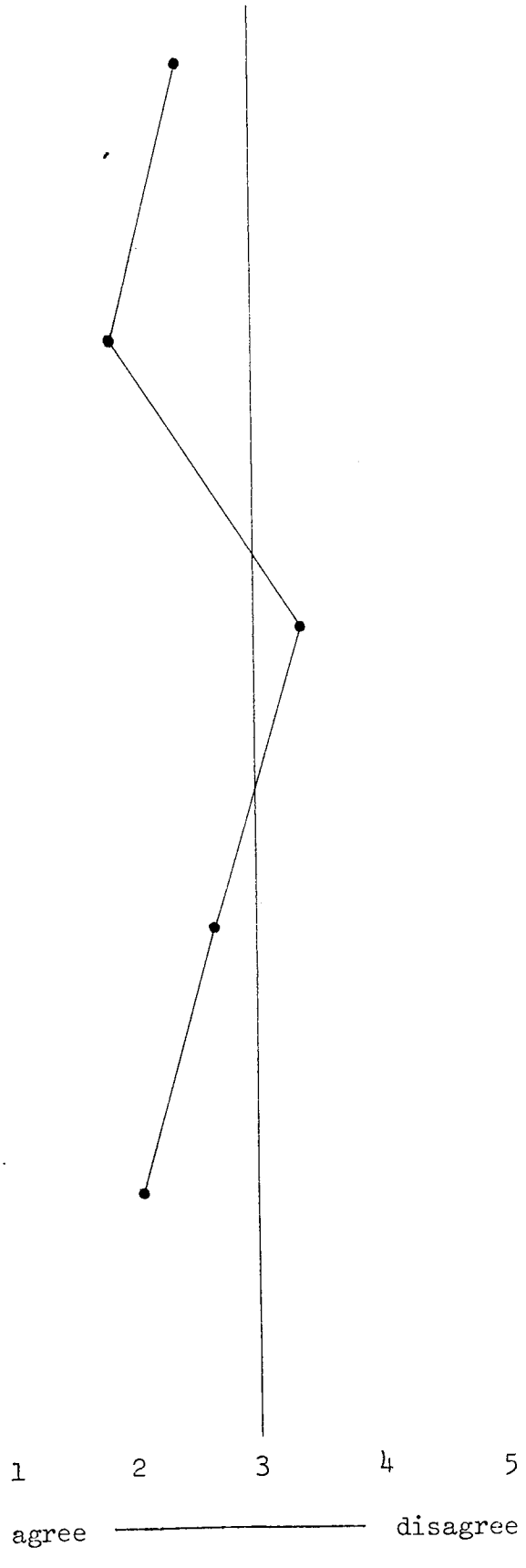
(a) there is good cooperation between groups?

(b) there is good cooperation amongst individuals within groups?

(c) there is a belief that conflicts and disputes can only be resolved in a win/lose fashion rather than by a compromise acceptable to both sides?

(d) there is good mutual understanding between groups and a clear appreciation of the problems and difficulties involved in other areas?

(e) there is a clear definition of the task(s) which the group has to fulfil?



Section (5) Group-related factors cont'd.

In the context of this department, how far do you feel that:-

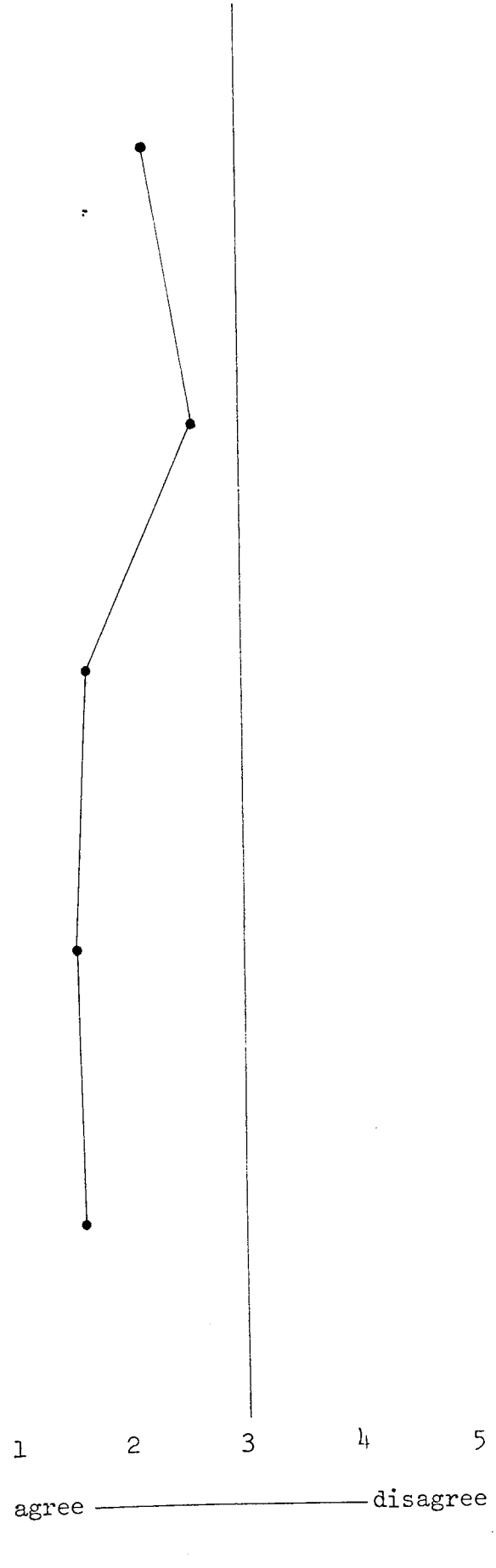
(f) there is a clear definition of the role the group has to play in the department?

(g) the clear understanding of role and task of the group leads to a sense of involvement, awareness and cooperation?

(h) that informal relationships help to strengthen a group from within?

(i) that informal relationships help to avoid confrontation situations between groups?

(j) that informal relationships help to foster a greater self-awareness and improve interaction with others both within and between groups?



Section (5) Group-related factors cont'd

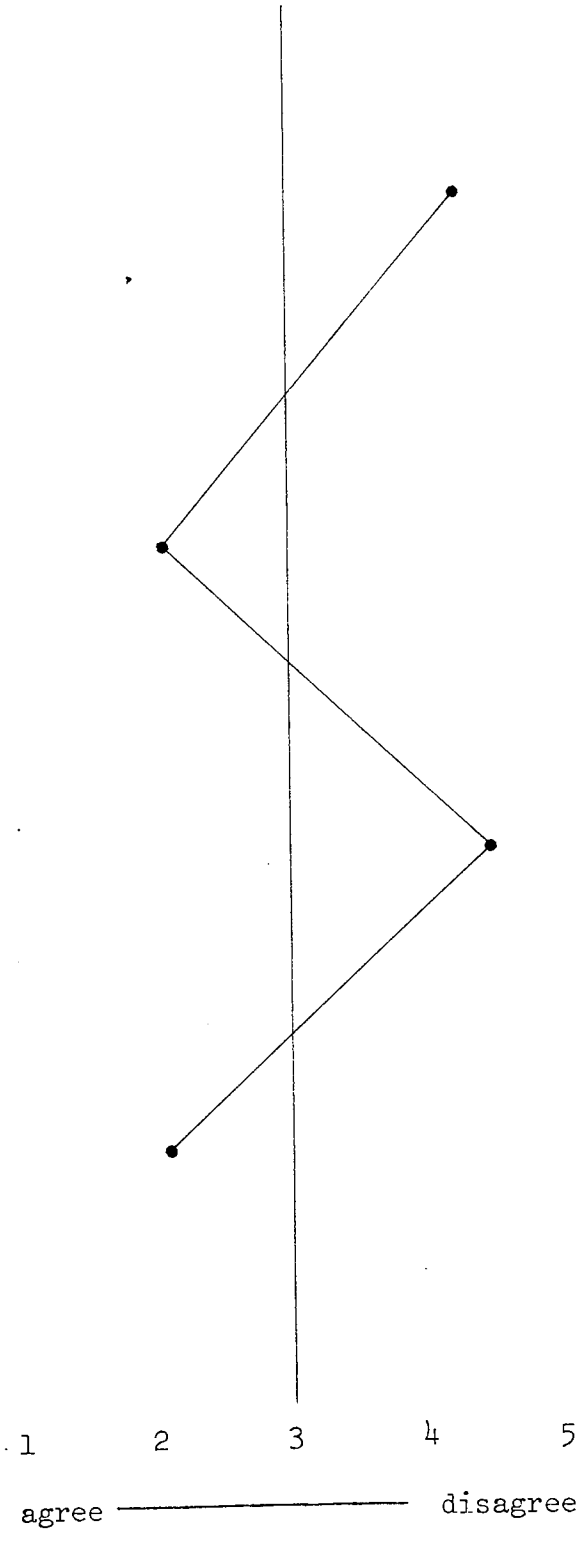
In the context of the Pigments Division organisation, how far do you feel that:-

(k) there is good cooperation between groups?

(l) there is a belief that conflicts and disputes can only be resolved in a win/lose fashion rather than by a compromise acceptable to both sides?

(m) there is good mutual understanding between groups and a clear appreciation of the problems and difficulties involved in other areas?

(n) that informal relationships help to foster a greater self-awareness and improve interaction with others both within and between groups?



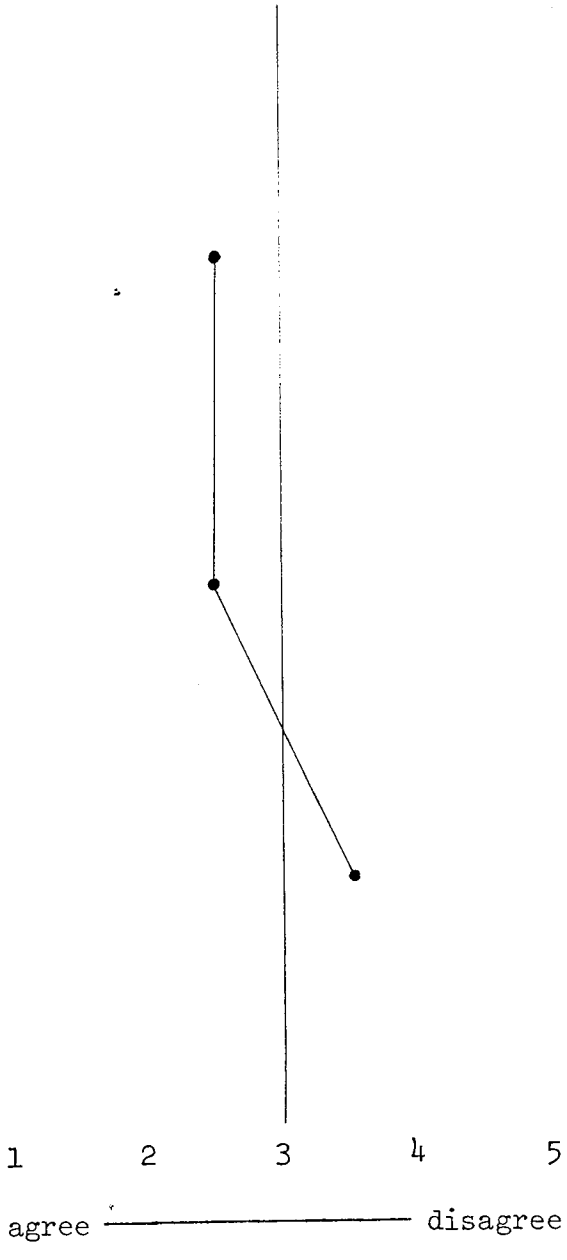
Section (6) Innovation cont'd.

In the context of the Pigments Division organisation, how far do you feel that:-

(f) these problems are not so much a function of the system itself as the personalities and behavioural factors involved?

(g) that the 'streamlining' of Meeting III has led to a 'gap' between functional departments in the innovative process and the R. & D. policy interpretation as performed by Meeting III.

(h) that the setting up of the T.C.G. has helped towards closing this gap by providing a link between functional departments and Meeting III?



Section (6) Innovation

In the context of the Pigments Division organisation, how far do you feel that:-

(a) attitudes towards innovation are too conservative?

(b) emphasis is placed on systematic work within procedure rather than on speculative, more radical work?

(c) the overall policy could be described as safe and sure?

(d) major departures from this policy would only result in major problems?

(e) the major barriers to innovation are not in the production of good ideas but in the process of carrying these into practice?

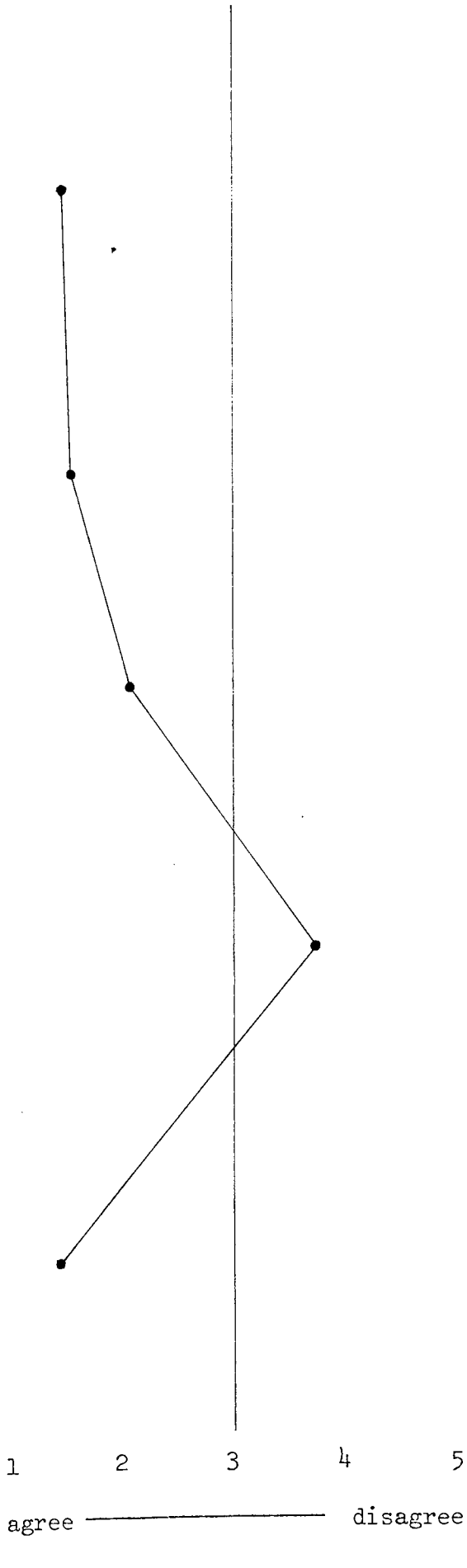


EXHIBIT 28 : Work preference questionnaire

As before, this instrument was used in an attempt to identify levels of risk-taking and innovativeness. Scores were high compared to the rest of the organisation; this is to be expected from a group whose dominant task is innovation.

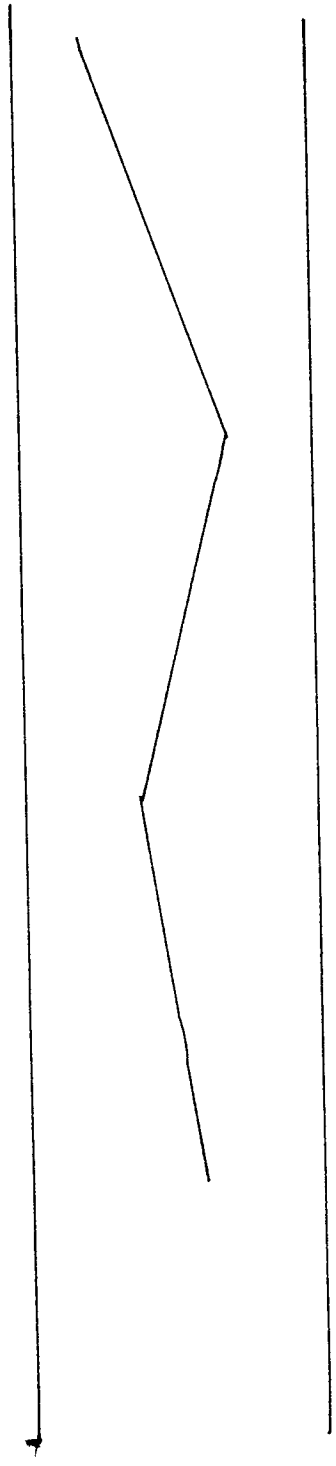
Of particular significance were statements about: interesting and challenging work (q6, q12, q16, q23), job satisfaction and motivation as opposed to hygiene seeking (q10, q5, q13) independence (q11, q15, q17), and support (q20). These responses are essentially similar to those given in Process Development and suggest once again that the predominant orientation is professional technical specialist.

Group relations are again felt to be significant: arguably needs for affiliation are higher than for achievement. This might explain the lack of product champions - individuals prepared to cross group norms and values and strike out alone are rare in this culture.

Work Preference Questionnaire

Would your ideal organisation be one...

1. Where a person's promotion is unpredictable and depends largely on his own good performance.



Where a person can see exactly how his career will progress after certain periods of time.

2. That regards special benefits, such as attractive bonuses, free pension schemes and a company car, as the prime incentive to remain in the job.

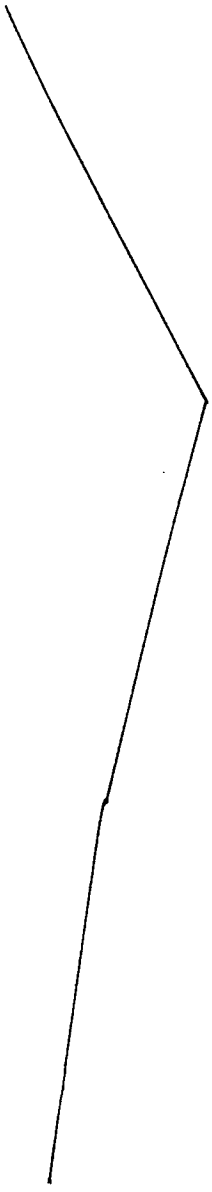
That concentrates on tempting new employees with interesting work, although it is not able to pay as much as other organisations providing less interesting work.

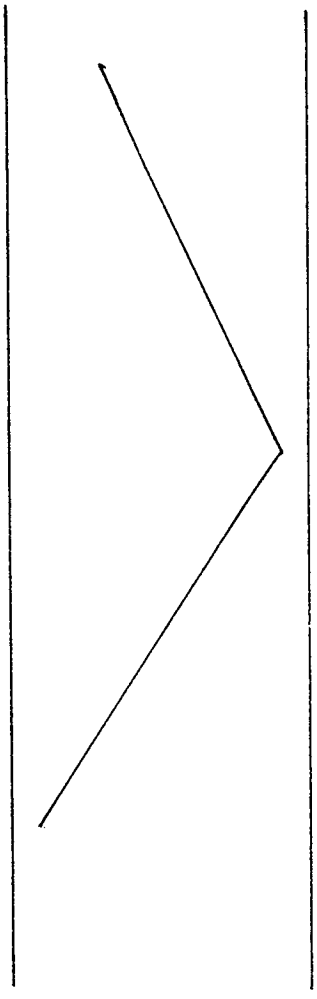
3. Where it is emphasised that the 'job comes first', therefore afterwork pleasures should take secondary importance.

Where it is very difficult to carry on work over a weekend period should someone so desire.

4. Where the few changes in tasks that occur allow people to perform one type of work with considerable care and proficiency.

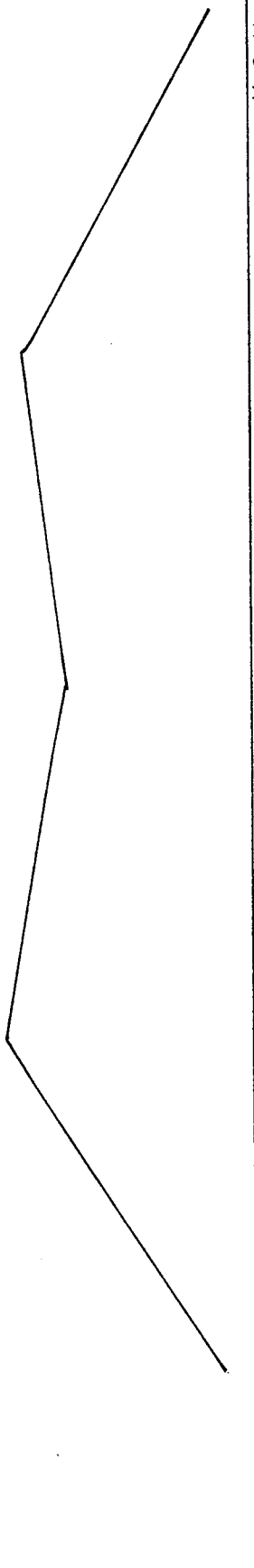
Where there is constant pressure to complete a task well in a short period of time and to then become involved with another task.

5. Where there is a general attitude that, even if the working conditions are poor, much can be compensated by interesting work.		Where little that is favourable can be said about the work itself but where the attitude of management towards its employees' welfare is first class.
6. That gives people jobs that can very likely be done well.		That gives people work which is not so difficult that they would have to rely on luck to do a good job nor so easy that they are bound to succeed.
7. Where it is expected that leisure time will be sacrificed if work pressure is great.		Where it is felt that working late is undesirable because eventually strain will be experienced in normal working hours.
8. That believes that if a person concentrates primarily on working in a warm close fashion with his co-workers, good work must follow.		That regards the successful completion of an employee's assignment as more important than the feelings of that person's co-workers.

9. That expects individuals to help the organisation by fulfilling their own personal goals.		That expects its employees to strongly identify with the organisation rather than think of themselves as individuals apart.
10. Where good working companions and generous holidays are provided to make up for the tedious nature of the work.		Where there is more concern with employees' satisfaction with the actual work that they do than with their general conditions of work.
11. Where each employee is solely responsible for most of the work that he performs.		Where several people are always responsible for, and take the credit for, a particular piece of work.

Would your ideal boss be someone.....

12.	Who gives his employees work that they feel sure of doing well without too much effort.	Who gives people work requiring quite a lot of struggling to master.
13.	Who insists on finding out how worthwhile his employees see their work but neglects looking into the enjoyment that they get from their work.	Who regards the pleasure that his employees get from their work as more important than the actual worthwhileness of the work.
14.	Who emphasises the importance of the work group's responsibility for its decisions rather than particular individuals in the group taking the responsibility.	Who relies on a particularly efficient individual in a work group to control the group's activities.
15.	Who expects to be consulted only for very exceptional work problems.	Who encourages employees to follow set procedures in their work.
16.	Who attempts to provide attractive work for his employees even if it is not of great value to them.	Who would not give people work that they could view as of little value even though it may be highly attractive to them.



17. Who gives his employees general guidelines on which to base their own decisions about how to proceed with their work.

Who gives clear, very comprehensive instructions on how employees should carry out their work.

18. Who finds that for group morale it is better to try to preserve good co-worker relationships that may be spoiled by letting people keep working at a task to their own satisfaction.

Who feels that a certain degree of bad feeling amongst employees is worth tolerating if they are very much involved with their work.

19. Who looks for future employees who will be able to work independently of others.

Who looks for future employees who will primarily be good at getting on well with other employees.

20. Who would rather employees consulted him with work difficulties than struggle with them themselves.

Who will not interfere with work for which employees have responsibility.

21. Who expects an individual's work rate to remain relatively uninfluenced by his colleagues.

Who relies on the group as a whole to produce a given amount of work expecting the group to influence an individual's quantity of work done.

22.	Who views good employee relations as being most important and incompatible with competitiveness.		Who insists on individuals trying to achieve a better performance rating than their co-workers.
23.	Who gives employees work where they need to write fairly detailed arguments about problem solutions.		Who gives employees work that involves very little written reporting or problem discussions.
24.	Who feels that working late should be avoided.		Who encourages working late in order to meet a deadline.

(vii) Applications Studies

(a) General Introduction

The full title of this group is Applications and Technical Service and its functions are to provide testing facilities within the company and service to customers outside. Structurally the department reflects this model of co-ordinating business and technical needs- there are three groups related to the key customer industry areas, and within these groups two sections, one concerned with Research and Development and one with technical service. Overall the department is part of the technical as opposed to the manufacturing element in the company; it grew up out of the strong links with industry in the early days of the company, and this explains the Manchester site since this is central for most of the UK market.

In terms of departmental function there are three basic threads;

(i) providing a technical service to marketing. This involves liaison with market representatives and executives and consists of customer service - problem solving, showing them how to get the most out of the pigments etc., and publicity - preparation of pattern cards, new product leaflets, information

/bulletins etc. (~ 20% effort).

(ii) providing a service to Research and Development. This consists of preparing product specifications, testing (and developing and updating test methods) for evaluation of new products. The testing operates though a screening laboratory at Paisley designed to pick up promising ideas and trends; products then came through to the main laboratories at Manchester where they are rigorously examined (~ 45% effort).

(iii) project work. The idea here is to undertake some longer term work aimed at improving understanding of aspects of the applications process - e.g. updating or exploring test methods, looking at how products behave in a new situation or process used by customers, etc. Some joint projects of interest to Research and Development and Marketing are also carried out - e.g. the replacement of a product range will mean evaluating markets in a new way, finding out what competition are doing etc. Routine work is also carried out in the way of small jobs, e.g. specific testing on new technology projects. Establishing standards

/is also the responsibility of Applications.

The group has recently absorbed the Paisley screening laboratories; hitherto these were under the control of the Quality Control group. The current arrangement represents a rationalisation but there is strong feeling that much will depend on how well this new arrangement can smooth earlier problems out. Certainly the major complaint in Paisley was the lack of test facilities and Applications personnel on site; this arrangement should improve things.

(b) Applications Studies

Most of this study involved interviews and a number of research instruments, notably the organisational mapping and beliefs questionnaires. In addition the results of an earlier survey of attitudes to testing between the two sites were made available to the researcher. A full list of problem statements appears in Exhibit 30.

In general, most problems are related to integration needs. Statements reflect criticisms of groups like Marketing for not supplying sufficient information and of groups like Research and Development for expecting the impossible of them.

The following issues appeared of particular importance:-

- uncertainty and dynamic character of the market-place. The role of Applications is partly to play the customer analogue, but this is difficult because the world outside changes so fast and has become so complex that what information there is isn't getting through - inadequate channels etc.

- unhappiness about strategic behaviour of the company.

- geographical problem. Inevitably there is great concern about this issue because it is a major source of dis-integration. There are strong arguments on both sides but the consequence is an element of insecurity amongst individuals who feel they might suddenly be moved. An illustration of this occurrred during the research; early discussions revealed that many people thought the researcher was conducting a survey related to the possibility of moving the operations to Scotland.

The classical argument is that the market place and the technical side should be kept apart at all costs, but the wisdom behind this thinking is dubious. There is the additional problem of lack of clear marketing contact with Basle who are responsible for the only really expanding market, that of European export. Two sites arise because of the geographical and logistical necessity of keeping the business operations near the industrial centres relevant to customer industry; Paisley is too far isolated for this.

In the end, the problem is more complex; part of it is undoubtedly a view that having senior management on the Paisley site would improve things and remove the 'absentee landlord' image. Good co-ordination is not a strong function of geographical location; it depends far more on mutual understanding and positive attitudes.

Exhibit 31 gives results for the organisational mapping questionnaire, and exhibit 32 for the work preference questionnaire.

As with the other groups studied, the major problem issues located in this area may be interpreted as relating to integration; as such they are discussed later in more detail.

EXHIBIT 30 : Applications Problems

(a) Innovation, Information Flow

- 'too much pressure from routine tasks'.

- 'organisational resistance is so high that you need a champion to put through anything really new'.

- 'the real problem is convincing people not so close to the market that they can see the need'.

- 'too much day-to-day work means that we have no chance to solve problems or even to get our priorities clear'.

- 'not enough care is taken in defining the problem to be solved'.

- 'lack of adequate testing methods and knowledge of requirements - nobody knows exactly what they want'.

- 'whatever it's causes, the insufficiency/uncertainty of input of information is a major source of problems'.

- 'role of competition is never clear'.

- 'problem of assessing rates of change in the market - 'is it a hiccup or a real trend?'.

- 'the company seem to be trying to play for the quantum jump changes and are leaving the modifications and incremental changes to other faster moving and smaller companies - as if we're loath to compete on equal terms - I'm not sure this is right'.

- 'the problem with information from the market place is that it comes via Marketing who are primarily concerned with selling not gathering intelligence'.

(b) Relationship with other departments

- 'there's a lot wrong with the belief that the marketplace and the technical side of the company must be kept apart at all costs'.

- 'the increasing difficulty of contact with Basle at a time when the only expanding market is the European one, handled through Basle'.

- 'the two-site problem is really a geographical and logistic necessity - the central position of Manchester could never be matched by Paisley and the UK market is based in the key industrial centres, all of which are easily accessible from Wythenshawe.

(b) Relationship with other departments cont'd.

- 'one of the really big problems is the lack of contact with Basle marketing and thus with the export market - so it's an issue of limited control over the operations in the market place which upsets people'.

- 'people in Paisley think we're a kind of servant with nothing else to do except keep them informed - no-one tries to get information, they never get in touch and then they blame us for not supplying it'.

- 'too often people in Paisley use criticism of Applications testing as an excuse for their own technical failure to meet specifications - I'm sick of having the blame for their failure laid at my door under the guise of 'too extreme testing'.

- 'what Paisley don't realise is that we are representing the customer - they don't trust our real marketing experience'.

- 'Research want more than we can give them - I put the blame on the general lack of information - that's why modified products are generally more successful than completely new ones - we already know something about them'.

- 'Research chemists tend to develop products blind to the real world'.

- 'Paisley don't see the dynamics of the market - for a start the time scales involved mean that things change several times in the course of a product's development'.

- 'chemists must accept that you cannot fix goalposts'.

- 'lack of understanding by the chemists of the breadth of task and role of Applications'.

- 'Basle are very difficult to get information from - and it doesn't help that they make all the basic decisions'.

- 'Research and Development people can't have direct contact with the market (for a number of reasons, both of policy and of distrust) - but they can't get a long-term perspective otherwise'.

- 'people in Paisley don't understand that we often don't have the information they demand - the market is so uncertain that, even with the best of working relationships we wouldn't know everything'.

- 'technical visit reports are the prime source of market information - how marketing make this input is a crucial determinant of how the strategy gets developed - our track record so far, with panic situations and so on, does not show this system up very well'.

(b) Relationship with other departments cont'd.

- 'not only is the quality of market information important but also who handles it - Marketing and Product Management are the rate determining steps in the response time for action, at least as far as the market-driven innovations are concerned'.

- 'Research and Process Development are generally overoptimistic in their expectations'.

- 'there's no trust in other people's skills - Process Development is on a hiding to nothing trying to come in on the chemistry side, because no one believes in Process Development chemistry; they'd be OK as an engineering group'.

- 'Applications have too spasmodic an involvement'.

- 'internal problems arising out of the change in testing arrangements at Paisley - is an Applications outpost there just the thin end of the wedge?'.

- 'Marketing do not provide enough formal contact and when it does take place, it's at too high a level - we have to depend on what we can glean from informal contacts with reps - we lack an overall picture at our level'.

- 'people don't understand - they assume Application's role is merely to rubber-stamp'.

- 'it's all down to communications - the message is getting through now but there are resistances which have to be broken down..'.

- 'our role is to simulate the customer internally - but it's difficult to know, what the industry we represent is really thinking'.

- 'I feel that the Paisley chemists are too sensitive - it's not their fault, the problem is the general belief that performance is assessed on successful achievement of targets - i.e. judgement by results, not effort'.

(c) d-m, co-ordination, planning

- 'too many decisions taken based on wrong or incomplete information'.

- 'the value of experience, particularly within specific fields or industries doesn't count in who takes decisions or on what grounds they are taken'.

- 'decision making can't be reduced to a mechanism - it depends on individuals and there is a great need for involving them'.

- 'most committees are wrongly constituted, both in the level at which they're set up and in the amount of specialist input they admit - thus decisions get taken for the wrong reasons'.

- 'a loss of trust and confidence in committees like the T.C.G..... they don't consult us enough'.

- 'we don't seem to be very good at judging threats in the market place'.

- 'T.C.G. have failed to really stop duplication of effort or lack of commitment because it operates at too high a level and loses first hand contact with what's going on'.

- 'T.C.G. doesn't work - need for more direct contact, need to monitor things more closely - it's OK for it's members, but irrelevant elsewhere'.

(d) Morale

- 'Pigments Division doesn't allow for sufficient mixing of experience in its personnel - there's no attempt to develop people'.

- 'people won't take the initiative - they'll say they want more participation in what happens but they won't take any responsibility'.

- 'too often it doesn't matter how factually correct your arguments are, it's the strongest voice or the most influence that carries a decision'.

- 'the politics of this company is founded on the principle of conflict, of divide and rule - and that goes back a long way!'

- 'all that matters in this company is scoring points - I sometimes wonder if we're working for the same company!'

(d) Morale cont'd.

- 'it used to be something to be proud of working for this company - now this is being eroded and there's a sense that people are being under-used - that's why so many good ones are leaving - the company doesn't seem to value them or to care about incentives other than money'.

- 'loss of people and experience to other competitors is a double blow since it simultaneously weakens us and strengthens them!'

- 'far too many politics - too much personal influence on high level decisions'.

- 'senior management are too rarely seen.....'

- 'we've lost our sense of direction.....'

- 'the company don't emphasise motivation in the right way, especially where junior staff are concerned'.

- 'there's a basic lack of understanding of people'.

- 'I feel very strongly that it's wrong to advance people on the basis of technical skills alone - there's a great lack of development or planned training'.

- 'lack of continuous basis in any action undertaken - e.g. communicator groups were a good idea but they never developed themselves'.

EXHIBIT 31 : Organisational mapping questionnaire

This was anattempt to 'map' problem areas: items of particular interest were:-

- Research and Development policy and objectives (1h, 1q, 6c)
- non-technological problems (1i)
- structure (2k)
- information flow (3b, 3d)
- intragroup co-operation (5b)
- group role definition (5f, 5g)
- informal structure (5h, 5h, 5j, 5n)
- intergroup co-operation (5l)
- attitudes to innovation (6a)

Here again is a strong belief in the value of the informal organisation, concern about information flow and about integration with other groups. The absence of concern about vertical integration is interesting since the senior management groups are located at Wythenshawe; this lends support to the view that Paisley is too isolated from this structure.

The business orientation of Applications is reflected in concern about objectives and policy for Research and Development; the group's role definition is also important, perhaps because there is an element of ambiguity in the eyes of other groups.

Once again non-technological problems are felt to dominate.

Organisational Mapping Questionnaire

Section (1) Objectives

In the context of this department, how far do you feel that:-

(a) the objectives have been realistically planned?

(b) the objectives have been effectively communicated?

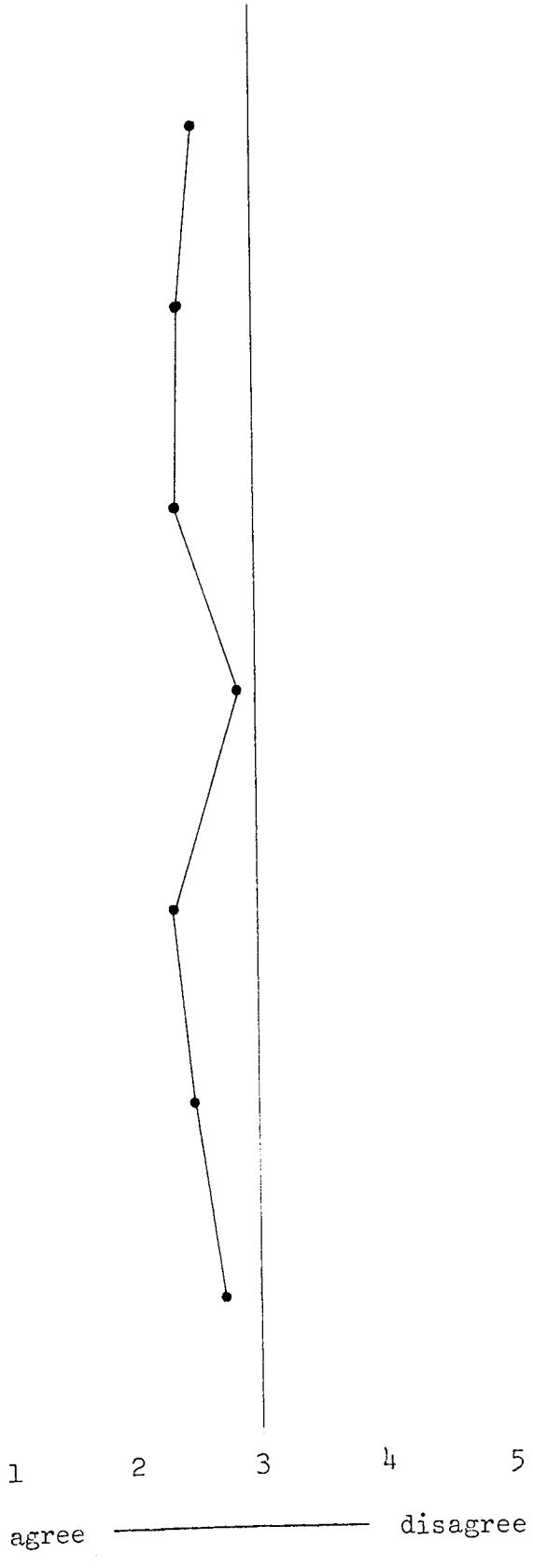
(c) the objectives have been clearly understood?

(d) the objectives have been successfully achieved?

(e) the objectives have been flexibly defined so as to be sensitive to changes outside the department?

(f) the objectives have been planned to make effective use of departmental resources (e.g. people equipment, etc.)?

(g) there is a high level of involvement in the development of a departmental strategy to meet these objectives?



Section (1) Objectives cont'd

In the context of this department, how far do you feel that:-

(h) there is a clear statement of formal R. & D. policy?

(i) the major obstacles to the fulfilment of these objectives arise from non-technological factors?

(j) the major obstacles to the fulfilment of these objectives arise from outside the department?

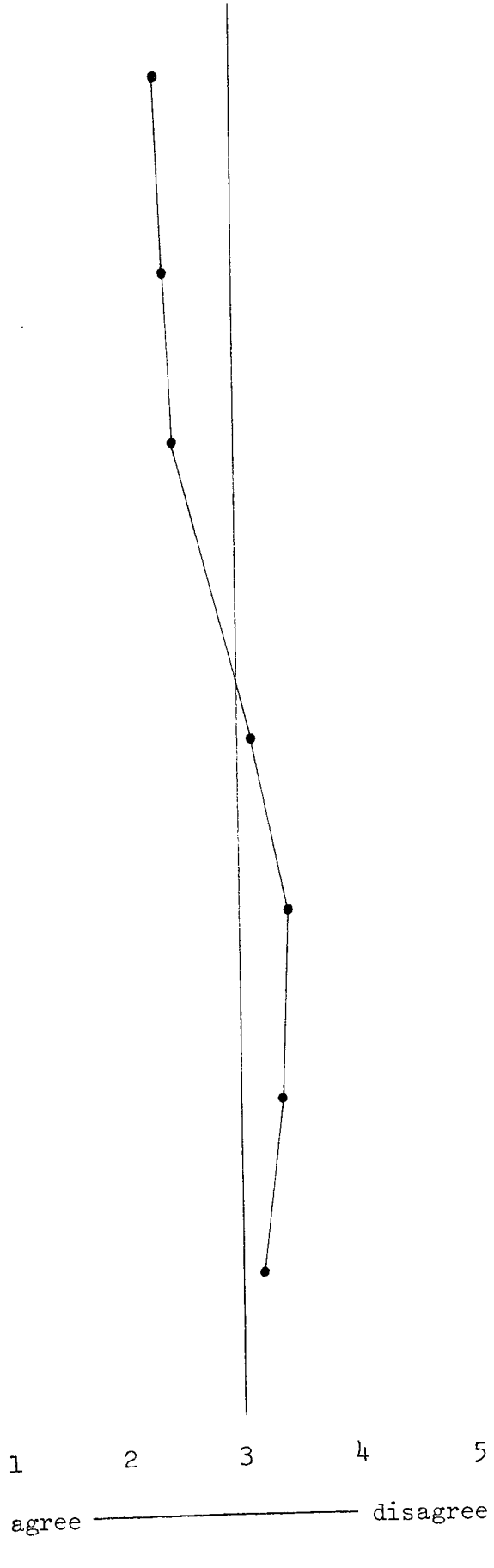
In the context of the Pigments Division organisation, how far do you feel that:-

(k) the objectives have been realistically planned?

(l) the objectives have been effectively communicated?

(m) the objectives have been clearly understood?

(n) the objectives have been successfully achieved?



Section (1) Objectives cont'd

In the context of the Pigments Division organisation, how far do you feel that:-

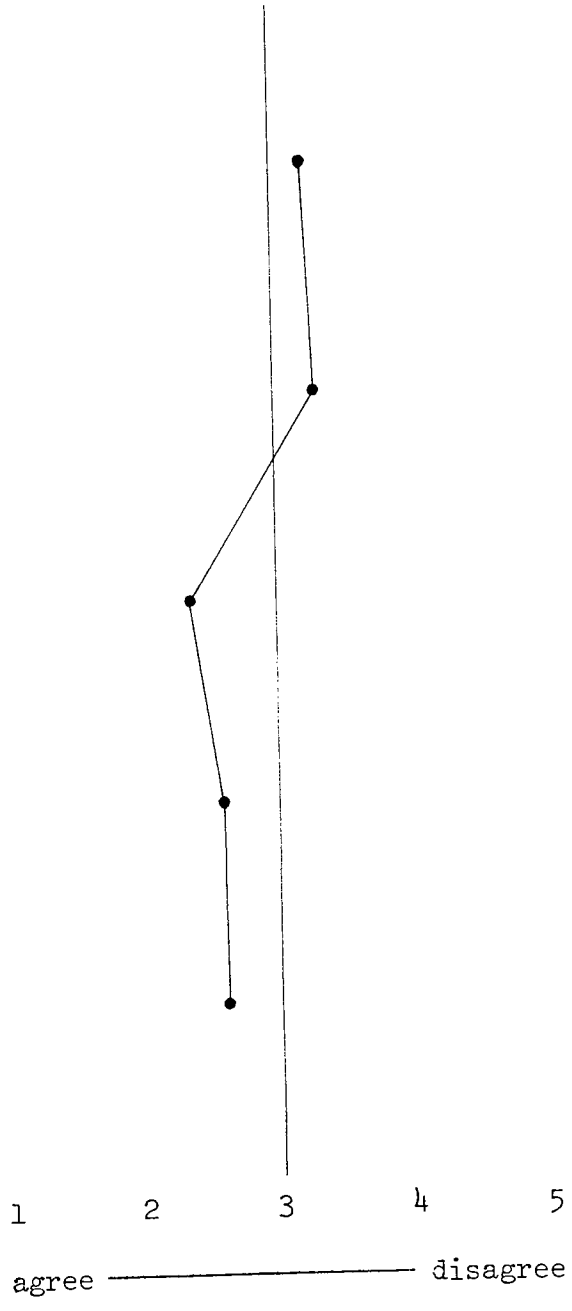
(o) the objectives have been flexibly defined so as to be sensitive to changes within the organisation?

(p) the objectives have been flexibly defined so as to be sensitive to changes outside the organisation?

(q) the objectives are too strongly influenced by Basle?

(r) there is a clear statement of formal R. & D. policy?

(s) there is a clear understanding of the role of R. & D. in the organisation of Pigments Division?



Section (2) Structural Factors

In the context of this department, how far do you feel that:-

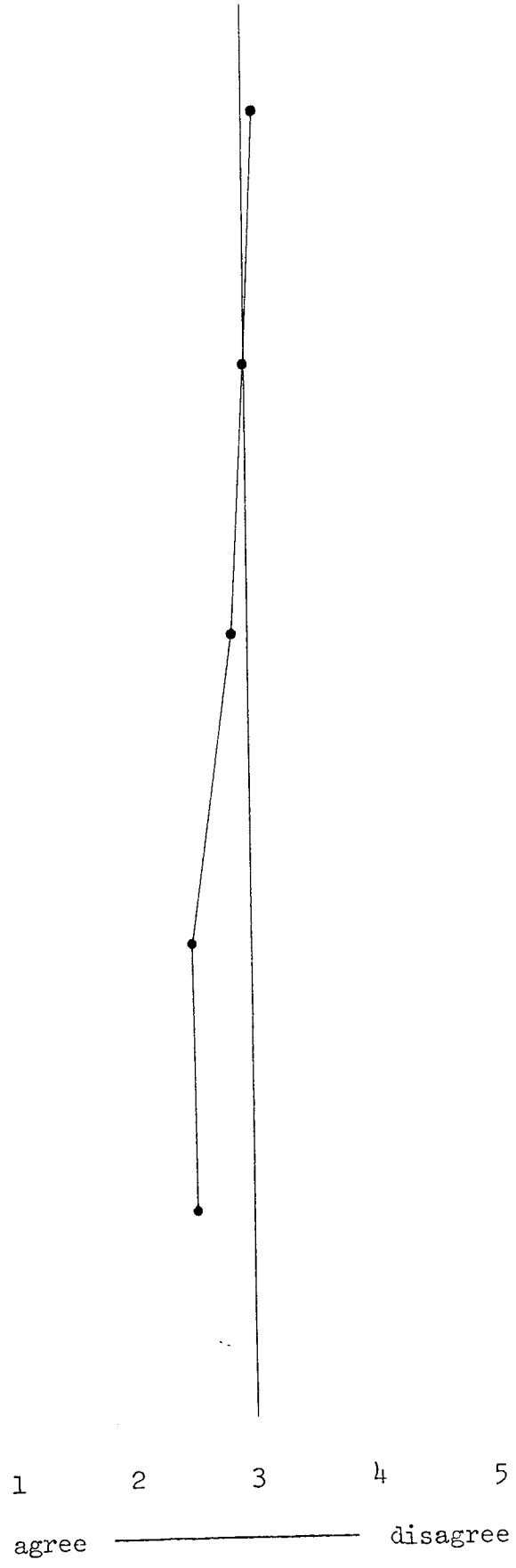
(a) the existing structure makes effective use of available resources (e.g. people, equipment, etc.)?

(b) the existing structure permits the use of individual initiative?

(c) the existing structure allows for greater delegation of responsibility?

(d) the existing structure permits each member of the department to make a significant contribution to, and to feel involved in, the life and work of the department as a whole?

(e) the existing structure is well adapted to the function the department has to perform?



Section (2) Structural Factors cont'd

In the context of the Pigments Division organisation, how far do you feel that:-

(f) the existing structure permits each individual to feel involved in and able to contribute to the life and work of the organisation?

(g) the existing structure allows for delegation of responsibility?

(h) the existing structure is flexibly defined to respond to changes in the outside world?

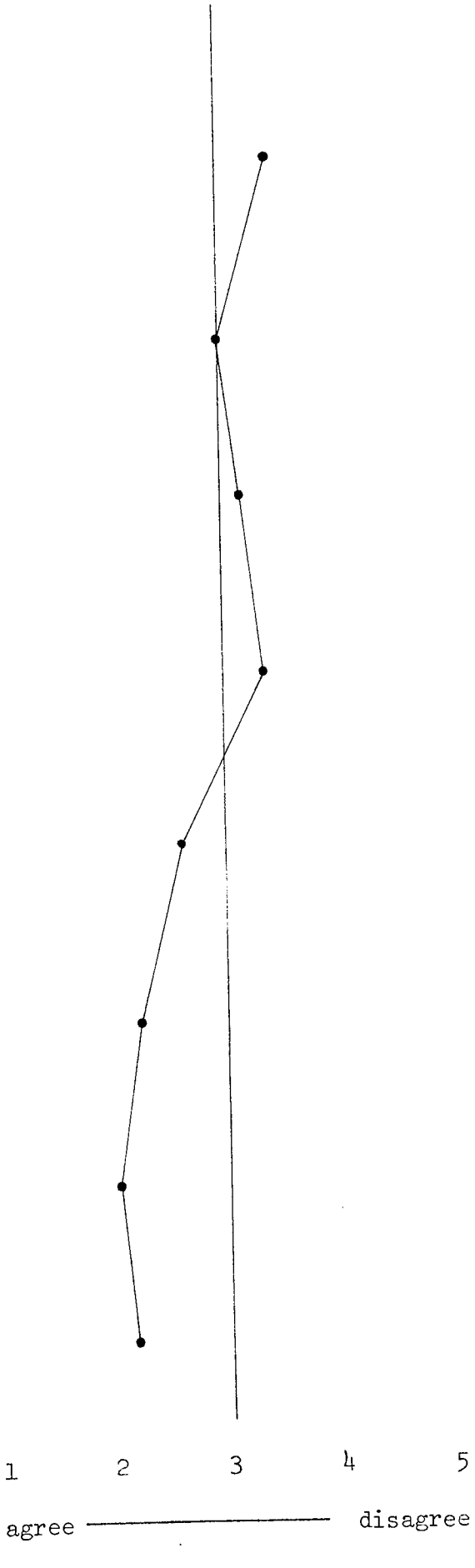
(i) the existing structure can quickly adapt to changes in the world outside?

(j) the existing structure is too far dominated by Basle?

(k) the existing structure is too rigidly defined to permit adequate contact between groups and departments?

(l) there is a gap between different levels in the management hierarchy?

(m) there is a distortion of perception across this gap?



Section (3) Communication

In the context of this department, how far do you feel that:-

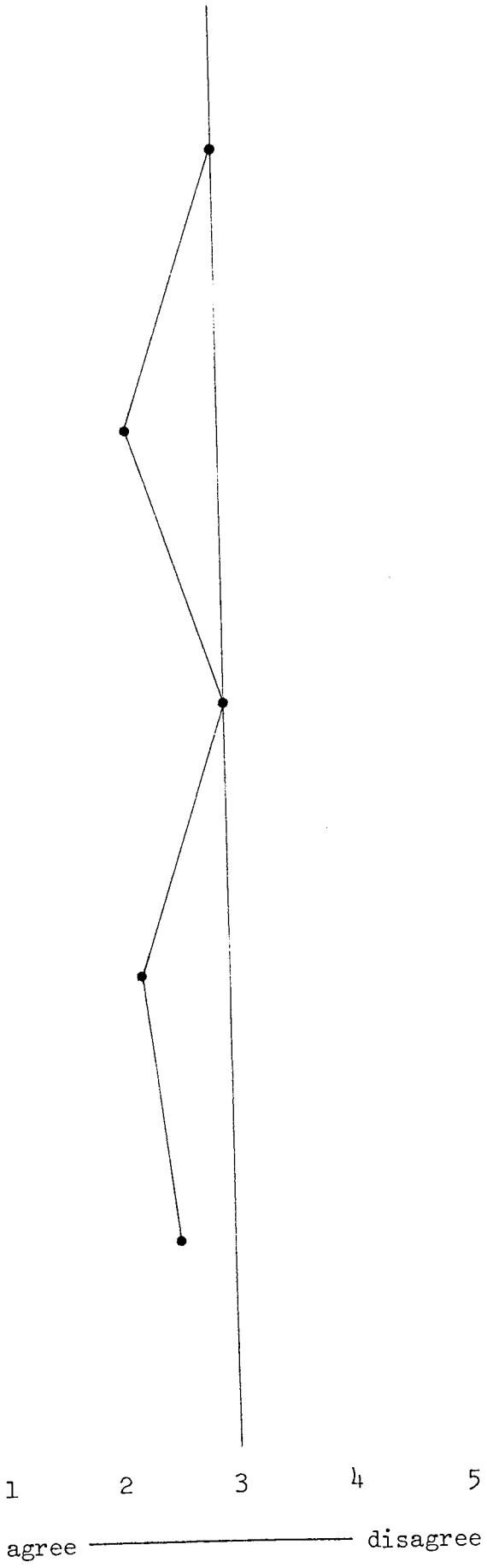
(a) information is effectively communicated?

(b) information is selectively 'filtered' before being communicated?

(c) information is communicated in a timely fashion, so that a sense of involvement and awareness is generated?

(d) information is more completely and openly communicated, i.e. that 'the whole story' gets passed on, by the informal network than by the formal one?

(e) information is more effectively communicated, and in a more rapid fashion by the informal network than by the formal?



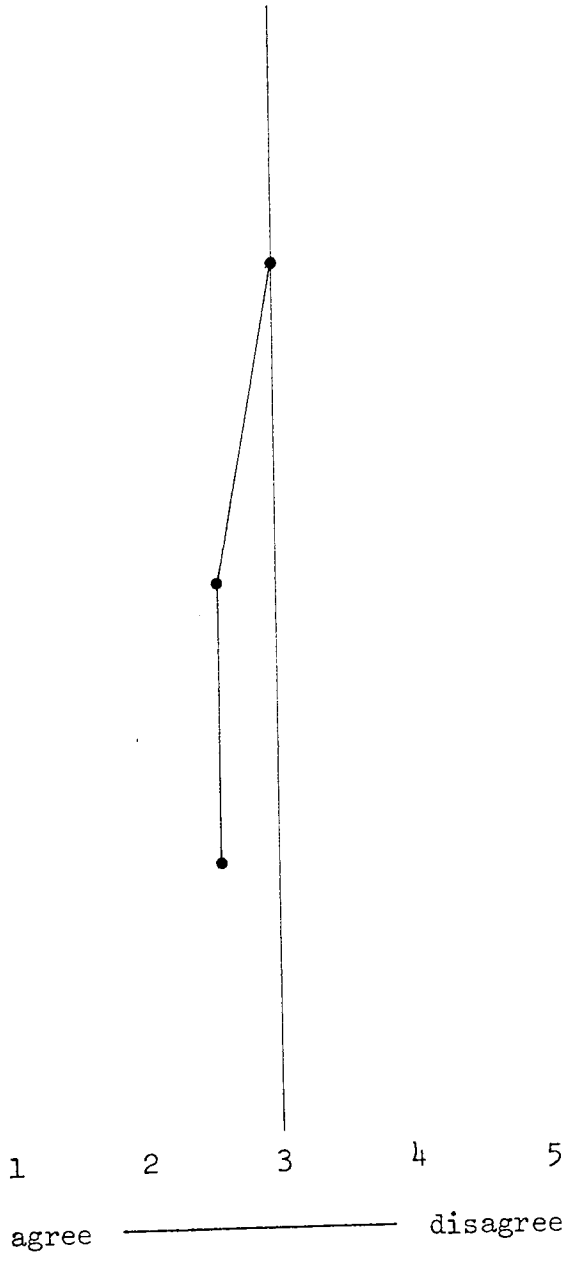
Section (3) Communication cont'd

In the context of this department, how far do you feel that:-

(f) the informal communication network is better adapted to keeping people informed and thus fostering a feeling of involvement and awareness?

(g) the informal communication network represents a distorting factor which contributes little to and may in fact inhibit the passage of correct information?

(h) the informal communication network reaches a much wider 'audience' with a much greater variety of information than does the formal?



Section (3) Communication cont'd

In the context of the Pigments Division organisation, how far do you feel that:-

(i) information is effectively communicated?

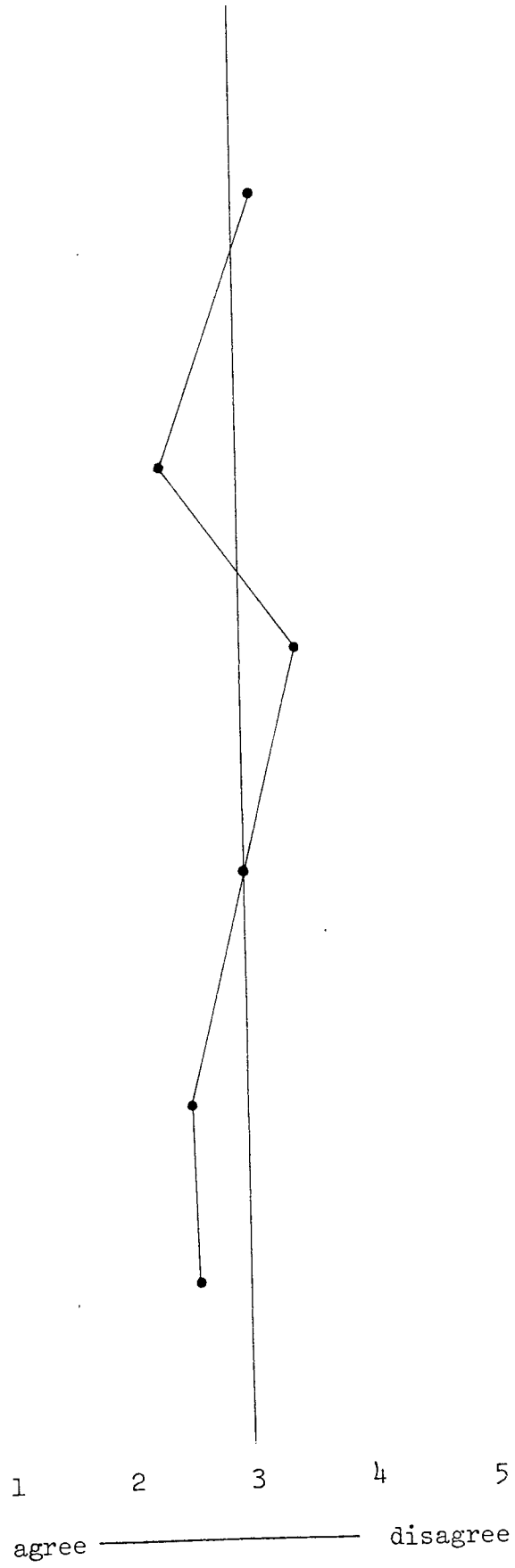
(j) information is passed on a selective 'need to know' basis rather than on a completely open 'telling the whole story' basis?

(k) information is communicated in a timely fashion such that a feeling of awareness and involvement is generated?

(l) information is more effectively communicated, and in a more rapid fashion by informal channels rather than by formal ones?

(m) the informal communication network represents a distorting factor which contributes little to, and may in fact inhibit, the passage of correct information?

(n) the informal communication network reaches a much wider 'audience' with a much greater variety of information than does the formal?



Section (4) Job-related factors

In the context of this department, how far do you feel that:-

(a) jobs are accurately defined?

(b) jobs permit a high degree of self-fulfilment?

(c) jobs offer a realistic opportunity for career development?

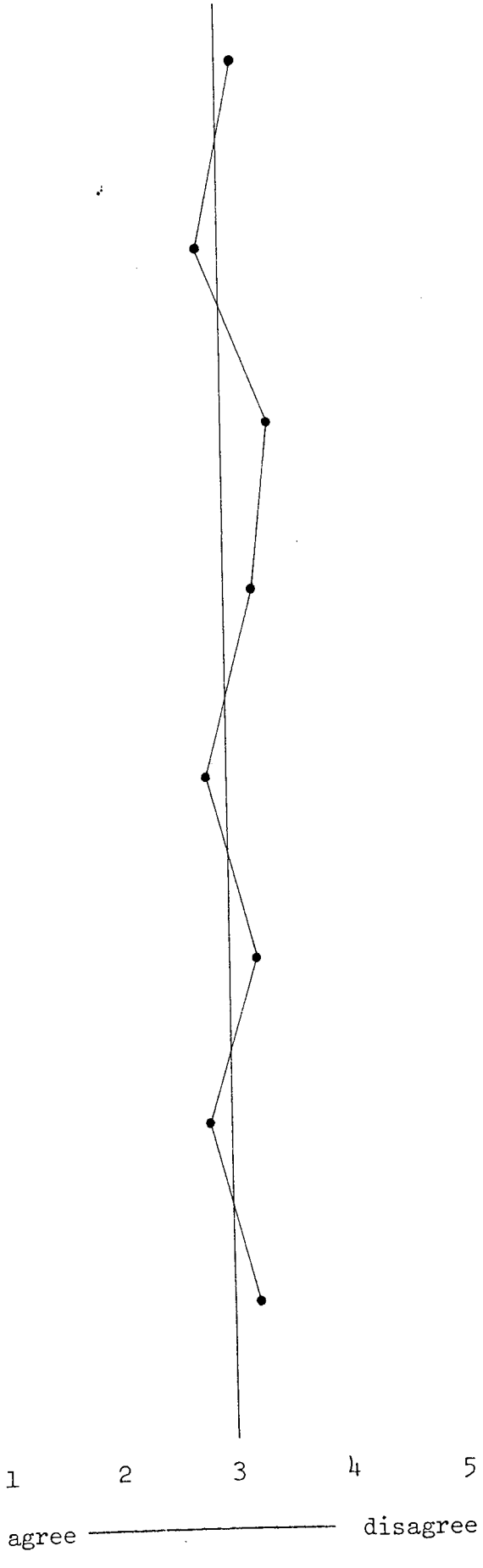
(d) the assessment procedures in use are effective indicators of performance?

(e) existing job descriptions offer the opportunity to contribute to the department as a whole?

(f) the assessment procedures are carried out in a uniform fashion?

(g) the assessment procedures permit an objective analysis of performance?

(h) promotions represent a meaningful change in job characteristics rather than an automatic 'step up the ladder'?



Section (5) Group-related factors

In the context of this department, how far do you feel that:-

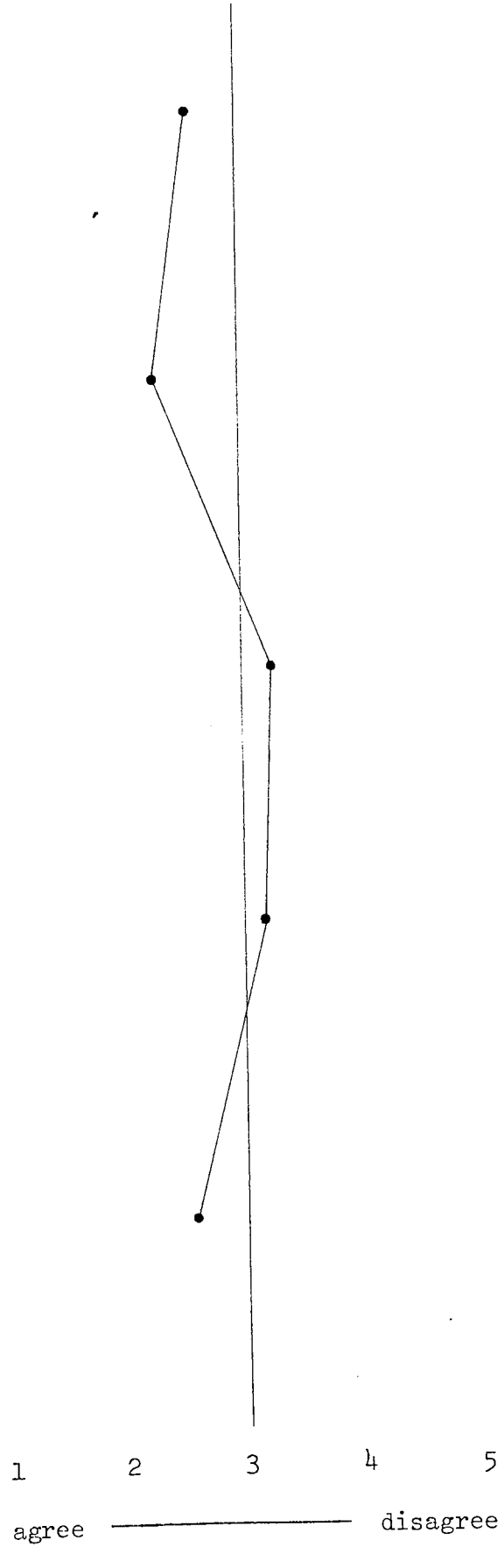
(a) there is good cooperation between groups?

(b) there is good cooperation amongst individuals within groups?

(c) there is a belief that conflicts and disputes can only be resolved in a win/lose fashion rather than by a compromise acceptable to both sides?

(d) there is good mutual understanding between groups and a clear appreciation of the problems and difficulties involved in other areas?

(e) there is a clear definition of the task(s) which the group has to fulfil?



Section (5) Group-related factors cont'd.

In the context of this department, how far do you feel that:-

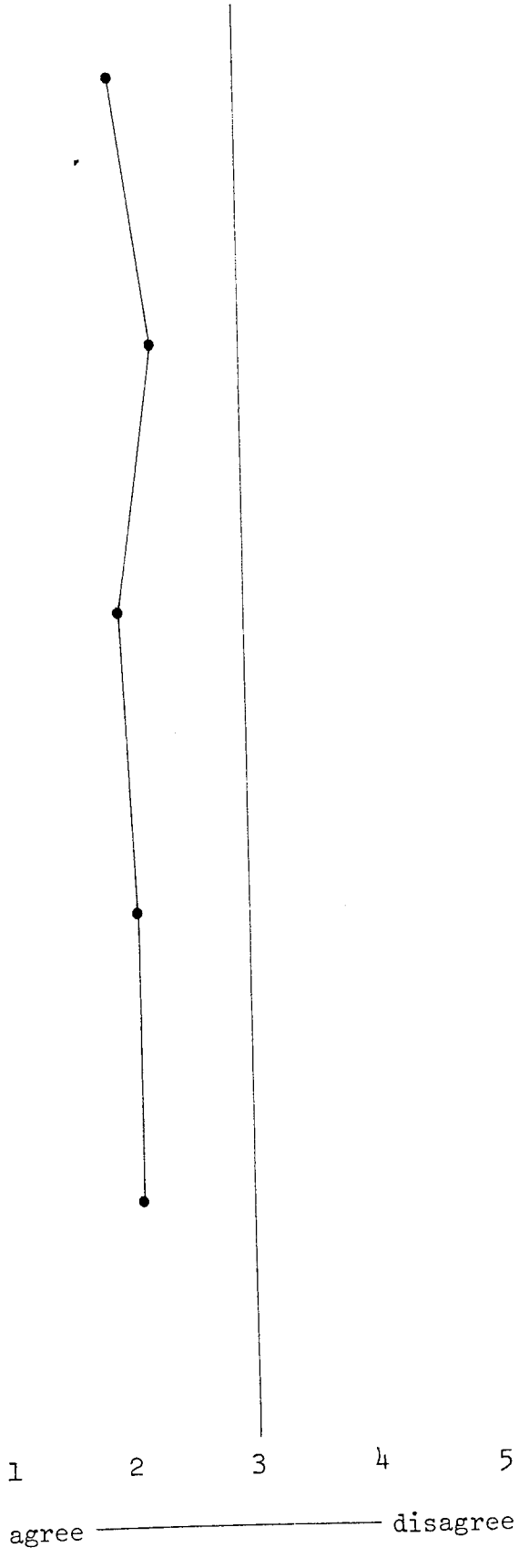
(f) there is a clear definition of the role the group has to play in the department?

(g) the clear understanding of role and task of the group leads to a sense of involvement, awareness and cooperation?

(h) that informal relationships help to strengthen a group from within?

(i) that informal relationships help to avoid confrontation situations between groups?

(j) that informal relationships help to foster a greater self-awareness and improve interaction with others both within and between groups?



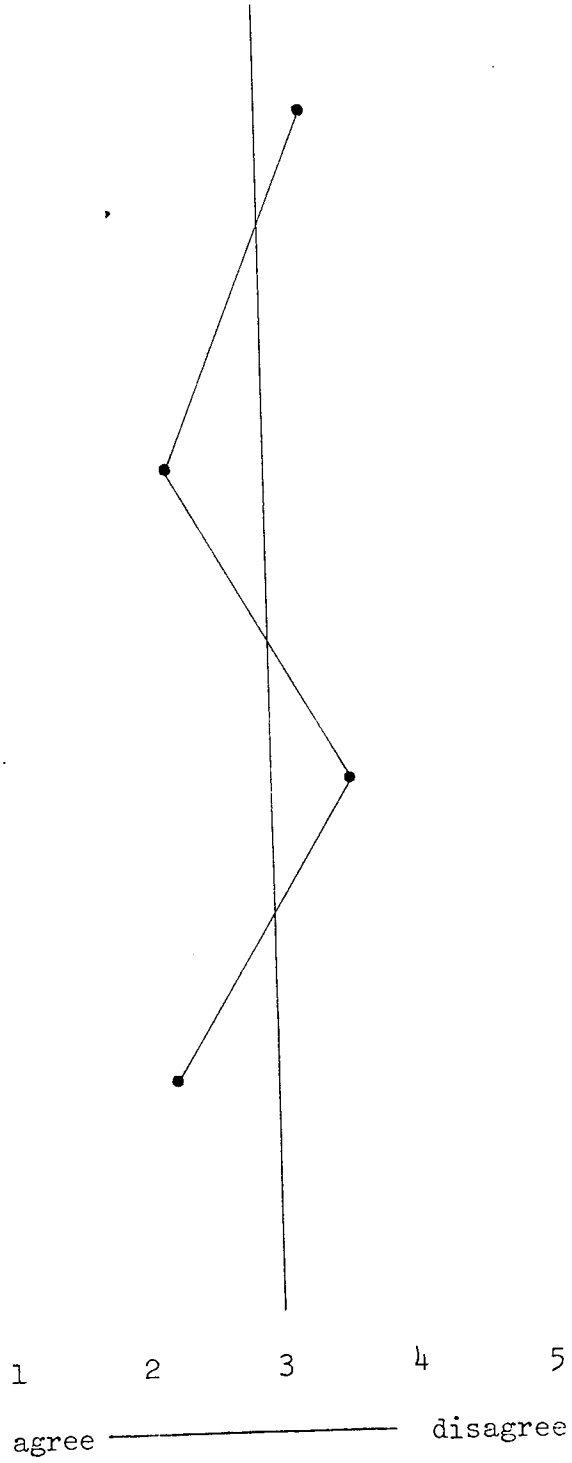
In the context of the Pigments Division organisation, how far do you feel that:-

(k) there is good cooperation between groups?

(l) there is a belief that conflicts and disputes can only be resolved in a win/lose fashion rather than by a compromise acceptable to both sides?

(m) there is good mutual understanding between groups and a clear appreciation of the problems and difficulties involved in other areas?

(n) that informal relationships help to foster a greater self-awareness and improve interaction with others both within and between groups?



Section (6) Innovation

In the context of the Pigments Division organisation, how far do you feel that:-

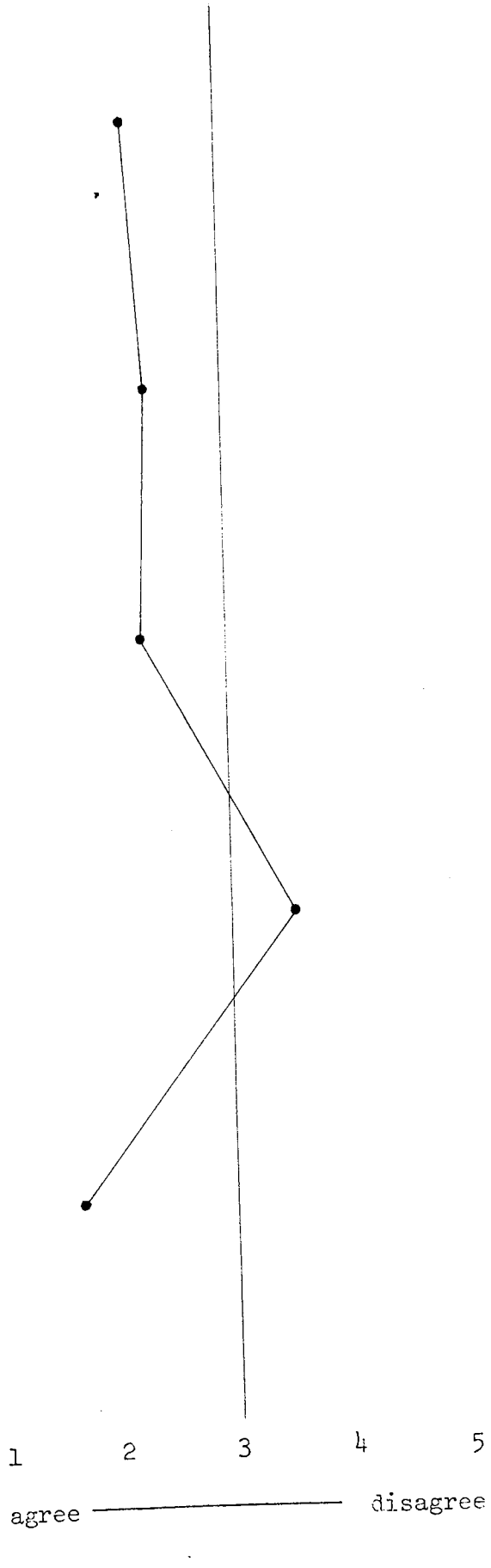
(a) attitudes towards innovation are too conservative?

(b) emphasis is placed on systematic work within procedure rather than on speculative, more radical work?

(c) the overall policy could be described as safe and sure?

(d) major departures from this policy would only result in major problems?

(e) the major barriers to innovation are not in the production of good ideas but in the process of carrying these into practice?



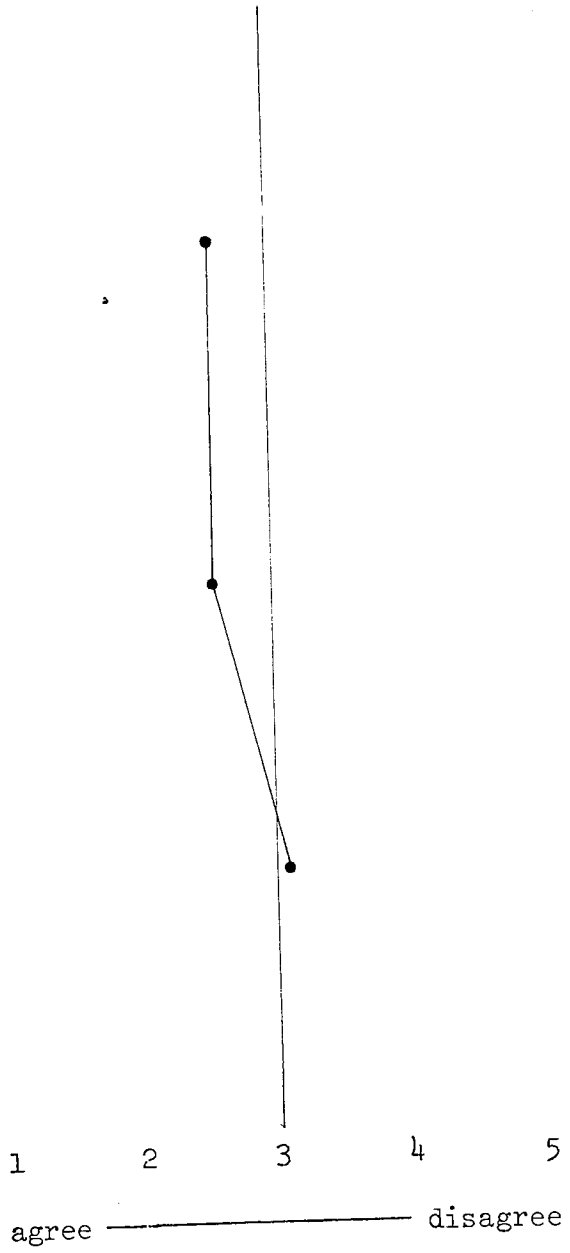
Section (6) Innovation cont'd.

In the context of the Pigments Division organisation, how far do you feel that:-

(f) these problems are not so much a function of the system itself as the personalities and behavioural factors involved?

(g) that the 'streamlining' of Meeting III has led to a 'gap' between functional departments in the innovative process and the R. & D. policy interpretation as performed by Meeting III.

(h) that the setting up of the T.C.G. has helped towards closing this gap by providing a link between functional departments and Meeting III?



As before, this measure was used to attempt to determine orientation towards risk-taking and innovation. Scores were comparable with the Production units and lower than Research and Development; this reflects the more routine nature of the Applications task.

Of particular significance were statements related to:

- incentives (q2)
- working under pressure (q4)
- self-identification as opposed to organisational (q9)
- job satisfaction (q13)
- independence (q15, q17)
- support (q20)
- group influence (q8)

Once again we can see the professional specialist orientation and group the group affiliation characteristics emerging. One interesting deviation is the value of incentives to this group; it suggests a more instrumental culture than one based on intrinsic satisfaction. This could be a consequence of the routine nature of much of the work carried out by members of this group.

Work Preference Questionnaire

Would your ideal organisation be one...

1. Where a person's promotion is unpredictable and depends largely on his own good performance.

Where a person can see exactly how his career will progress after certain periods of time.

2. That regards special benefits, such as attractive bonuses, free pension schemes and a company car, as the prime incentive to remain in the job.

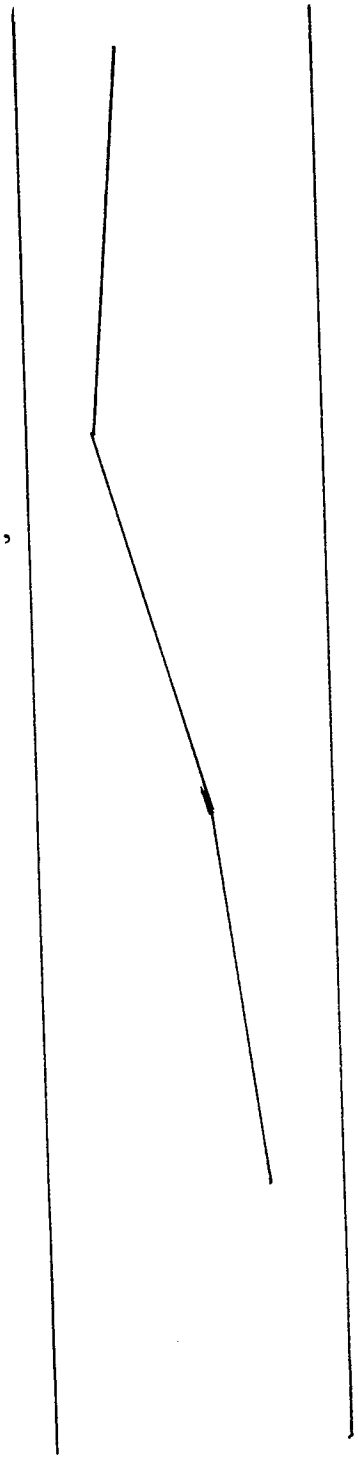
That concentrates on tempting new employees with interesting work, although it is not able to pay as much as other organisations providing less interesting work.

3. Where it is emphasised that the 'job comes first', therefore afterwork pleasures should take secondary importance.

Where it is very difficult to carry on work over a weekend period should someone so desire.

4. Where the few changes in tasks that occur allow people to perform one type of work with considerable care and proficiency.

Where there is constant pressure to complete a task well in a short period of time and to then become involved with another task.



5. Where there is a general attitude that, even if the working conditions are poor, much can be compensated by interesting work.

Where little that is favourable can be said about the work itself but where the attitude of management towards its employees' welfare is first class.

6. That gives people jobs that can very likely be done well.

That gives people work which is not so difficult that they would have to rely on luck to do a good job nor so easy that they are bound to succeed.

7. Where it is expected that leisure time will be sacrificed if work pressure is great.

Where it is felt that working late is undesirable because eventually strain will be experienced in normal working hours.

8. That believes that if a person concentrates primarily on working in a warm close fashion with his co-workers, good work must follow.

That regards the successful completion of an employee's assignment as more important than the feelings of that person's co-workers.

9. That expects individuals to help the organisation by fulfilling their own personal goals.		That expects its employees to strongly identify with the organisation rather than think of themselves as individuals apart.
10. Where good working companions and generous holidays are provided to make up for the tedious nature of the work.		Where there is more concern with employees' satisfaction with the actual work that they do than with their general conditions of work.
11. Where each employee is solely responsible for most of the work that he performs.		Where several people are always responsible for, and take the credit for, a particular piece of work.

Would your ideal boss be someone.....

12.	Who gives his employees work that they feel sure of doing well without too much effort.	Who gives people work requiring quite a lot of struggling to master.
13.	Who insists on finding out how worthwhile his employees see their work but neglects looking into the enjoyment that they get from their work.	Who regards the pleasure that his employees get from their work as more important than the actual worthwhileness of the work.
14.	Who emphasises the importance of the work group's responsibility for its decisions rather than particular individuals in the group taking the responsibility.	Who relies on a particularly efficient individual in a work group to control the group's activities.
15.	Who expects to be consulted only for very exceptional work problems.	Who encourages employees to follow set procedures in their work.
16.	Who attempts to provide attractive work for his employees even if it is not of great value to them.	Who would not give people work that they could view as of little value even though it may be highly attractive to them.

17. Who gives his employees general guidelines on which to base their own decisions about how to proceed with their work.

Who gives clear, very comprehensive instructions on how employees should carry out their work.

18. Who finds that for group morale it is better to try to preserve good co-worker relationships that may be spoiled by letting people keep working at a task to their own satisfaction.

Who feels that a certain degree of bad feeling amongst employees is worth tolerating if they are very much involved with their work.

19. Who looks for future employees who will be able to work independently of others.

Who looks for future employees who will primarily be good at getting on well with other employees.

20. Who would rather employees consulted him with work difficulties than struggle with them themselves.

Who will not interfere with work for which employees have responsibility.

21. Who expects an individual's work rate to remain relatively uninfluenced by his colleagues.

Who relies on the group as a whole to produce a given amount of work expecting the group to influence an individual's quantity of work done.

22.	Who views good employee relations as being most important and incompatible with competitiveness.		Who insists on individuals trying to achieve a better performance rating than their co-workers.
23.	Who gives employees work where they need to write fairly detailed arguments about problem solutions.		Who gives employees work that involves very little written reporting or problem discussions.
24.	Who feels that working late should be avoided.		Who encourages working late in order to meet a deadline.

(viii) Product Management and Marketing Studies

The Product Management group is of special interest, since it has an essentially integrative function to perform.

Studies were confined to brief interviews and questionnaire instruments, but some picture of the group emerged.

The group itself has a somewhat blurred role and is undoubtedly facing major difficulties in gaining acceptance as part of the overall organisation. Its non-line function adds to this problem. In full, the group's title is Product Management and Planning and it has the responsibility:

- for preparing and selling the one year and medium-term plans.

- to knit together the functional activities of the business.

- to concern themselves with anything which may affect the profitability of the company

- to stimulate, action in various areas as and when needed

- to justify products in a formal sense which Applications will then convert to technical specifications

- to rationalise and update product mix, range etc.

In general it is responsible for co-ordination, for making sure that things are happening; it is also a 'top table' group with some executive responsibility and a major input as unofficial assistants to the Managing Director.

Meeting 3 is primarily a Product Management meeting and provides one of the direct ways of influencing the innovation process.

One of the key problems for this group is their lack of formal sanctions; they have to depend on getting action by force of argument - 'the better our recommendation, the closer we come to making decisions'. The charge of 'empire building' was often levelled because of the group's emergent status coupled with its influence at high levels.

The task of 'safeguarding the future' requires extensive work, especially lubricating key interfaces between technical and business activities. Another major element in day-to-day operation in all aspects, and relating these to long-term strategies. Strategies are developed by Product Management who also have responsibility for securing commitment to them.

Equally there is strong feeling that existence of this group suggests a lack of faith in conventional line management and systems (e.g. the T.C.G.) to carry out co-ordinated activities.

Response to these charges is based upon the argument that the group has (potentially) the unique position of a very broad perspective on operations. (Lawrence and Lorsch (1967) suggest a group of this kind is most suitable as a co-ordinating agency). Thus whilst other groups might be concerned with 'local' interests, Product Management have a whole-company orientation.

An example of this problem can be seen in the difficulties encountered with the T.C.G. Following criticism that Meeting 3 did not relate effectively to T.C.G., it was proposed that one or both of the Product executives should attend T.C.G. meetings to act as information channels. However there was considerable hostility to this on grounds of status, on grounds that the T.C.G. was an open forum for free exchange of opinion behind closed doors - and that the presence of outsiders would inhibit this - and on the grounds that this was enlarging the control Product Management had over operational as opposed to strategic matters. In fact at the operational level, most chemists interviewed were grateful for closer involvement of Product Management since this meant more information about the project/

/they were working on - what it was for, what the state of the market was, what high level plans there were for it etc. - the 'window on the world'.

This hostility appears to represent a contradiction; documents such as the 'Fate of New Products' criticised Product Management for failing to feed in information yet there is resentment and suspicion about arrangments to improve this. On closer examination it becomes clear that a number of problems between individuals exist: mismatch of styles, fear and suspicion of ambition, personality clashes etc.

There are other problems too, associated with the new product process. Although Product Management are responsible for justifying new products, the rapid fluctuations in the market make this a difficult practice. All specifications must be based on 'guesstimates'; even these are limited by the level of information available. The primary source for Product Management and Applications is through the Marketing group - but there are several problems attached to this.

In the first case, the task of Marketing is, as its name suggests, to sell: thus the gathering of information is essentially a secondary activity. So the quality and quantity of information available is limited even at the first line; by the time it is channelled through to other groups it has lost still further.

This represents a difficulty in the UK case where Marketing representatives are on the same site as Product Management; in the case of the export market it poses a major problem. Marketing of overseas exports (the only growing part of the operation) is carried out by Basle on behalf of the UK company. Information from the Swiss marketing groups is first fed to Product Management and Applications groups in Basle before being passed by these to their UK counterparts. Inevitably the system suffers from delays and distortions - as one executive put it, 'the gaps in knowledge and lack of trust or confidence build up - it's like working with one hand tied behind your back'. One measure of this problem is the estimated time-span of feedback from the market-place; there is a very quick response in the UK but a delay of anything up to 6 months against European contribution.

Strategy is also a major problem for Product Management: as one of the executives put it, 'the problem is that we are a <u>low growth</u> industry but much of our organisation particularly mentally - attitudes, opinions etc. - is geared to other conditions'. We have already seen some of the strategic issues, e.g. the battle for continuing speculative research work: resolution of these issues in a realistic fashion is one task of Product Management.

One of the early complaints made was that there was no clearly defined strategy so people didn't know what they were aiming at. That hurdle has been overcome in that a great deal of effort went into developing an azo and a phthalocyanine strategy in formal terms, rationalising the product range, anticipating future trends, ensuring plant and investment availability etc. The problem now is that people have little faith in these strategies; thereasons for this are multiple. Particularly there is high sensitivity in areas where the strategic decisions taken over the publication gravure market delivered a severe blow to confidence amongst chemists in the business direction of the company. Allied to this is the apparent lack of clear justification for some of the products being cut out of the range; to the chemist it is hard to understand the problem if there are existing customers and the technology is sound. Future business and strategic thinking is outside their sphere of experience; for this reason one of the most important integrative functions of the Product Management group is the informal information they supply to chemists etc. giving them elements of a broader outlook. This has the function of clarifying objectives, and mobilising support and commitment to them on a <u>personal</u> rather than a functional basis.

Another difficult area of strategy arises from the fact that Basle influence decisions made about the overseas market since they are responsible for marketing in these areas. The problem is that this is the only really expanding area of operation within the industry, and so integration difficulties already experienced are likely to grow worse. Innovation in the European customer industries tends to be far in advance of the UK (e.g. in ink-making technology)so there is increasing dependence on Basle for expert knowledge of the market; however there is evidence to suggest that the same qualities of market misjudgement, panic reactions, unrealistic appreciation of competition role etc. are present.

Marketing Studies

As with Product Management, there was little opportunity to carry out studies of the Marketing department: what is reported here is based upon a small number of interviews and other instrumental data.

Essentially, Marketing are concerned with selling: this is complicated by the range of markets and the overall company structure. Although UK pigments division has a high level of autonomy, there are strong links with the parent division in Switzerland. The product range is split so that Paisley produce mostly high volume and 'classical' pigments whilst Basle produce the smaller volume, high value ones. Reciprocal marketing takes place, i.e. Basle sells UK pigment in Europe and vice versa. The problem with this arrangement is that, whilst it assumes that each marketing group will have relevant specialist experience in their own 'territories' (and that duplication of marketing effort would largely waste time and resources), it takes no account of integration problems involved.

In the UK group there is a long tradition of close involvement with customers; this is to be expected in view of the strong market-pull basis to the innovation process. Three dominant markets are considered, each under a marketing executive; plastics and fibres,

/inks and wallpapers, and paints and other miscellaneous areas. (In terms of sales, inks > paints > plastics). In addition there are executives responsible for market services and for market research.

The prime function of this wide range of activities is to provide feedback to the company about the direction and trends in the market-place. (In terms of uncertainty and market dynamics, plastics > paint > inks).

As far as innovation is concerned, most work is involved in incremental product modification rather than major changes. Market needs dominate, and these can only be partially influenced by the pigments industry; for example the quantity of pigment used in plastics manufacture is so small that it would be very difficult to exert pressure to change technology etc. By contrast, the CIBA company before the merger were able to exert a strong influence on the market because they were involved in selling high-value and speciality pigments; they were an acknowledged market leader in both senses of the word.

The mechanism for transferring market knowledge to the company is via direct contact with interested groups (formally and informally - e.g. Marketing director is present at Meeting 3) and via circulation of visit reports to other marketing people, Product Management and Applications.

This is often criticised but the Marketing response to the challenge that they don't supply enough information is that there is a general lack of information available. 'It doesn't just lie around waiting to be picked up!'

Another criticism is that marketing representatives could allow Applications or other people to accompany them on visits; the problem here, apart from the fact that most representatives appear to enjoy working alone, is that the information gathering exercise is not the dominant activity when visiting customers.

Underlying the criticisms of lack of information is a strong need for a better information base from which to work the innovation process; the need for this background and general knowledge is acknowledged by Marketing but there are logistic problems. 'The world outside is vast and it would be impossible to pass on all that we know to the chemist - even assuming that it were relevant anyway'. Presentations and discussions aimed at giving a broader viewpoint are one way around this but the issue is tied up with the role of marketing - 'is it to sell products or to inform the rest of Pigments Division?'

Despite these difficulties, most people feel that the UK market poses few problems; there is a good information base arising out of the personal experience of many people in the company over a long period of time, and from the extensive coverage by representatives. The major problems come with market information derived through Basle about overseas operations. This involves a completely separate handling with no interrelationship with the UK marketing people: consequently a long chain for information flow, and one which is not without delays and distortions. One effect of this is that stock levels must be high because forecasting of the market demand becomes much more difficult.

(ix) Total Organisation Studies

In addition to the previously reported studies of specific areas, a number of observations were made across the whole organisation. Generally these took the form of surveys of various kinds: the salient features are discussed here.

(a) Cally Seminars: a number of management seminars were held off-site; notable amongst these was one held at the Cally Hotel in 1976. A large and representative group of managers were involved in discussing, via small group and large forum sessions, the central problems facing the company.

Exhibit 33 lists the major problems raised at this seminar. In addition, the company house journal 'Spectrum' published a series of interviews with managers concerning their reactions to the seminar Exhibit 34 lists extracts from these interviews.

(b) Creativity Audit: in conjunction with Dr. Rickards of Manchester Business School, an attempt was made to link two different research projects. That reported here as a specific, long-term and in-depth study and the MBS study based on a broad cross-section of industry from an external viewpoint. The major instrument used in this research was the creativity audit, a questionnaire-type measure described in

/the methodology section.

The results of this study were published as the substance of the seventh quarterly report; exhibit 35 reproduces these together with the discussion as then reported. Subsequent work on the project suggests that there are several key factors which account for most of the variation across the large data sample. Principal amongst these are factors concerned with integration and with the relationships within and between groups. Research is continuing and will be published later.

(c) Organisational beliefs questionnaire: this instrument (discussed in the methodology section) aimed at identifying some common beliefs across the site. It incorporated some Business Organisation Climate Index questions (Payne and Pheysey 1971). Exhibit 36 discusses the results.

(d) Organisational Mapping questionnaire: this instrument is described in the methodology section. Exhibit 37 discusses the results.

(e) Work Preference questionnaire: this measure of need for achievement is described in the methodology section. Exhibit 38 discusses the results.

(f) Personal Beliefs measure: this attempted to summarise beliefs about work, and is described in the methodology section. Exhibit 39 discusses the results.

(g) Short Course observation: in April 1977 a short course on Technical Group Leadership was held at Aston University: amongst the participants were several managers from Pigments division. Exhibit 40 presents some observations of this event.

EXHIBIT 33 : Problem areas identified at Cally Seminar

- strategy unclear
- Basle dependence
- product rationalisation needed - too many standards
- lack of information base
- Research and Development outside the division
- fear of innovation
- motivation
- 'inbreeding' in Production
- productivity
- profitability of 'classical' pigments
- raw material vulnerability
- high overheads
- high infrastructure
- decision-making not devolved
- staff unionisation
- poor plant design
- slow reaction to change
- lack of investment
- employee attitudes
- stockholding policy
- underpricing
- quality control too tight
- lack of Research and Development policy
- inflation
- leadership
- parochial attitudes
- misuse of resources
- poor communication
- lack of involvement
- abdication of management decision-making to unions
- processes too labour intensive
- mismatch between production and market
- too few 'winners' in Research products

EXHIBIT 34 : Extracts from Interviews with senior management about the management seminar and related topics

(i) Marketing Manager

- general: - 1976 a better year, coming out of the doldrums. 'A year of recovery even though towards the end of the year competition was fiercer than ever.....1977 will be a year of consolidation.....the problems arise from the nature of the markets we serve.....we face competition from nearly every industrialised country for our share of the British market'.

- on communications: 'Management at the top are more aware that people down below have meaningful comments to make. They are listening more than they were to these comments'.

- on morale: '.....improved. A lot of the unhappiness was directly related to the insecurity about jobs and the future. I think it has improved with the improvement of the business environment'.

(ii) Manager of Project Engineering

- general: things much improved by the general investment go-ahead on new azo and phthalocyanine units

- on delays in capital projects: - 'Technology.....is not standing still. More advanced and economic processes continue to come from Process Development. If these are not incorporated in our designs, we are not making the most of our resources and may be curtailing our profitability. When a project is restarted, redesign and modification may be needed in order to incorporate the new technology. .....if, on the other hand, a project is stopped before any building work is carried out, the designs have to be shelved - very demotivating for the people who worked on them..... The problem we face is to forecast three to four years in advance what will be required. In times of rapid change, this is very difficult'.

- on communication: 'Senior management are communicating much more information.....I believe this is vitally important. Everyone has to make decisions and a knowledge of the background is important if you want people to act for the best interests of all. There are constraints, of course..... commercial secrecy for one, and of course a cost in terms of time'.

- on integration: 'Engineering as a group is certainly pulling together, and efforts are being made to create more teamwork generally in the Division'.

(iii) Applications and Technical Service Manager

- on communication: 'In the area in which I am involved there has been greater acceptance of the Managing Director's policy of discussion, consent and delegation. There has been more positive involvement of managers at different levels and people seem more prepared to do things on their own.....there are a lot of schemes and ideas, such as briefing groups, which have developed since the Cally seminar to improve communications. But I still feel a lot of insecurity among my staff here. This is not only a result of the Company situation, but stems from a general lack of confidence in Britain, and the lack of ability to reqard performance fully'.

- on integration: 'The biggest distinction we have is between Paisley and Wythenshawe, the problem of a split location. It's harder to resolve problems by writing, you get a different impression in a face-to-face situation which makes it easier to get over any problems that occur. .....I think as a company we are still having growing pains from the merger and then the split company. Change will always bring problems but hopefully it will also bring improvement'.

(iv) Phthalocyanine Production Manager

- on communication:- 'Communications are never perfect but imperfections can only be seen by those who are uninformed.....talking to people is still the best method of communications'.

- on integration:- 'I have always appreciated that departments, like engineering, have a difficult job to do. Having had this confirmed at the seminar has not made my demands on their services any less. If anything you become more critical of services when you know how much they cost to run. This makes one feel that their efficiency should be very high and makes any deficiencies, real or imagined, less easy to accept'.

- general:- 'I still do not feel that bold decisions are yet being taken. There are too few people prepared to take decisions because they know they will meet opposition. Expediency still carries too much weight. Consensus tends to be short-term thinking, it will choose the easiest route. Nevertheless, I think we will survive better than most'.

(v) Plant Manager (dry grinding unit)

- on communication:- 'Upward communication is the problem. We need to make the Management Committee more aware of the opinions and attitudes of people below them. People do not necessarily want greater involvement, but they do need to feel that those above them know they are there'.

- on integration:- 'People cannot feel confidence in management and senior management if they feel that management does not know that they exist. It's not enough just to have feelings, you have to see and be seen. If members of management sit in their offices all day they set an example which others will imitate and remoteness of management becomes the normal state of things.

The size of the company and the split location.....do not help, but they need not be a problem if people make the effort to see and be seen. People will only feel real confidence in management when they see that management is trying to understand what they are doing'.

- general:- 'With the right decisions, this Division has a very bright future. I don't feel we are seizing all the opportunities, we are letting them slip by us. We have seen a 20-fold growth on this site but we seem to lack the confidence to take further steps forward.....'.

(vi) Divisional Production Manager

- on communication:- 'In industry generally there is a changing attitude which is putting more pressure on management and making it harder to do the job. Some staff and professional people now feel with the size of the company that they make less contribution as individuals, that they are less noticed and unheard and are turning towards trade unions to voice their views. It is essential that people should be informed of what is going on and have the chance to express their views'.

- on integration:- 'As every football manager knows, the creation of a team has to be worked at. It takes time and effort and a willingness from the top to have a team approach as well as a willingness of people to be part of a team'.

EXHIBIT 35 : Results of Creativity Audit

———— Ciba-Geigy scores

~~11111111~~ Sample ($\bar{1}$) n = 109 respondents

~~00000000~~ Sample (2) n = 100 respondents

(No comparative data was available for the first section on 'Changes taking place in the last six months').

The comments have been grouped under the general headings of the questions they refer to, e.g. 'morale','management style' etc.

- Morale

'It is very difficult to envisage improvements in production due to the high turnover of factory personnel. A person with six years experience is considered a long-service member'.....I feel something must be done to keep our staff and build up a more highly trained and experienced workforce in our factory.'

'...personnel loss indicates strong dislike for current situation regarding morale.....'

'...no effort seems to be being made to discover why so many people are leaving from certain departments...'

'...if the Company showed a little more concern for the individual and his abilities were recognised then perhaps a better team spirit may develop...'

'I should be interested to study a Company with worse middle and junior management morale - if I could find one!'

'...competitors are snapping up some of our most capable and experienced people...'

'...we are losing far too many man because of better wages outside. Requests for replacement labour seem to be ignored. Position is now getting desperate - by the time we do bring the squads up to strength we will have lost more of the existing labour and be back to our present position...'

'...job satisfaction within the unit is negative...'

'...this is a rather special 6 month period during which we have had a more than average transfer of personnel out of the Company, usually to competitors...'

- Management Style

'...I feel that there is not enough co-operation between departmental managers...'

'At present we have too many managers who do not realise that the 1970's are here. The attitude is 'well we've always done it this way'. Some managers seem to be afraid of any new talent coming up through the ranks'.

'...too many chiefs all trying to do each others and subordinates jobs...'

'...there seems to be a distinct lack of interest by certain laboratory heads in the welfare/needs of their staff...'

'...changes in personnel make little difference - the organisation tends to nullify the effect of individuals...'

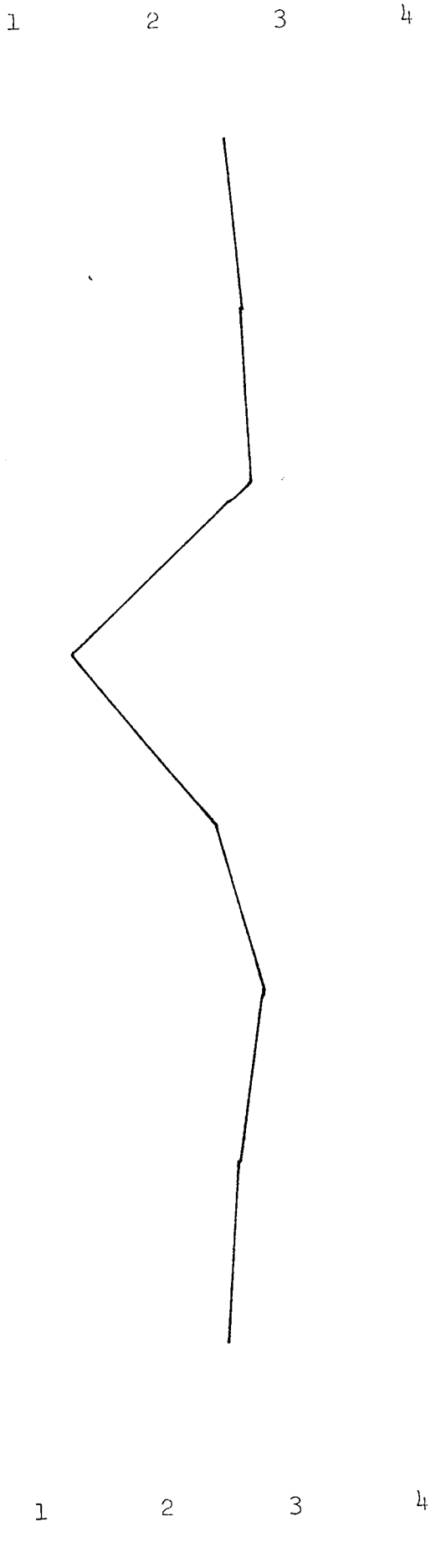
- Planning, Decision Making and Co-ordination

'...what we are developing very much depends on what our customers want. The general feeling is that by the time we have it they don't want it any more. Our processes of getting a new product through are too slow'.

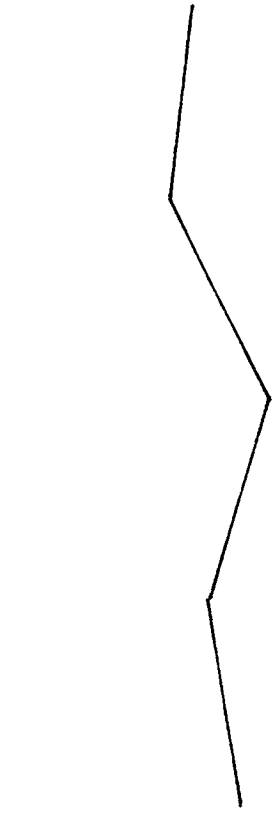
'...plans for the future do not appear to be based on valid or correct information at all times...'

'...we are muddling along with no evident sense of direction and absolutely no leadership'

The Individual's Immediate Climate

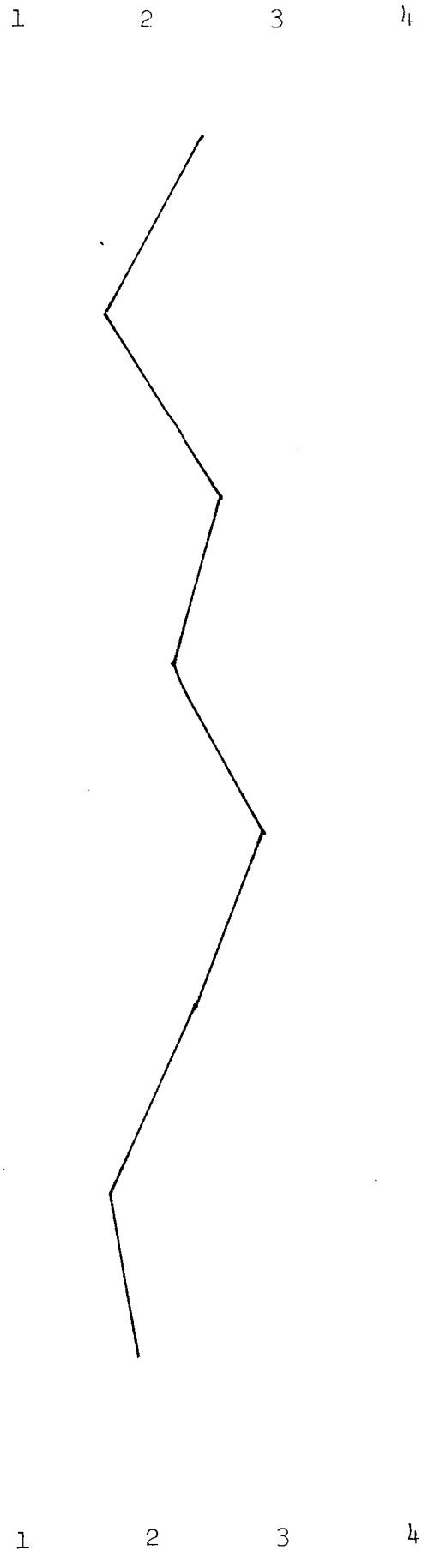


		1	2	3	4
Communications are generally satisfactory within our group.	9				
In times of success credit is shared among the group members.	10				
We have a mix of different experiences within the group that contributes to its effectiveness.	11				
We do not have enough time from pressures of day to day tasks to plan for the future.	12				
Responsibility for a task is usually linked with sufficient authority to carry it out satisfactorily.	13				
	0	1	2	3	4



disagree ← → agree

The Organisational Climate



We have a good track record of innovation by comparison with competition in similar organisations.

Our management style does not impede the introduction and development of new products or processes.

In this organisation, there seems strong forces which favour the preservation of the status quo.

The organisation is by and large enthusiastic for organisational changes that might lead to improved performance.

The organisation operates to minimise the risks that any individual can take.

The most able people do not usually get promoted as quickly as they deserve.

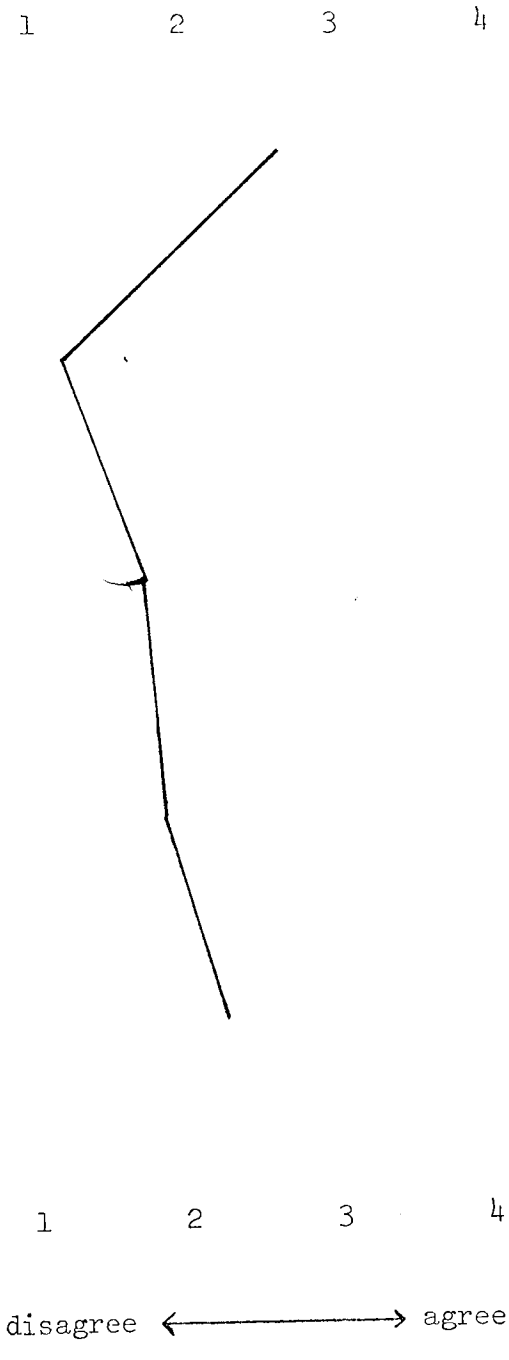
There is a general attitude of defeat towards new ideas.

It is generally accepted in the organisation that there is outstanding creative talent in its ranks.

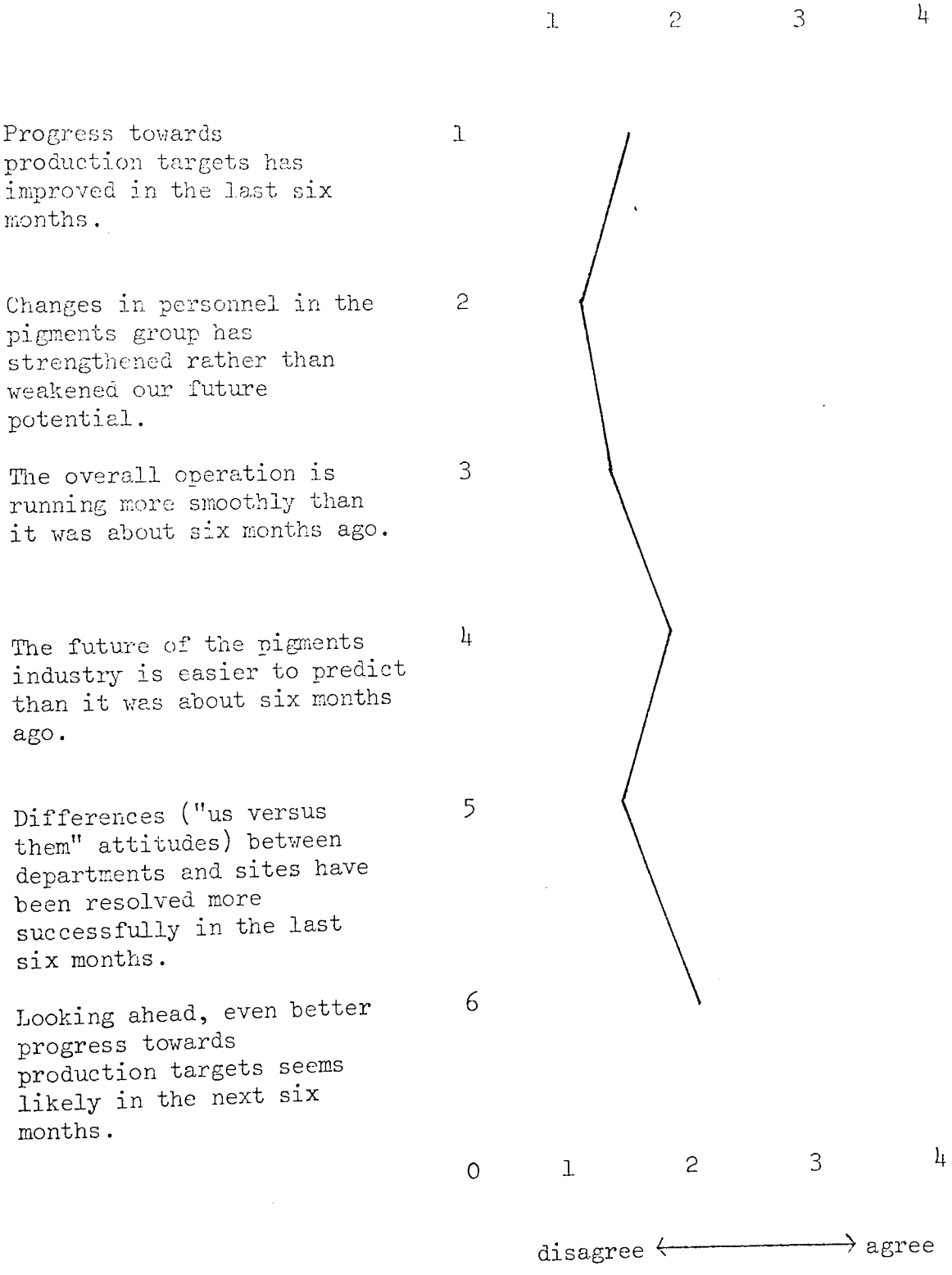
		1	2	3	4
There are influential people in the organisation who will support new ideas entirely on their merits.	9				
The management control over its activities is not an inhibiting factor for progress.	10				
There are efficient mechanisms for the flow of information necessary for managers to carry out their jobs.	11				
The organisation is attempting to stimulate creative thinking through its training programme.	12				
The organisation is successful in understanding and meeting the needs of its customers.	13				
The organisation has been active in changing its structure to cope with the changing needs of today.	14				
In this organisation managers are expected to confine their interests to their specialised skills.	15				
	0	1	2	3	4

disagree ⟷ agree

The organisation makes use of outside technology and scientific advice.	16	
As far as you can tell morale is generally high throughout the ranks of the organisation.	17	
The company has an atmosphere which encourages its managers to discuss their work openly with colleagues in other departments.	18	
The organisation is in danger of failing to plan for the future through its concern for day to day operation.	19	
The specialists (e.g. technologists or accountants) tend to become involved in general company policy and problems.	20	



Changes Occurring Over the Last Six Months



DISCUSSION

The Individual's Immediate Climate

Questions (1) to (3) correlate well with the general experience of other companies: the fact that all these answers, together with questions (11), (13) are positive indicates a healthy attitude within groups. They feel that they have an important task to perform and a contribution to make, that they have the necessary resources, experience, flexibility etc. to do it and that their team can work together to achieve it. Equally, question (5) indicates that the group is capable of coping with the changing environment described in question (1).

Communications (question 9) and external relationships, at least in terms of listening to ideas (question 7) are adequate and groups appear favourably disposed to ways of improving idea production (question 6).

Apart from a general feeling, shared by other companies, that there is too much pressure from day-to-day activities to plan for the future (question 12), the major problems seem to be concerned with the credit and acknowledgement given for effective contribution (questions 4 and 10). In fact, this feeling appears to be directed mainly at sources outside the group, i.e. a general lack of appreciation for what the group is achieving by others in the organisation.

This feeling occurs again and again in the Aston study: people are aware of putting a great deal into their work only to find this effort unrewarded or frustrated by the organisation's apparent indifference. In many ways this is similar to feeling expressed in the previous report between two different areas: once again the problem seems to be 'how to achieve better integration of specialist groups'.

In some ways the organisation is failing to work as a co-operative unit with common aims and goals and is instead frustrating itself with inter-group problems. Lack of trust, lack of contact, lack of faith in decision-making and planning, lack of risk-taking, etc. will inevitably contribute to a basic lack of success. Since this pattern only fosters these negative factors, a vicious circle develops in which the prevailing attitude becomes one of intense frustration - 'why should I bother - it's like banging your head against a brick wall'. All your hard work within a group comes to nothing when it goes outside - it just gets lost in the system and finally dies as a result of politics, fence-sitting blind conversatism and sheer lack of interest. This Company claims to be desperate for innovation- but when they get it, they don't know what to do with it' - might be a typical comment.

DISCUSSION cont'd.

Changes Occurring over the Last Six Months

The general trend of the profile is negative and suggests that the current attitude is summed up by question (3), i.e. that the overall operation is running no more smoothly than six months ago. Failure to make progress in resolving problems of integration of departments and sites (question 5) and the continual loss of valuable personnel (question 2) contribute to this somewhat bleak view, which cannot be blamed entirely on the national economic climate.

In fact, the picture is much as would be expected from the other profiles where the effectiveness and contribution of individual groups and departments is reduced by organisational factors.

The Organisational Climate

Question (1) suggests that the division sees itself much as other companies with respect to its track record on innovation; question (3) however, indicates a strongly conservative bias. Question (5) suggests that this restricts the level of individual risk-taking although (questions(8), (9)) imply a basically innovative attitude amongst people within the organisation.

Information flow (question 11) and technical advice (question 16) appear to be adequate and question (4) indicates a favourable attitude towards organisational development. The lack of a comprehensive training and development programme for staff, particularly managers has been criticised before and question (12) indicates further a need for such a non-technical training input.

The major problem areas, however, emerge strongly from the profiles - question (2) on the effect of management style and questions (17) and (18) on the overall morale and atmosphere of the organisation. References to the comments will confirm the importance of these.

Whilst it is generally accepted that the current economic climate and Government policy have contributed to a hostile environment, the deviation from the other organisations on these points suggests that these are fundamental problems arising within the division.

A summary of the situation might be as follows.

'The Pigments Division is made up of effective groups who see themselves as flexible, resourceful, able to adapt to the demands of a rapidly changing environment. Despite the strong team spirit within these groups, there is dissatisfaction because their potential contribution is frustrated by a range of organisational problems: these include,

The Organisational Climate cont'd.

- systems for innovation which are too slow to respond.
- conservative management who won't take risks.
- too much fence sitting - no real decision-making.
- reluctance or refusal to delegate or to invite participation.
- management hierarchy too far removed from the operational world.
- management style out of step with needs of staff.
- intergroup conflicts, politics.
- lack of confidence, trust, co-operation between groups.

EXHIBIT 36 : Organisational Beliefs questionnaire

This was an attempt to identify dominant beliefs and attitudes in the organisation. In terms of the overall organisation, there was strong feeling about statements dealing with:

- emphasis on technical skills (q10)
- decision-making (q14)
- planning process (q18)
- senior management (q25, q27, q49)
- information flow (q73)
- competence (q71)

These fit well with results in the organisational mapping studies; once again integration, particularly vertically, is of importance. The feeling appears to be that much of the organisational inertia is due to problems of conflict at high levels. Ability to influence the planning or decision-making process is limited and thus there is no way of changing the situation.

The lack of emphasis on 'people' skills is felt strongly and suggests one direction in which the organisation could develop.

Moving to individual departments, we find an interesting distribution of relevant issues. In the case of Process Development, these were:-

- rules orientation (q1)
- pressure to perform (q7, q42)
- emphasis on technical skills (q10)
- planning process (q18, q29)
- individual/company relationships (q5, q21, q24, q48)
- senior management (q4, q27, q49)
- innovativeness (q46)
- consideration (q66)
- information flow (q73)

Here there are factors beyond the overall organisation and with the perceived pressure in the environment. This appears to reflect a lack of integration between what people feel they can contribute and what they expect from the organisation on one hand - and what actually happens on the other.

In Research the dominant issues were:

- rules orientation (q1)
- senior management (q4, q25, q27, q49)
- emphasis on technical skills (q10)
- planning process (q18)
- openness (q19)
- pressure to perform (q42)
- group spirit (q50)
- management concern (q70)
- safety consciousness (q77)

Here there are similar factors to Process Development on dimensions concerned with pressure and demands on individuals. Climate factors like openness and levels of support from peers and superiors are important; these may relate to the high levels of uncertainty facing this group.

In Production the major issues were:

- senior management (q25)
- isolation (q45)
- information flow (q73)

The small number of issues reflects limits on the statistical approach rather than lack of strong opinion: what does emerge is the sense of isolation the groups feel in this area.

In Applications, major issues were:

- success on leaving the company (q13)
- decision making (q14)
- management skills (q16, q56, q61)
- planning process (q18)
- individual/company relationships (q24, q48, q55)
- senior management (q27)
- company future (q32)
- emphasis on technical skills (q37)
- innovativeness (q47)
- pressure to perform (q41, q67)
- openness (q55, q75)
- information flow (q73)

Here there are the dominant organisational issues coupled with individual/organisation mismatch.

Senior management is not seen to be a big problem - perhaps because they are on site at Wythenshawe. The future of the firm and its level of innovativeness is an area of concern, however. Management skills, particularly concerned with training and developing staff are also important; here again the direction for organisation development is clear.

Overall this instrument provides support for propositions already advanced elsewhere: it gives a quantitative indication of how important these issues are.

Organisational Beliefs Measure

Applications

1. Formal rules and regulations have a very important place here?

2. People here tend to hide their deeper feelings from one another?

3. This company has failed to keep pace with a changing world?

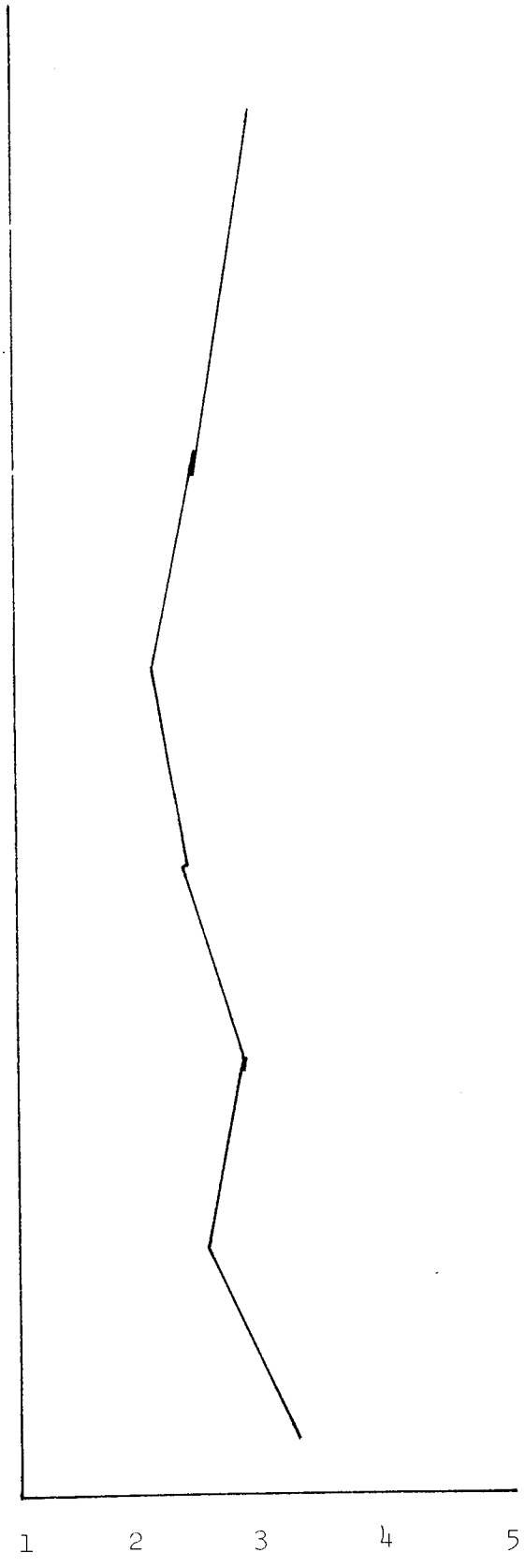
4. Senior management are out of touch with what's really happening?

5. This company treats some people as just a pair of hands?

6. Management style in this company is out of step with the demands of the present day?

7. There's not enough pressure put on people to perform well?

8. This company does not care about the well-being of its employees?



9. This place has a reputation for being indifferent to the needs of the wider community?

10. This company places too much emphasis on technical skills and not enough on 'people' skills?

11. The company is always trying to take advantage of us?

12. There is a lot of bootlicking here?

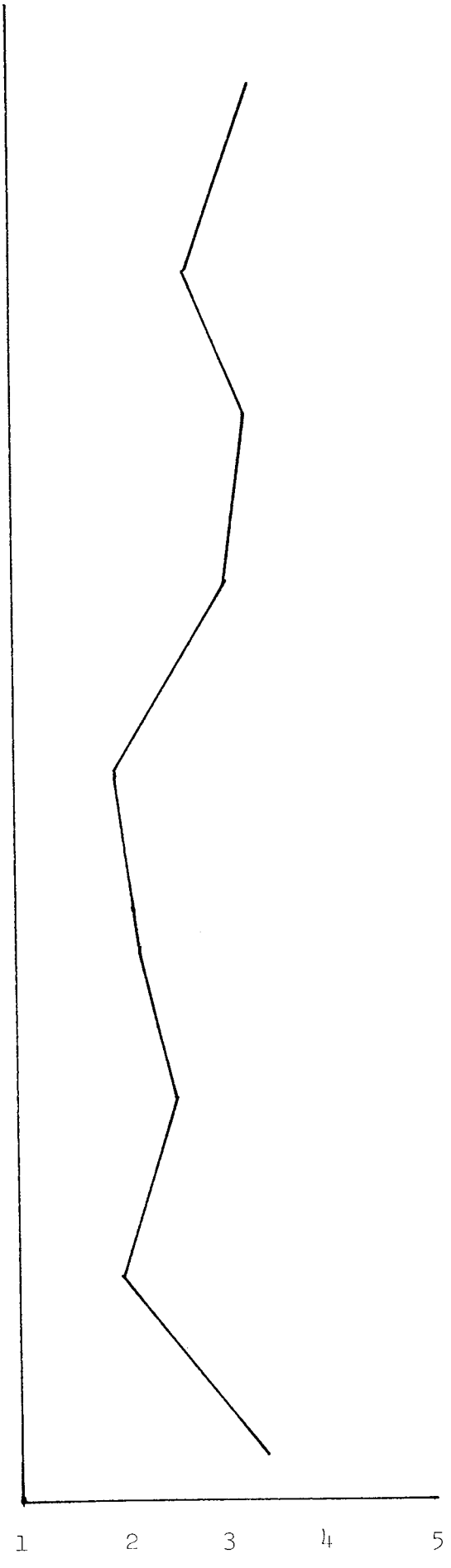
13. When people leave this company, they become much more successful?

14. In this company, decisions are made by groups too far removed from what's really happening?

15. Too many of our managers are failures?

16. Managers in this company often lack 'people' skills?

17. High-level co-ordination is often irrelevant at the technical level?



18. The planning process is too remote?

19. In this company issues never get raised or confronted openly.

20. People tend to stick to old-established rules and procedures rather than try and introduce new ways of doing things?

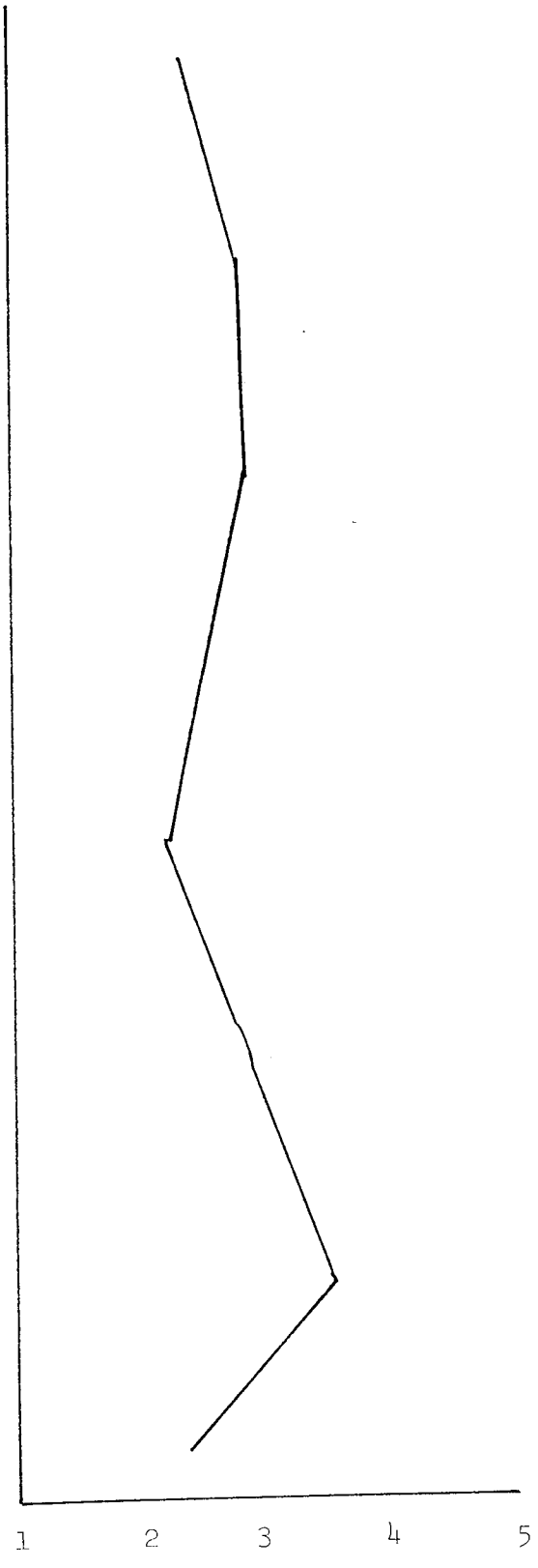
21. People tend not to see any connection between company performance and their own responsibilities?

22. This company is too conservative?

23. Senior management have too narrow an outlook?

24. People who get pushed around here are expected to fight back?

25. Senior management are too isolated?



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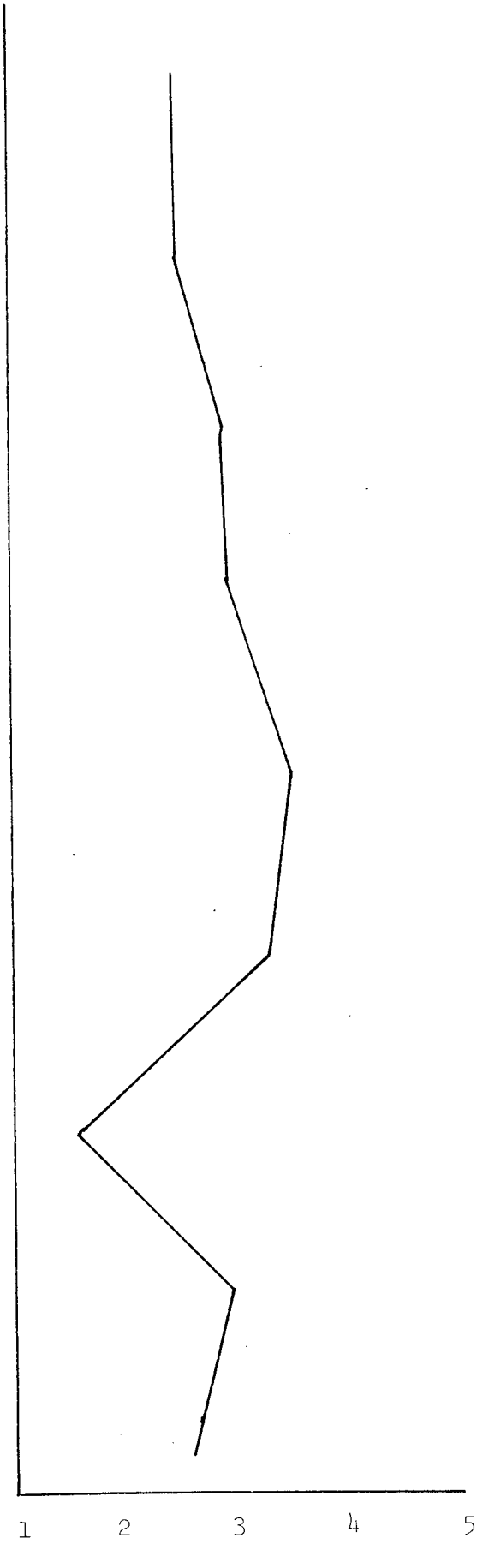

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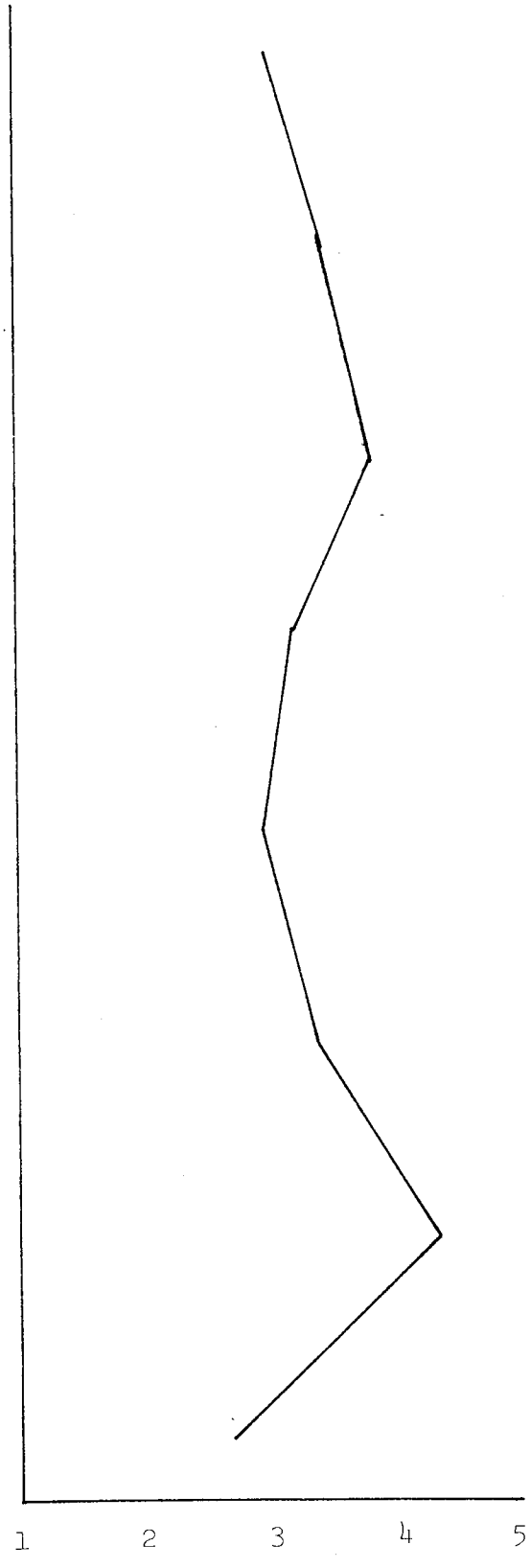

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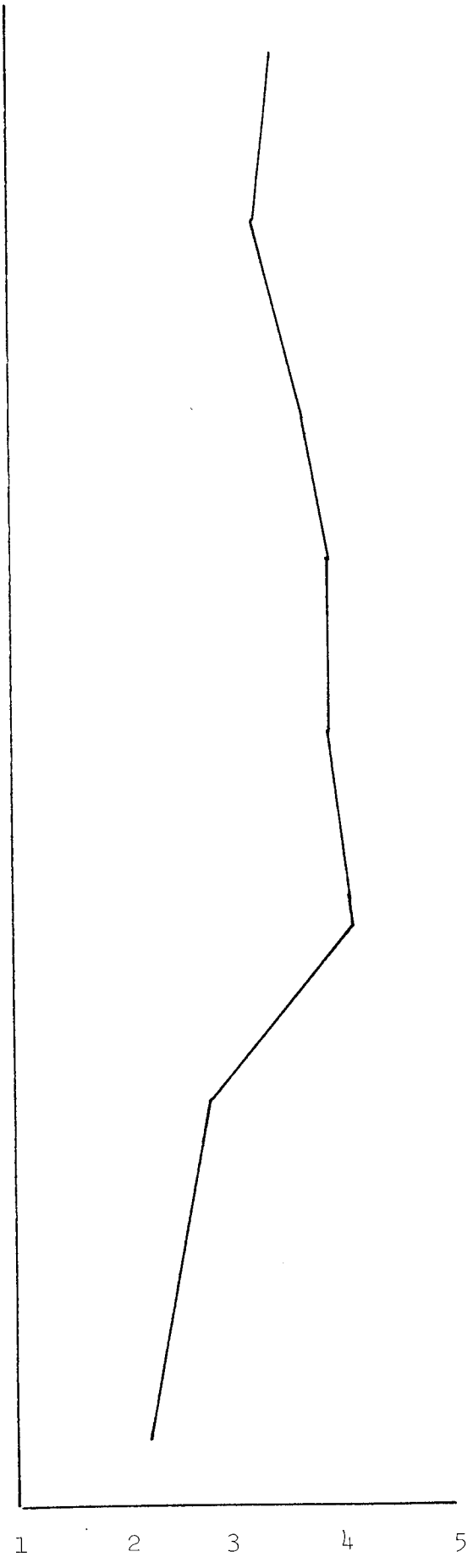

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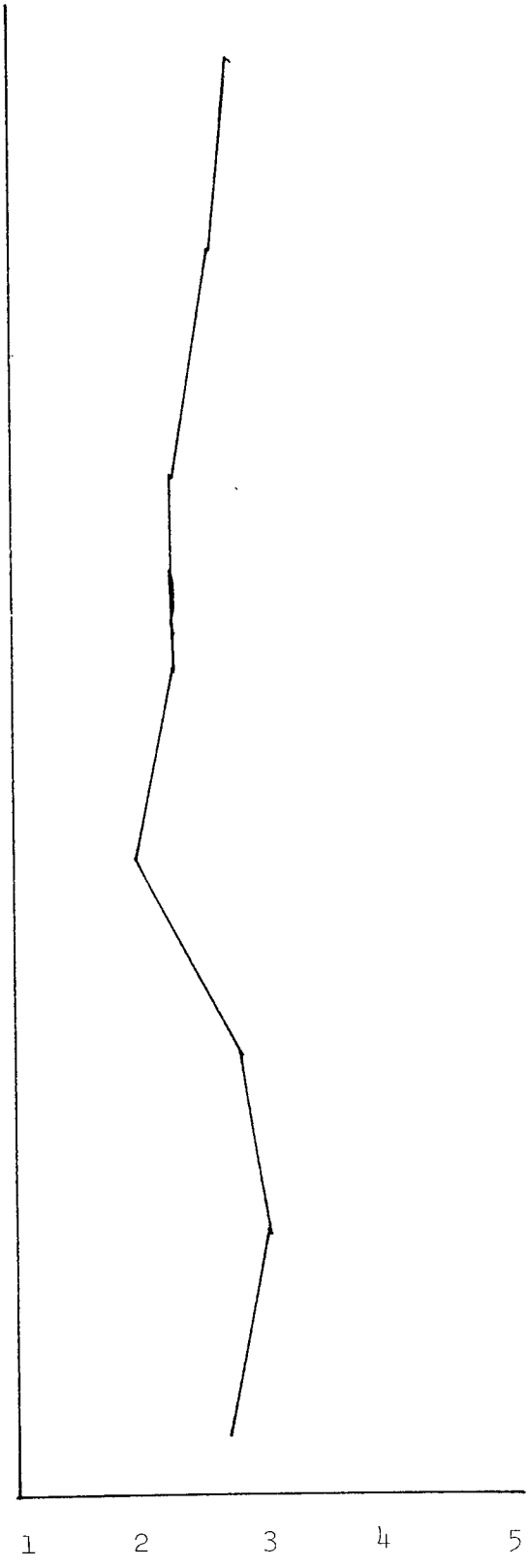

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65. Most activities present a real personal challenge?

66. Most people here seem to be especially considerate of others?

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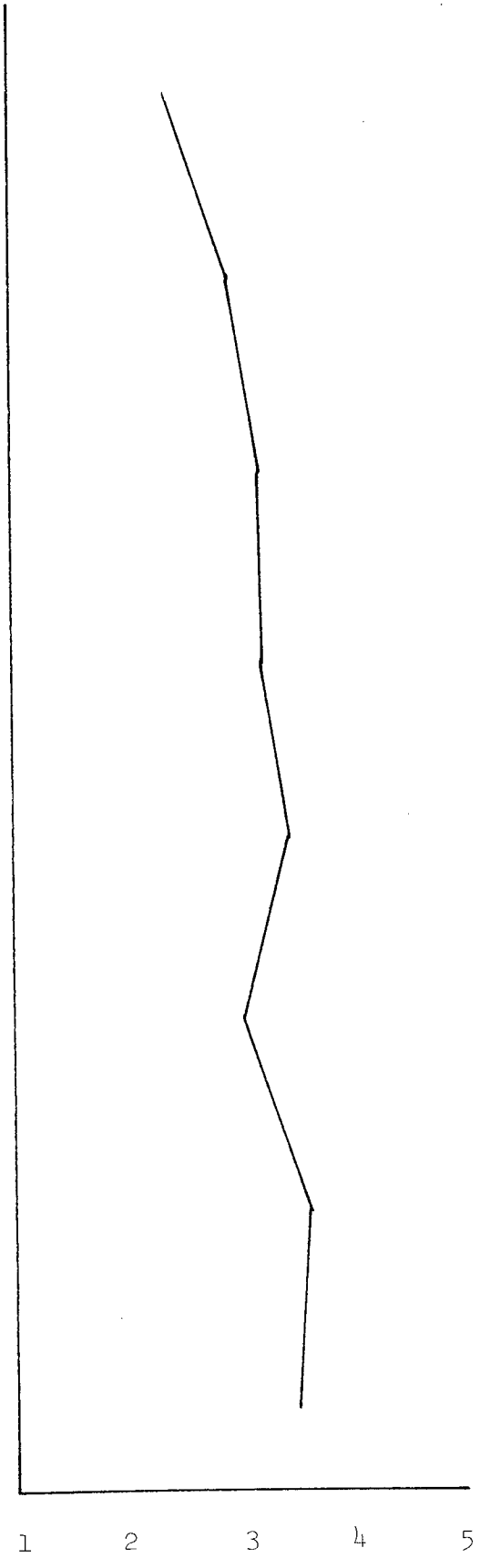

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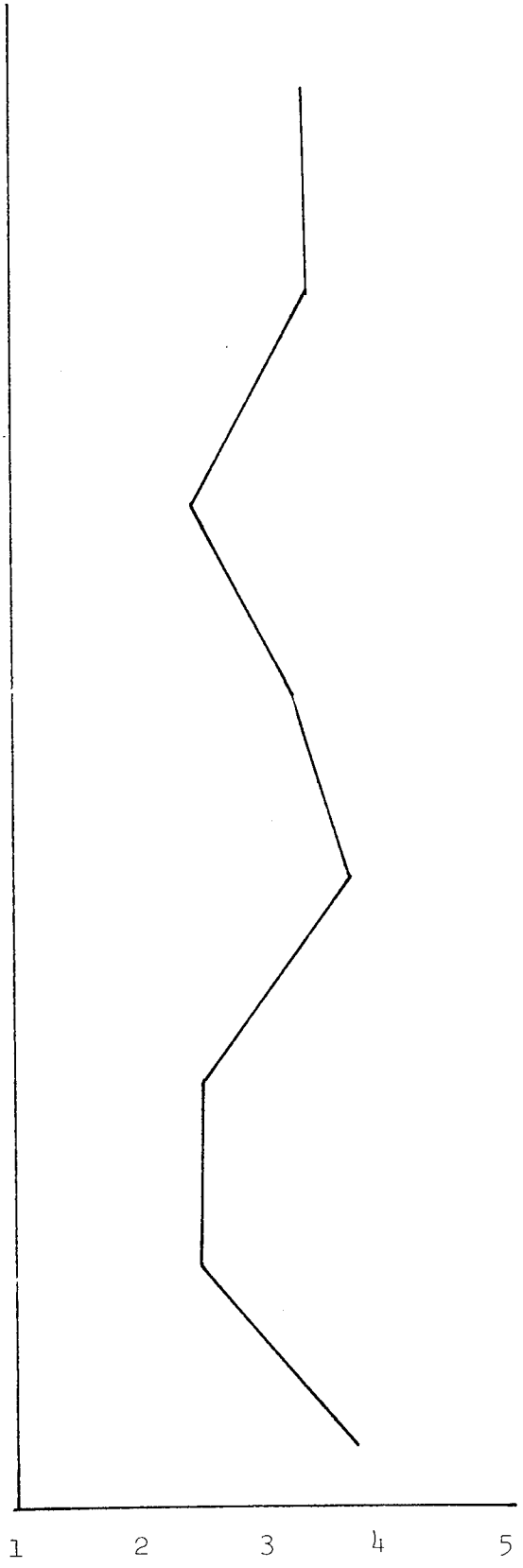

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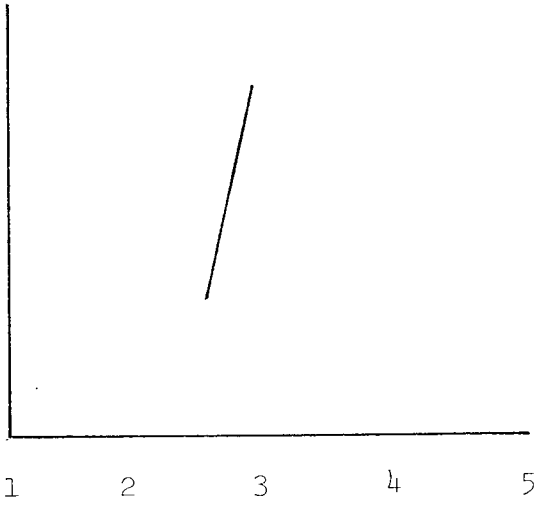

Organisational Beliefs Questionnaire

Production

1. Formal rules and regulations have a very important place here?

2. People here tend to hide their deeper feelings from one another?

3. This company has failed to keep pace with a changing world?

4. Senior management are out of touch with what's really happening?

5. This company treats some people as just a pair of hands?

6. Management style in this company is out of step with the demands of the present day?

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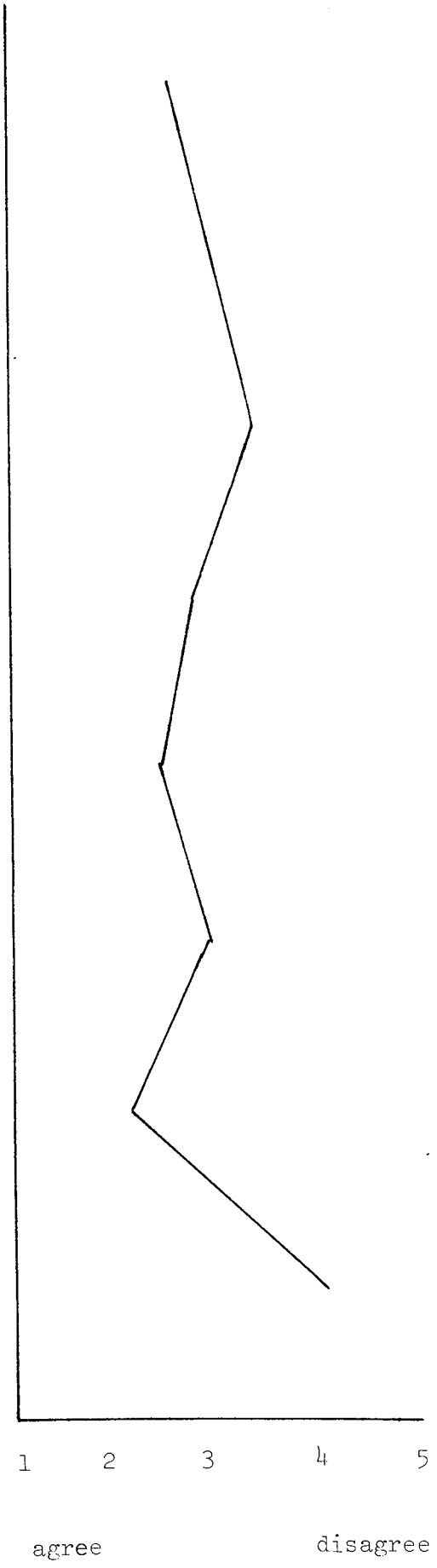

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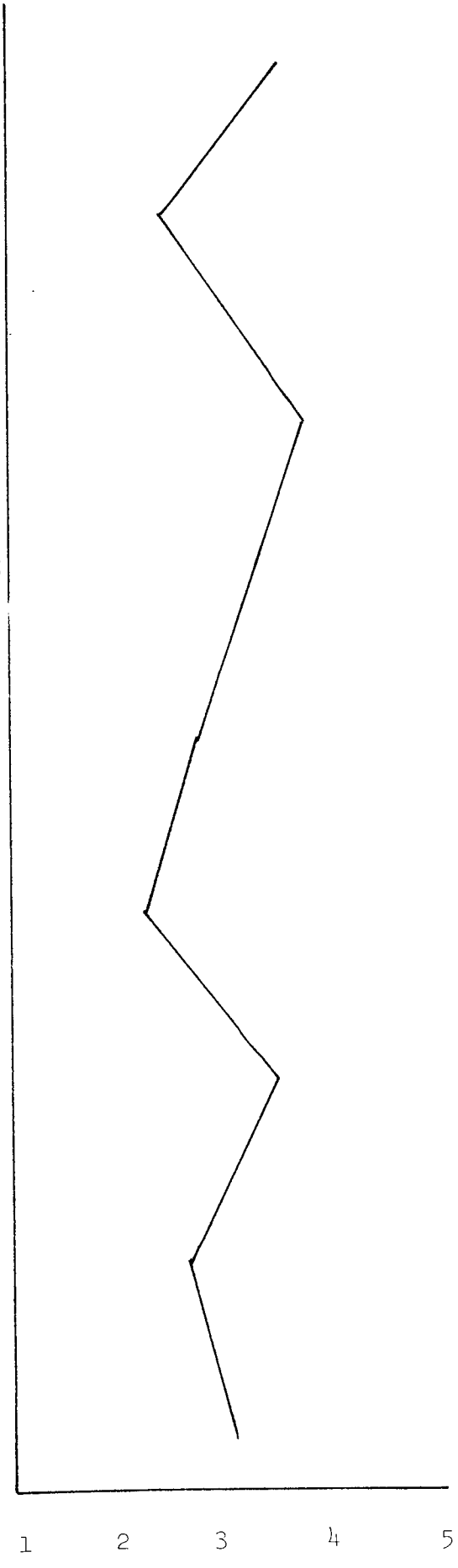

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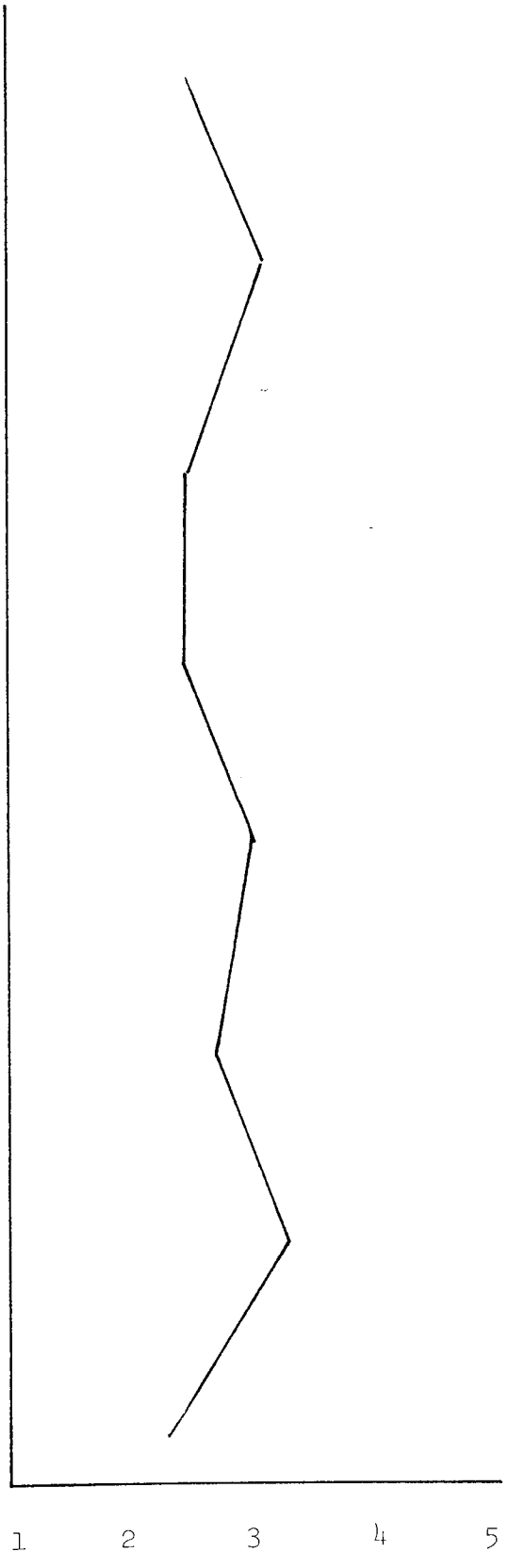

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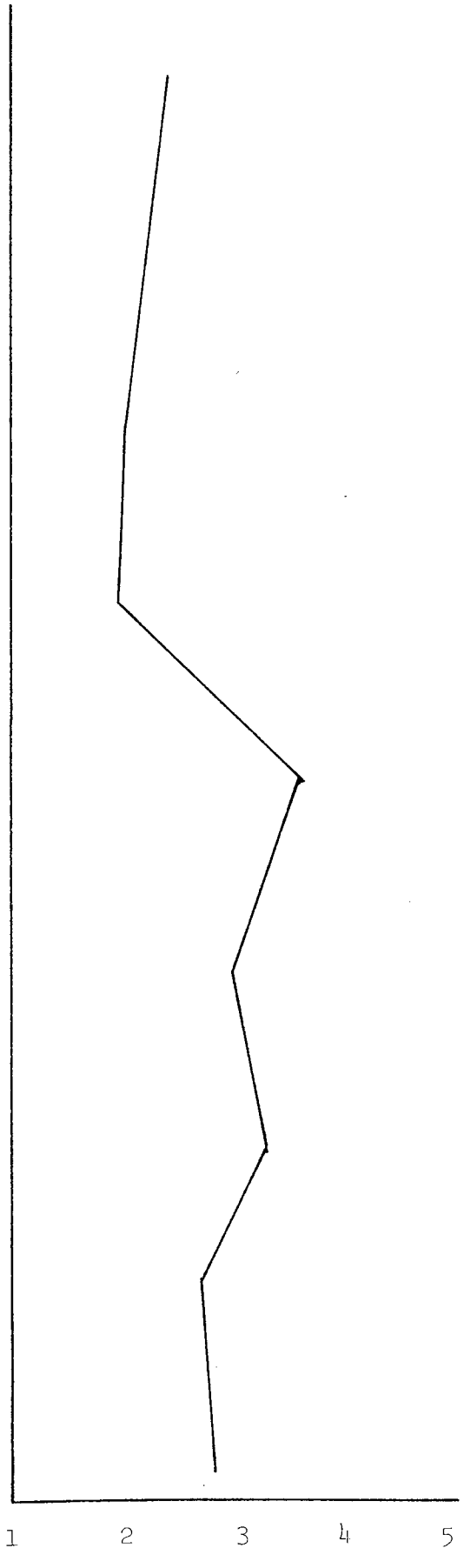

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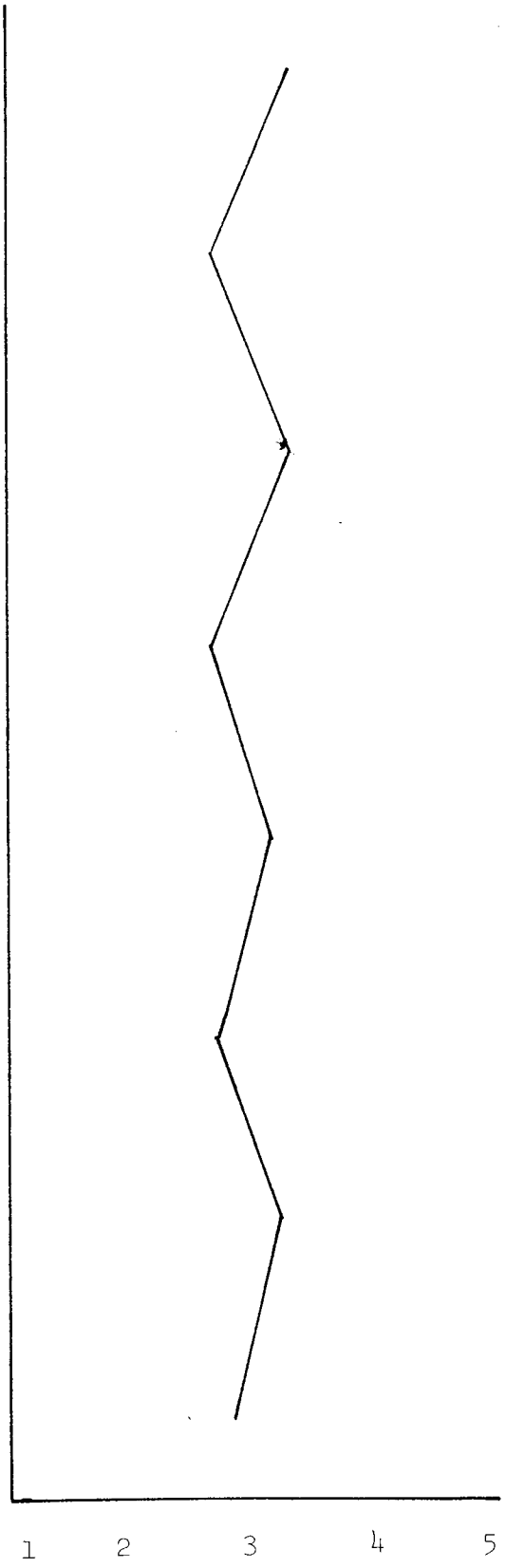

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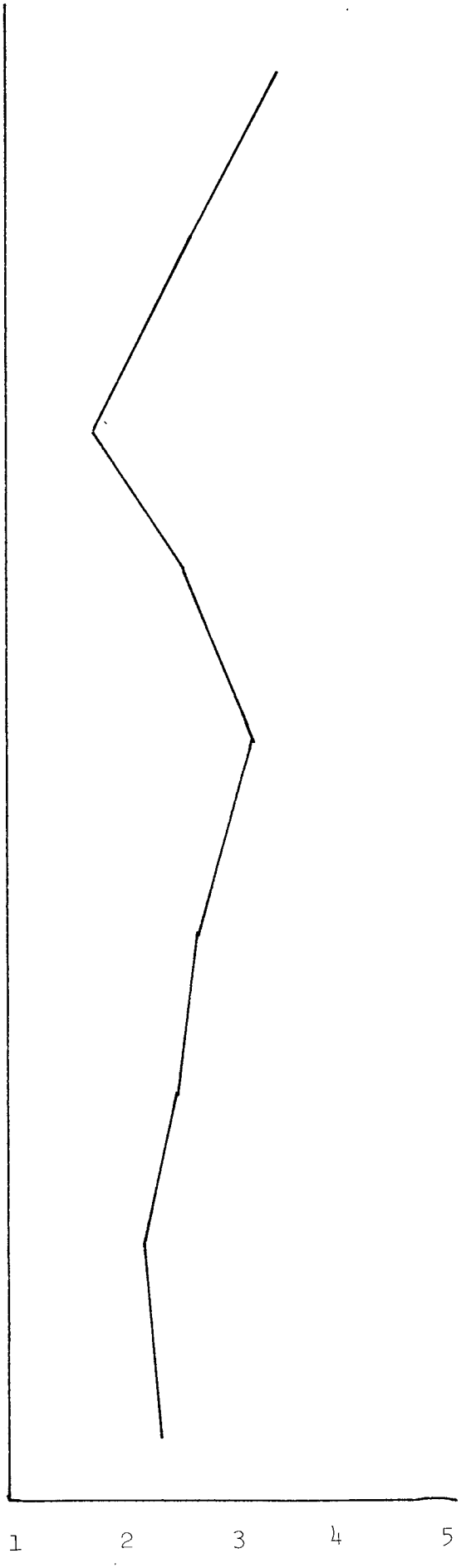

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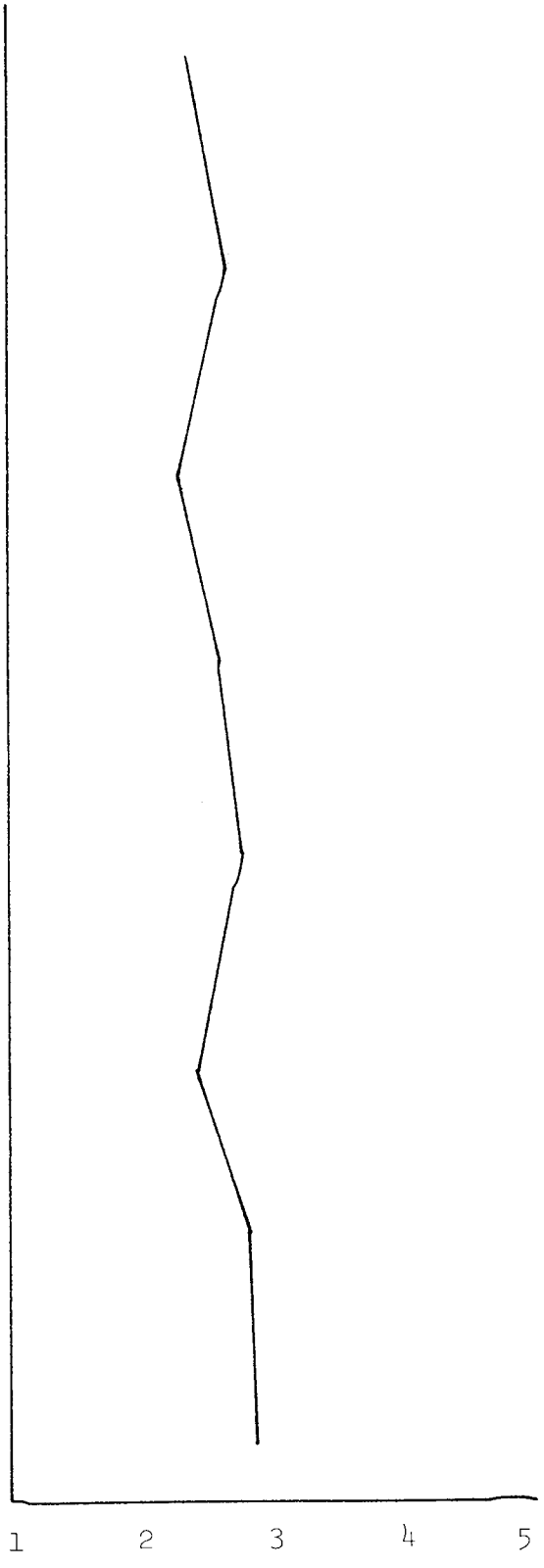

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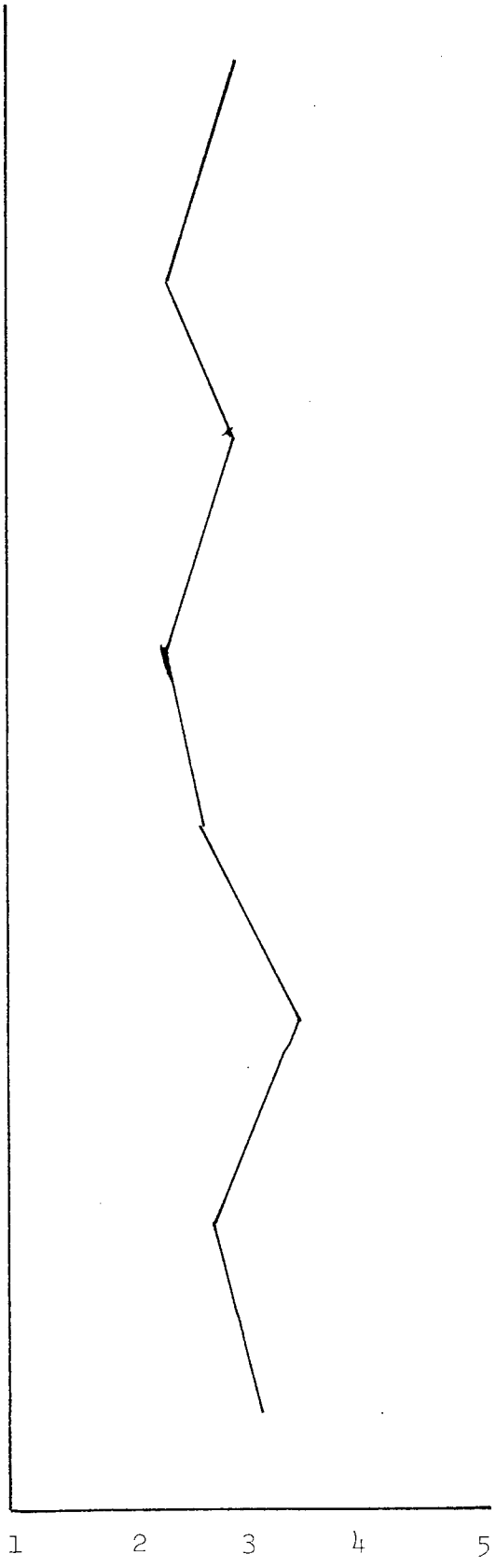

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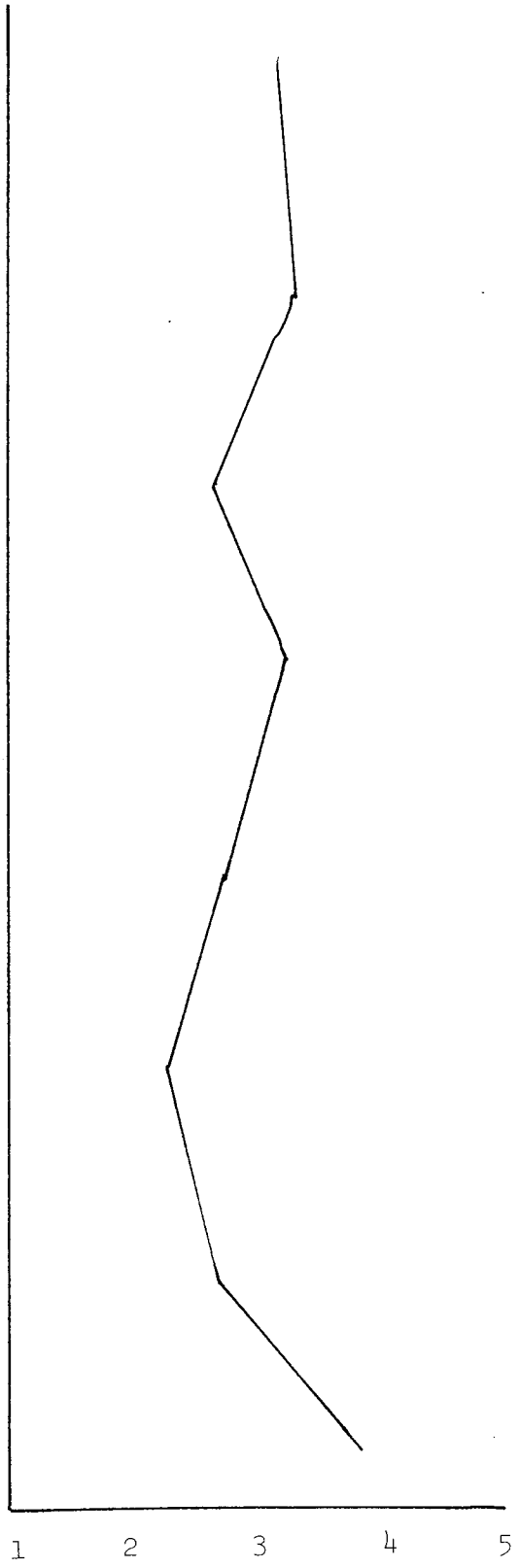

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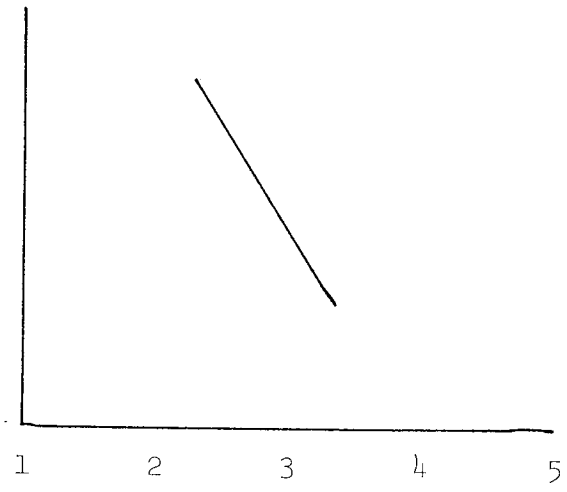

Organisational Beliefs Questionnaire

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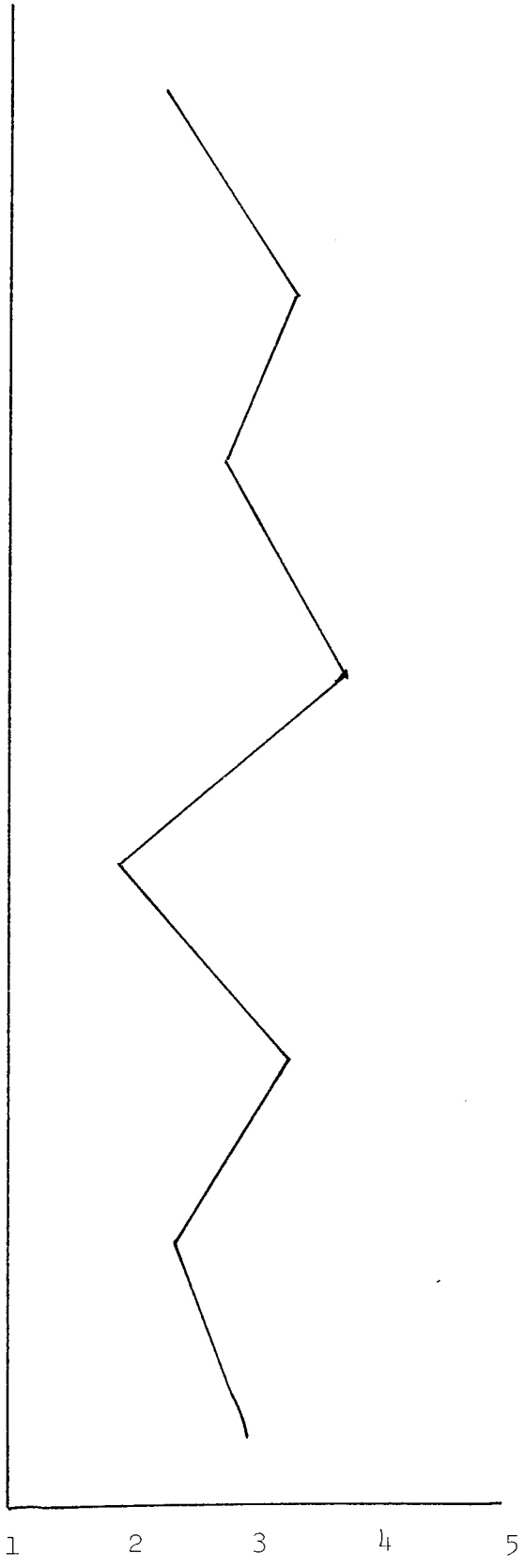

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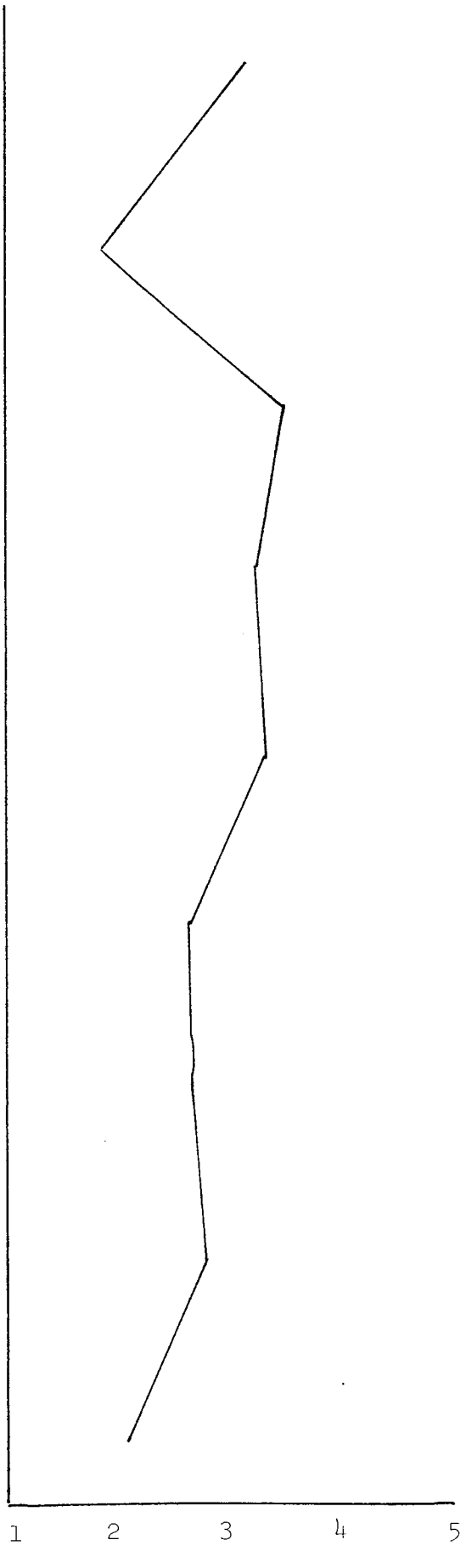

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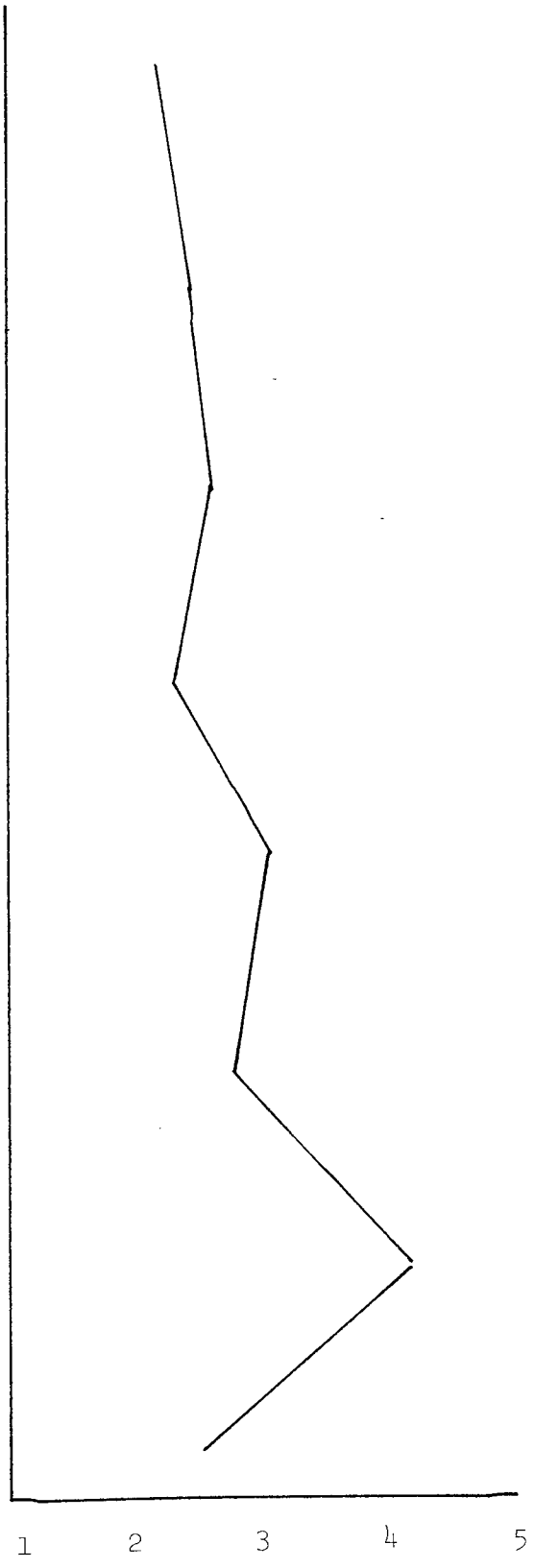

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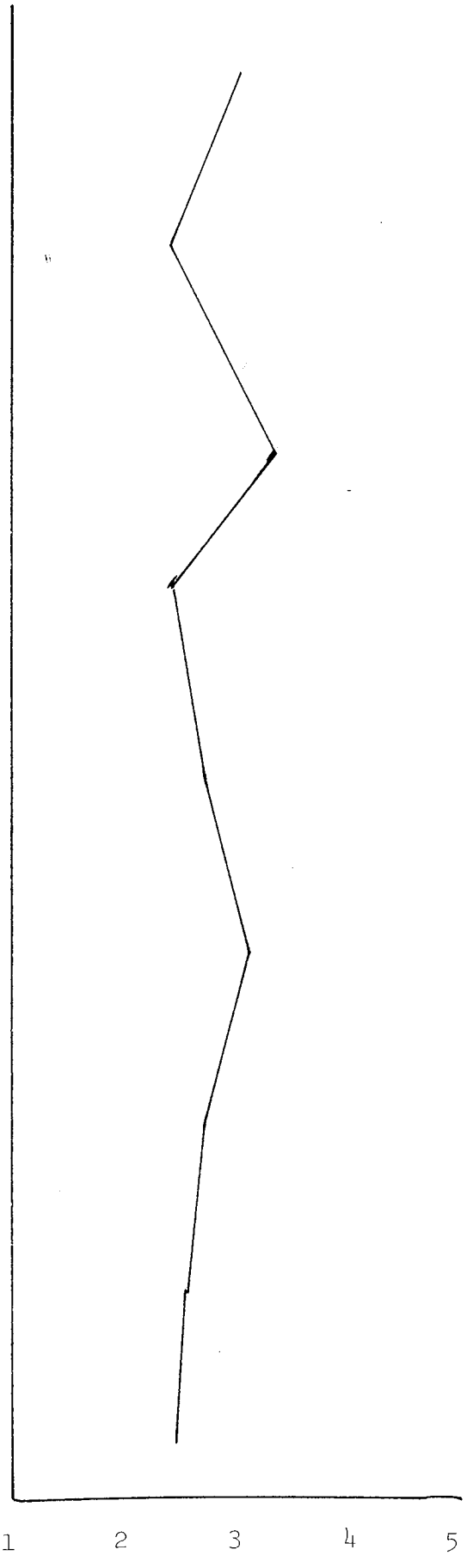

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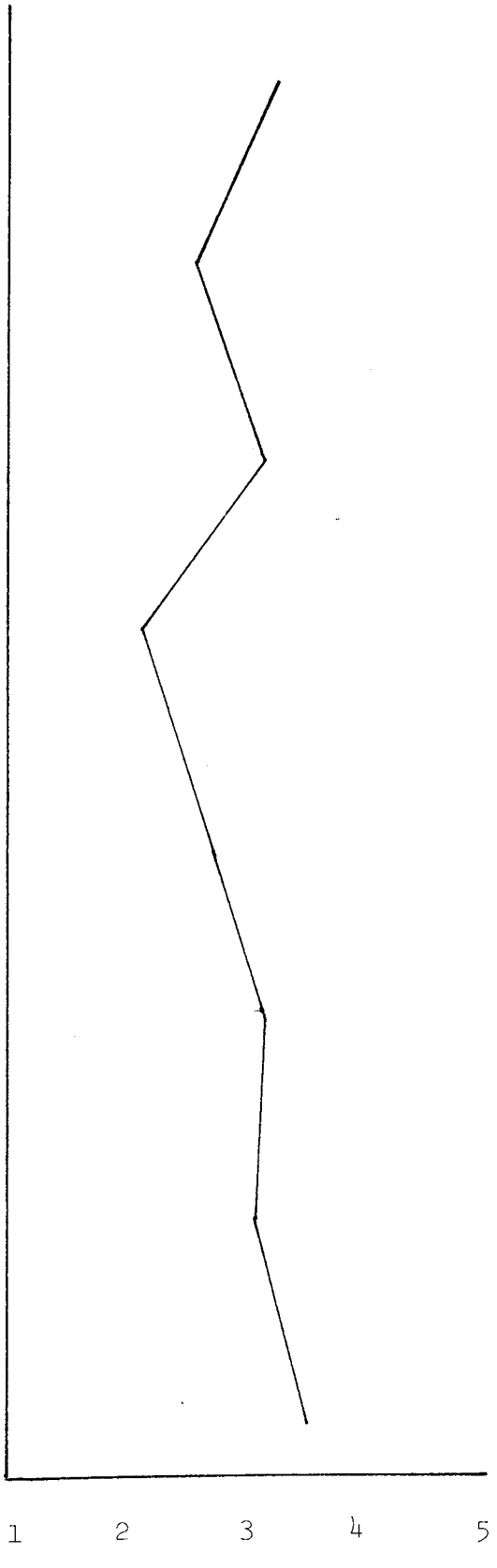

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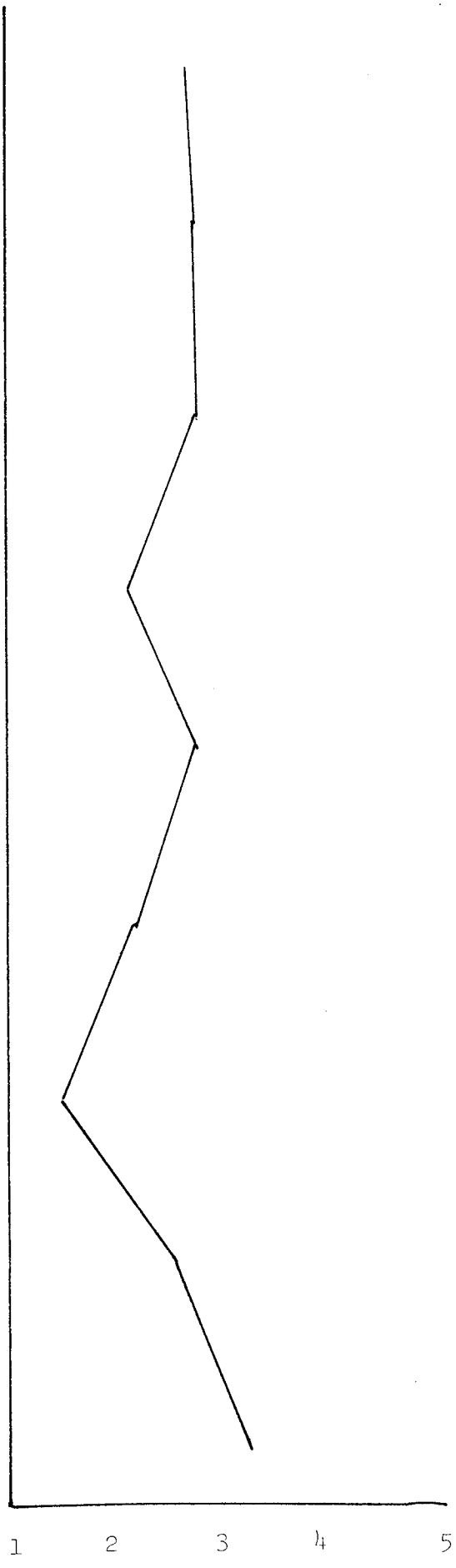

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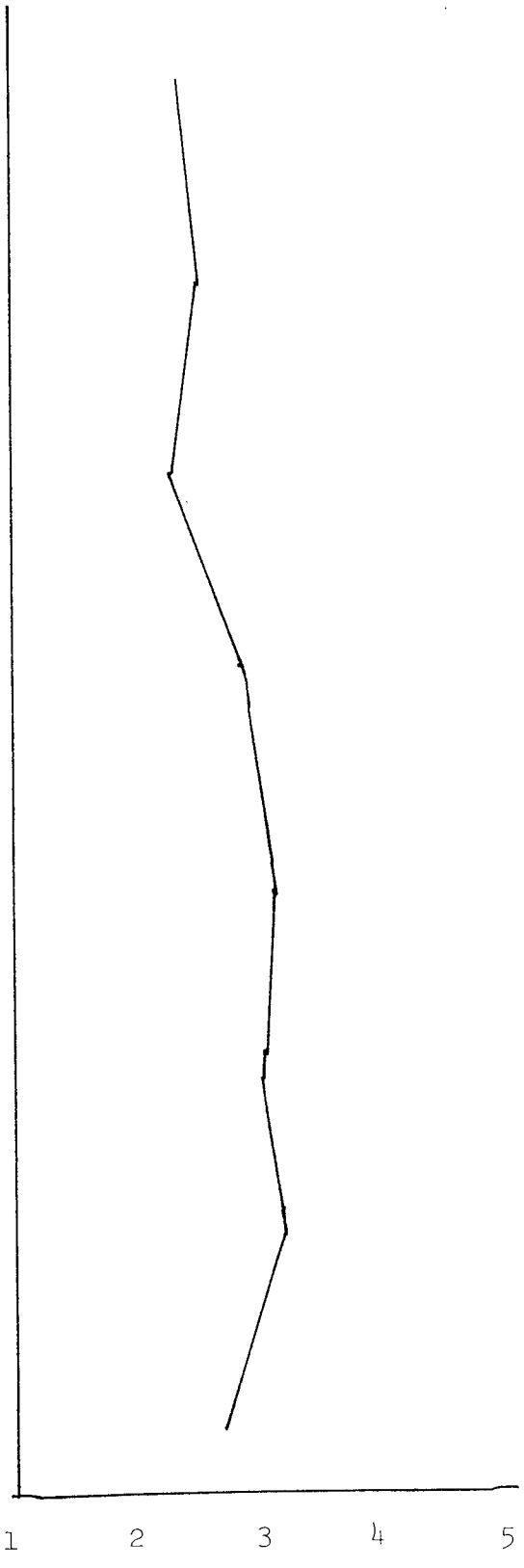

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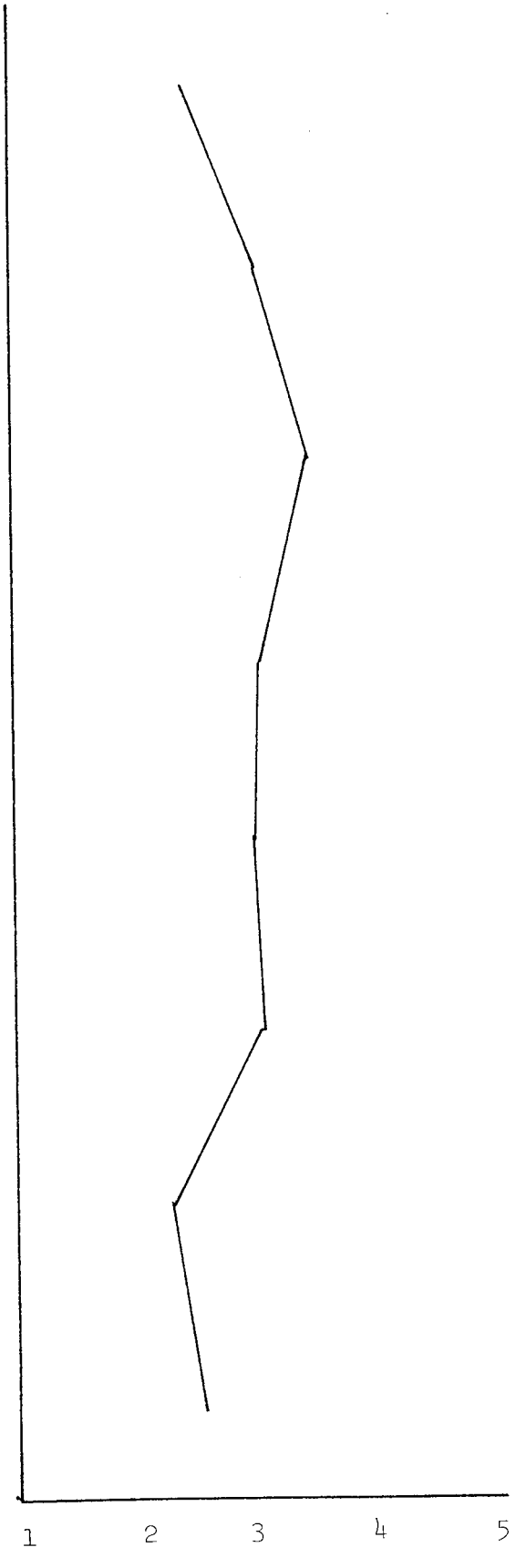

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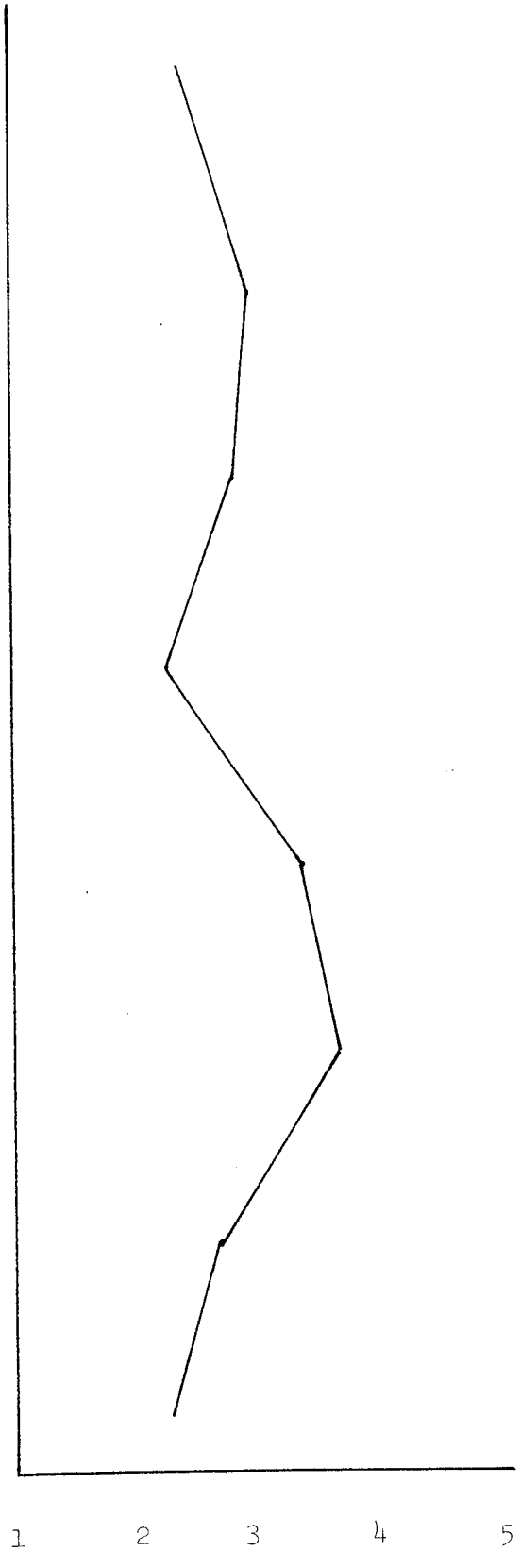

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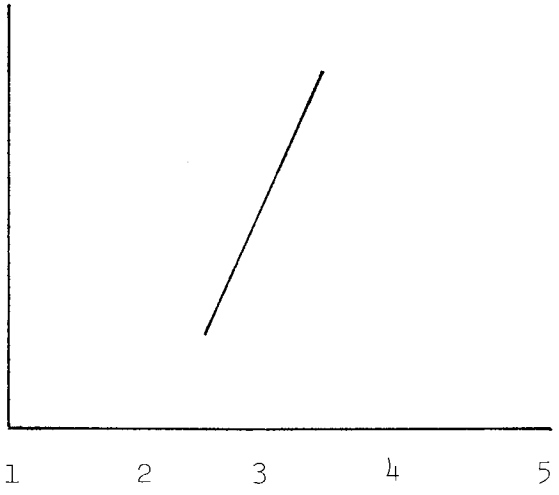

Organisational Beliefs Measure

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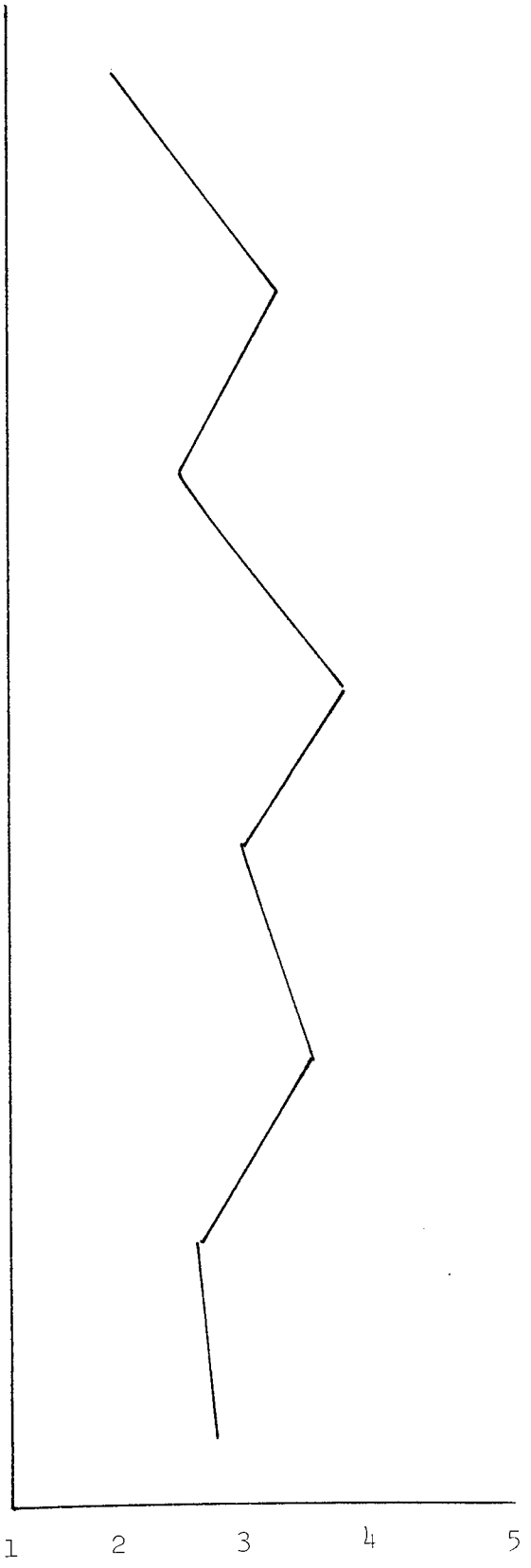

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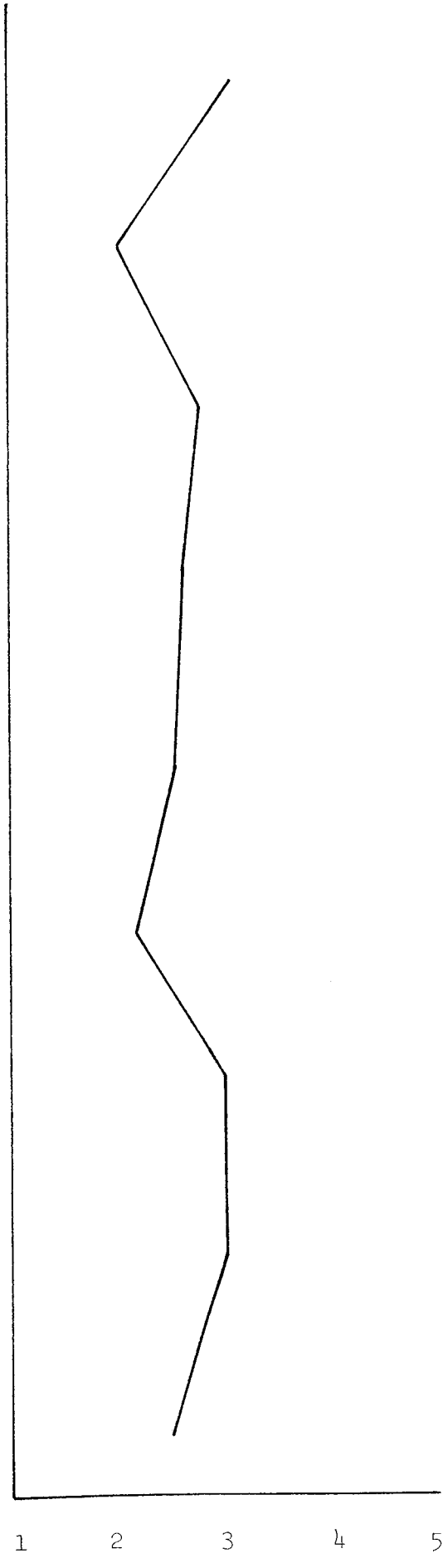

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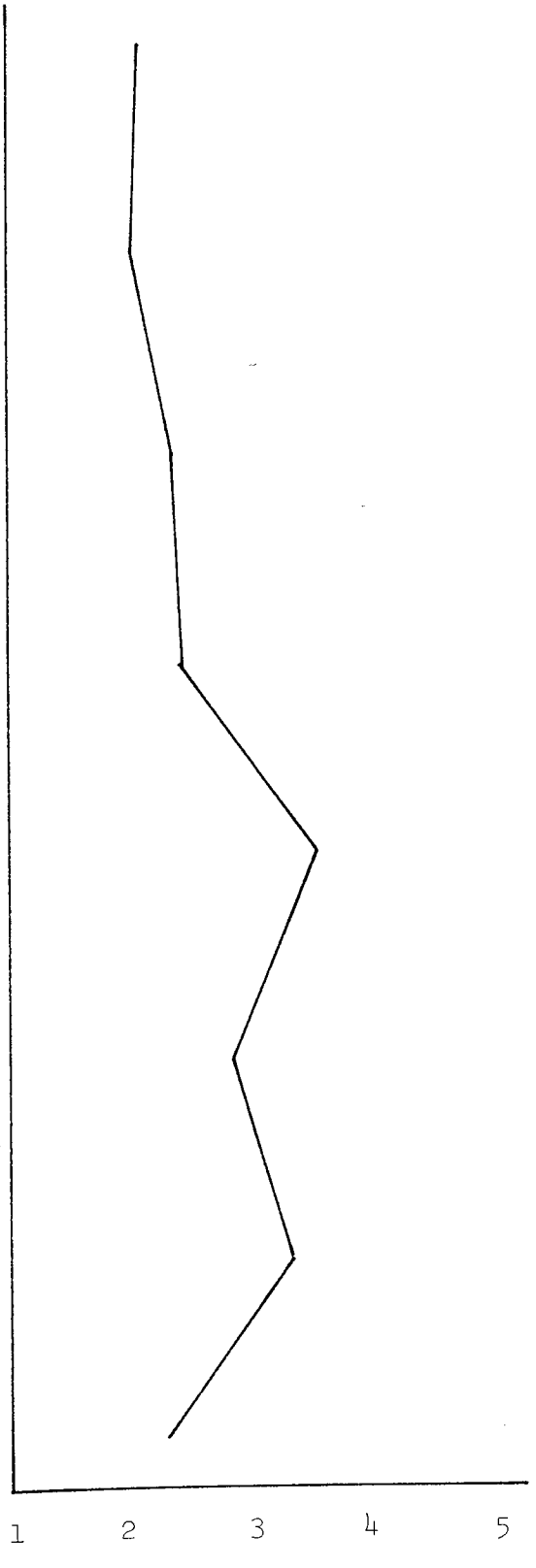

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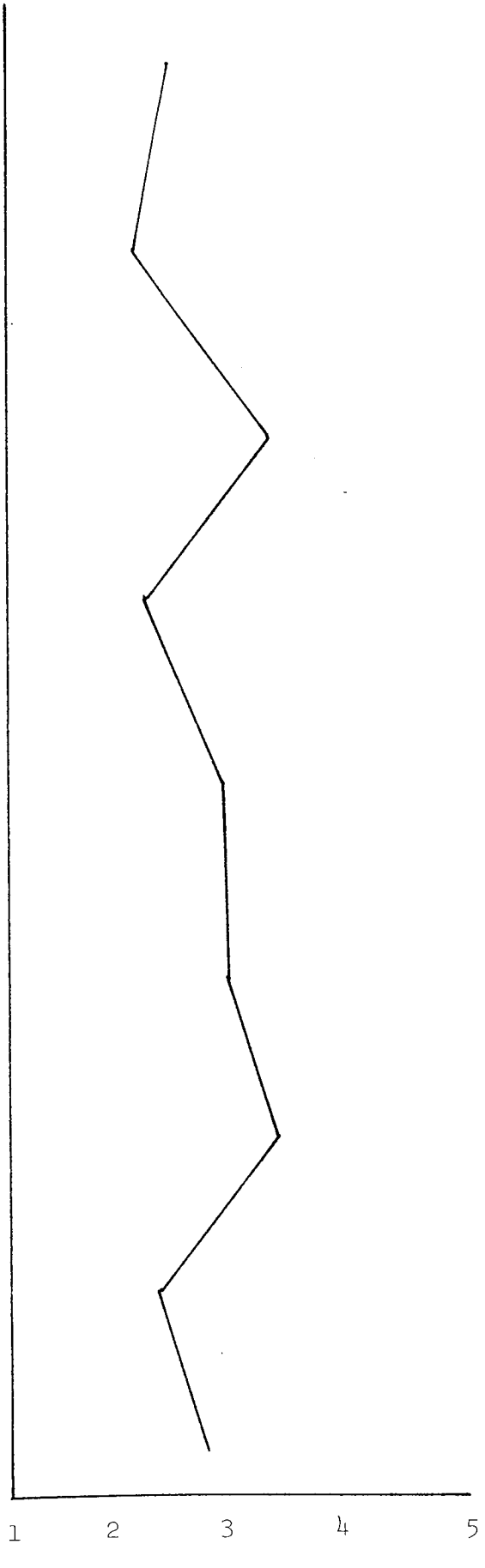

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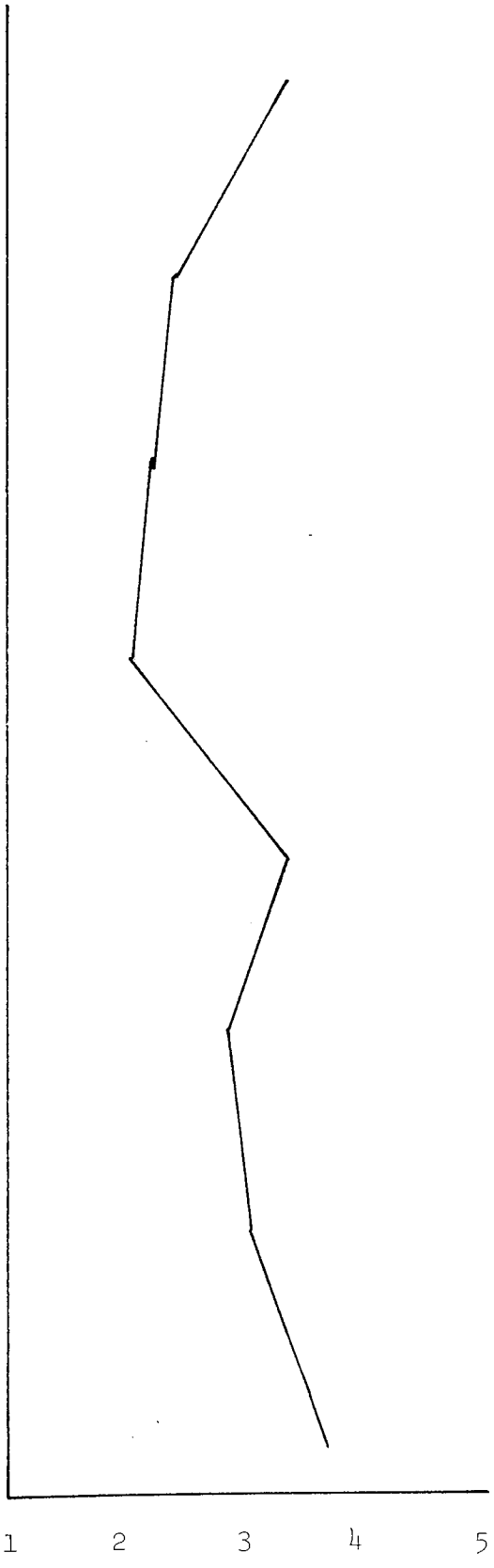
40. People aren't generally interested in the company's problems?

41. People are satisfied with the routine and mediocre?

42. It is fairly easy to keep up here without working too hard?



43. People here are encouraged to take a long-term view?

44. People think that the company owes them a living?

45. People here don't know anything about the rest of the division?

46. New ideas are always being tried out here?

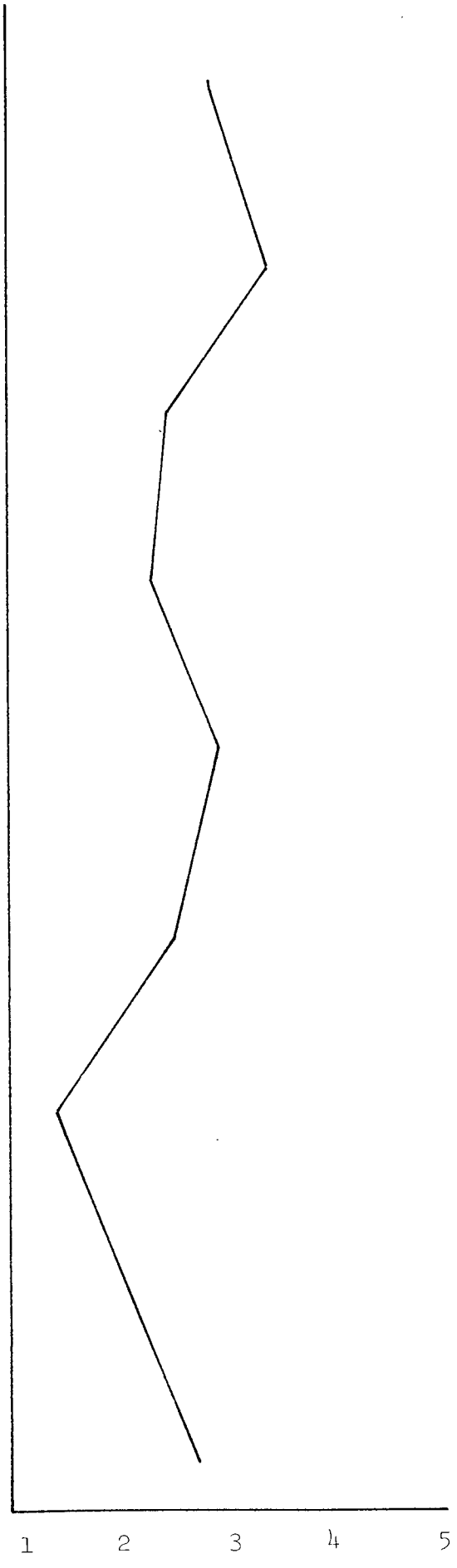
47. Unusual or exciting plans are encouraged here?

48. There are no favourites in this place - everyone gets treated alike?

49. This company suffers from unresolved conflicts at high level?

50. There is a lot of group spirit around here?

51. There always seem to be a lot of little quarrels going on here?



52. Careful reasoning and clear logic are highly valued here?

53. People ask permission before deviating from common policies or practices?

54. There are few opportunities for informal conversation with senior personnel?

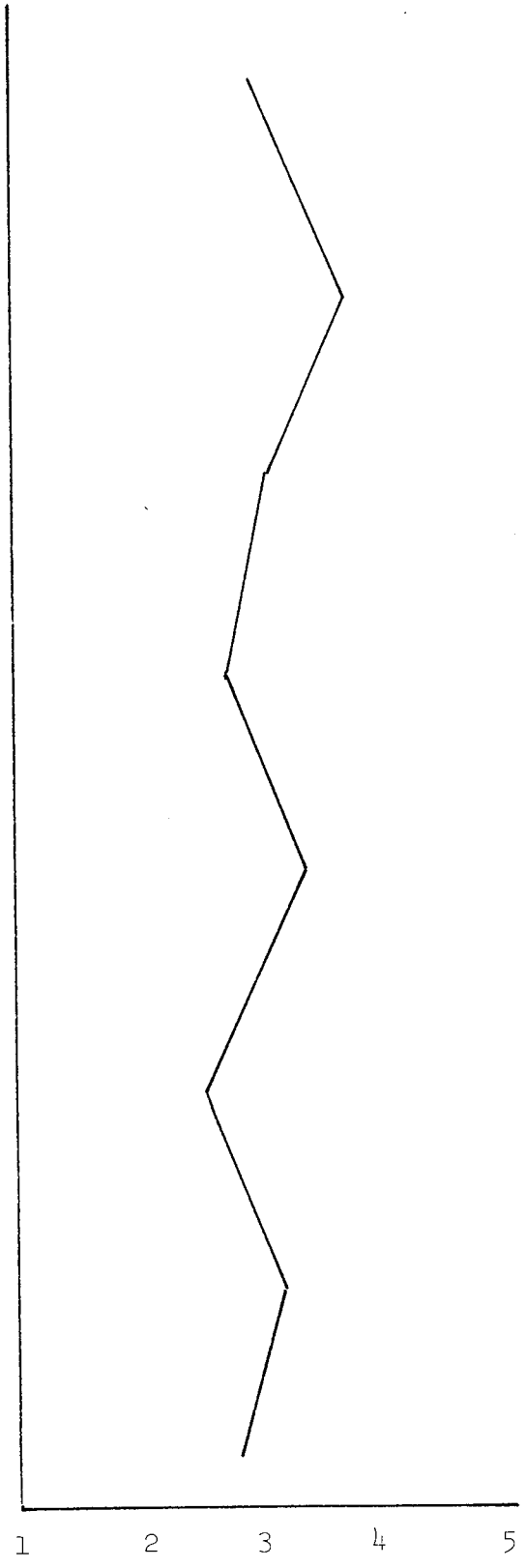
55. Criticism is taken as a personal affront in this organisation?

56. Managers and supervisors tend to overlook their training and development responsibility?

57. Groups and departments in this company don't really trust each other?

58. People enjoy working for this company?

59. People are generally good listeners?



60. People avoid direct clashes with senior personnel at all costs?

61. Managers tend to de-emphasise training and development in favour of more pressing demands?

62. Work is well organised and progresses systematically from week to week?

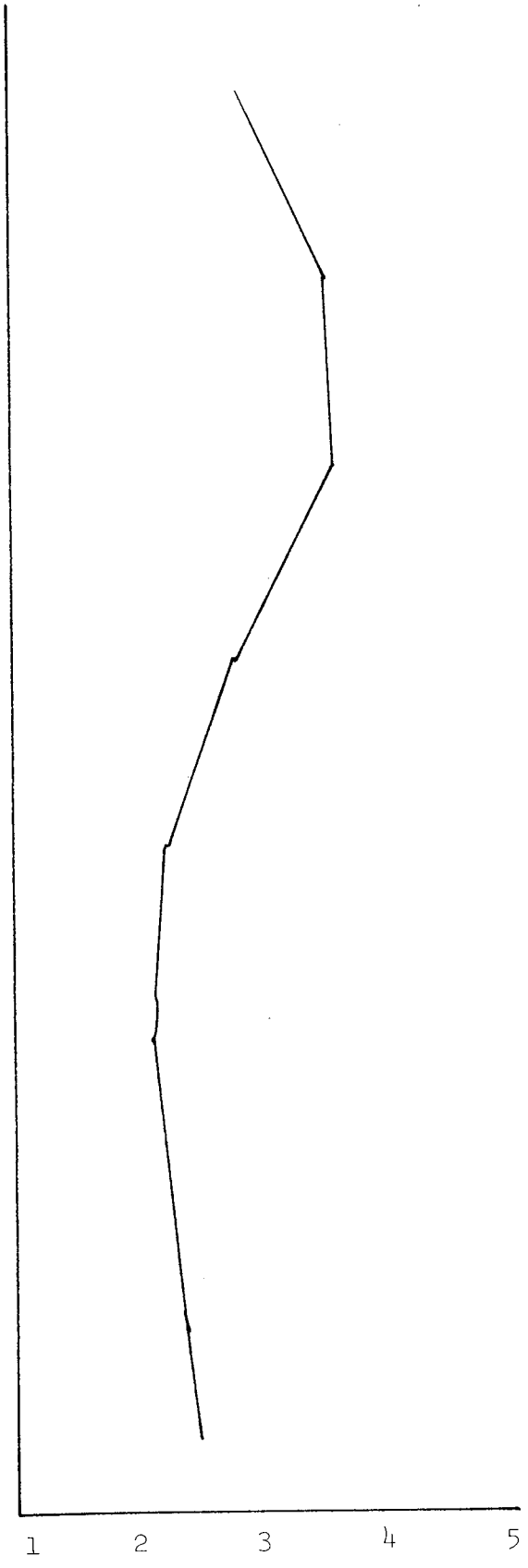
63. A discussion about the latest scientific developments would not be uncommon here?

64. The work atmosphere emphasises efficiency and usefulness?

65. Most activities present a real personal challenge?

66. Most people here seem to be especially considerate of others?

67. People here feel they must really work hard because of the important nature of their work?



68. People get recognition for new ideas?

69. There is so much to do here that people are always busy?

70. Managers and supervisors really care about the people they supervise?

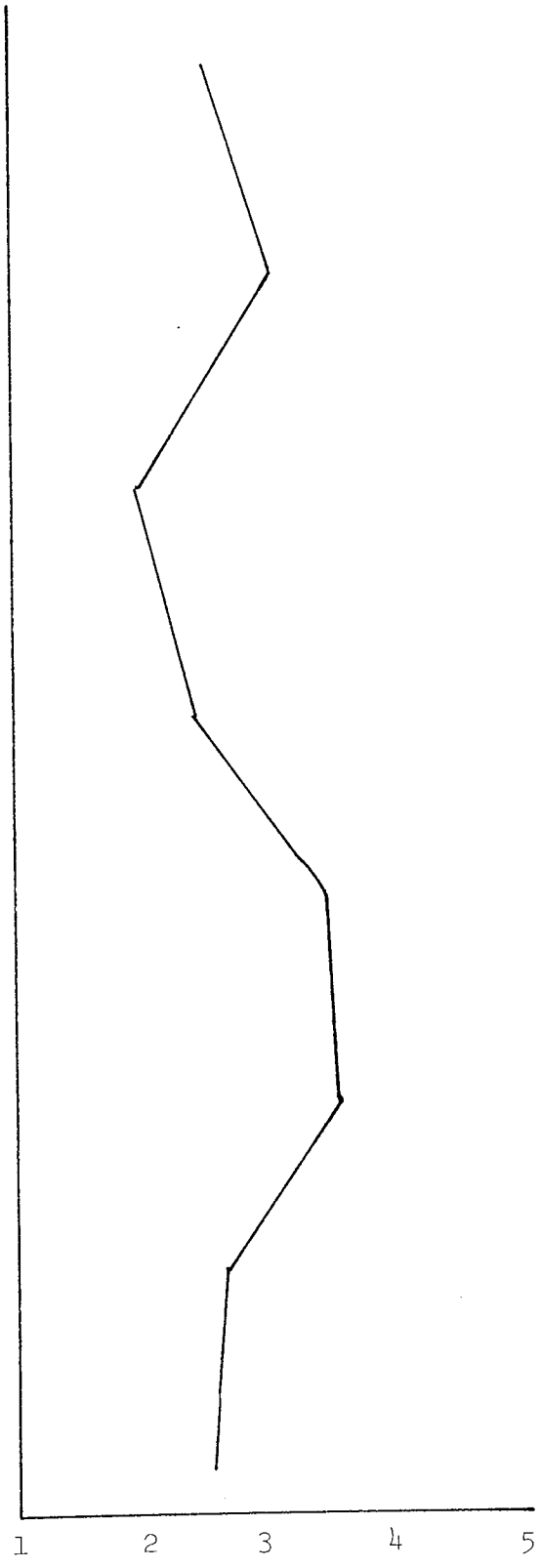
71. People here are generally efficient and successful in practical affairs?

72. People go out of their way to develop effective working relationships with others?

73. The flow of information downwards is smooth and efficient?

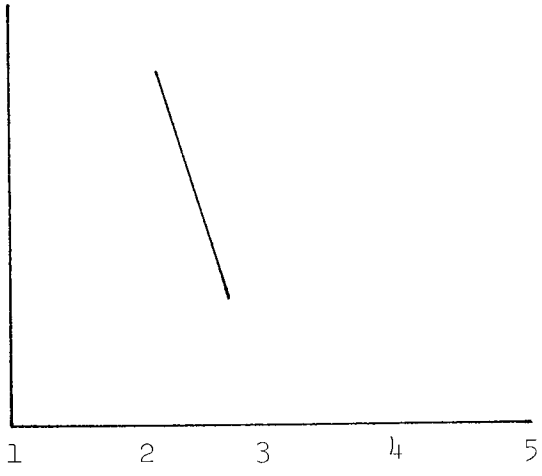
74. The ability to plan ahead is highly valued here?

75. People here speak out openly?



76. People feel that there's no point in trying harder - nobody else does?

77. Everyone here is safety conscious, anxious to avoid accidents and put the right the conditions which produce them.



Organisational Beliefs Measure

Total Organisation

1. Formal rules and regulations have a very important place here?

2. People here tend to hide their deeper feelings from one another?

3. This company has failed to keep pace with a changing world?

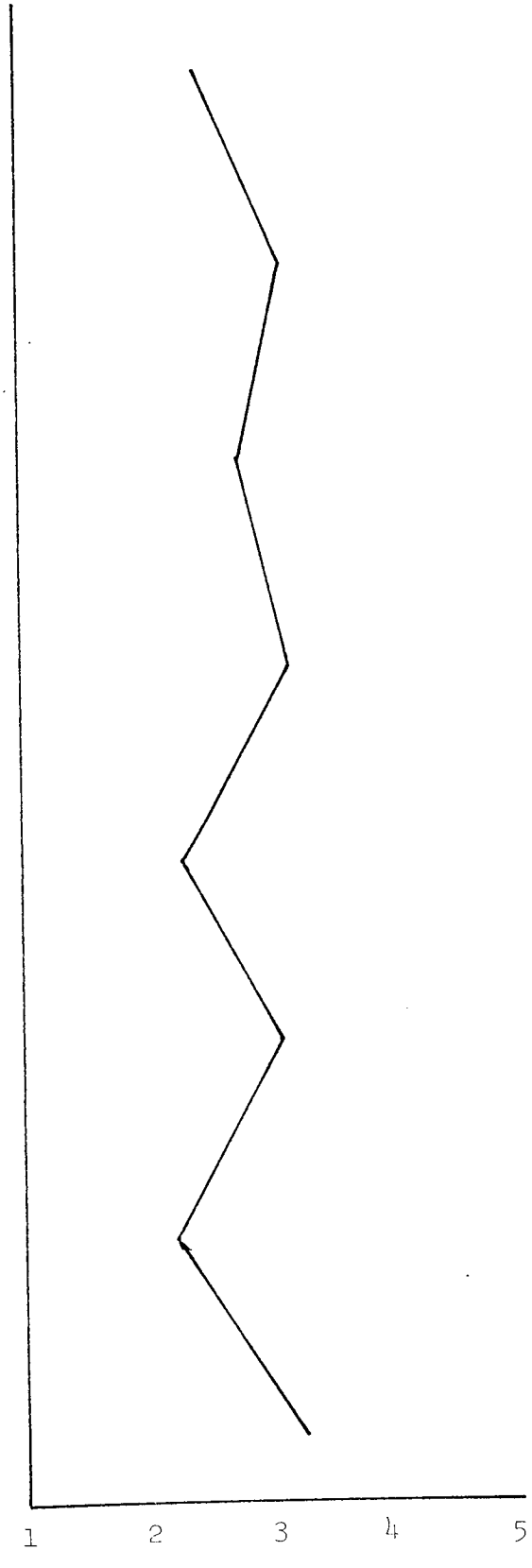
4. Senior management are out of touch with what's really happening?

5. This company treats some people as just a pair of hands?

6. Management style in this company is out of step with the demands of the present day?

7. There's not enough pressure put on people to perform well?

8. This company does not care about the well-being of its employees?



9. This place has a reputation for being indifferent to the needs of the wider community?

10. This company places too much emphasis on technical skills and not enough on 'people' skills?

11. The company is always trying to take advantage of us?

12. There is a lot of bootlicking here?

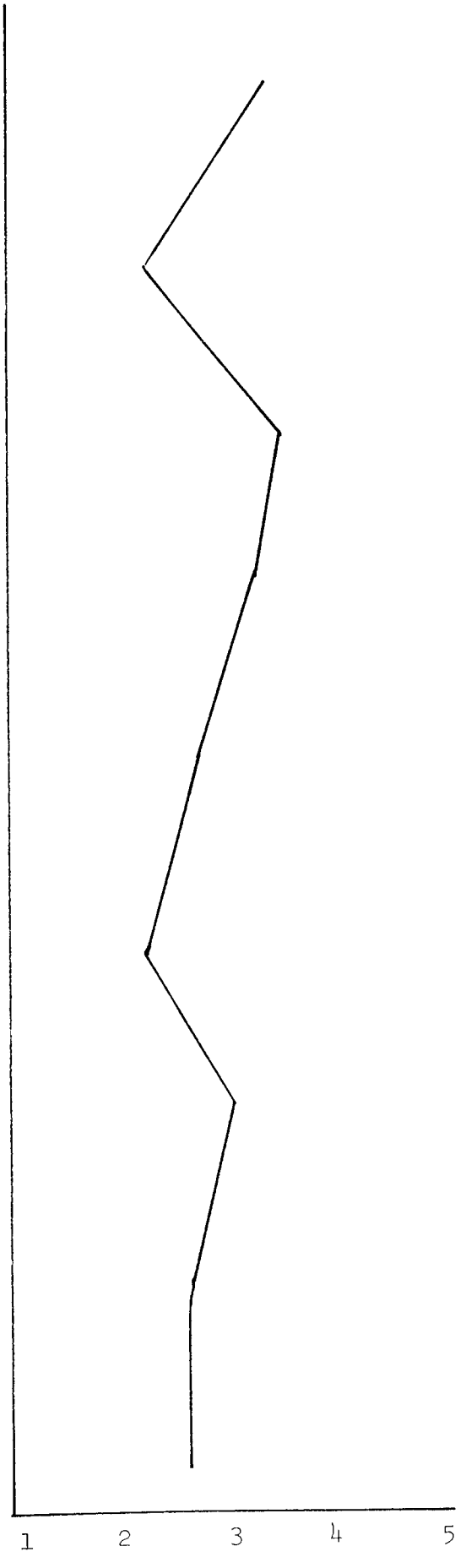
13. When people leave this company, they become much more successful?

14. In this company, decisions are made by groups too far removed from what's really happening?

15. Too many of our managers are failures?

16. Managers in this company often lack 'people' skills?

17. High-level co-ordination is often irrelevant at the technical level?



18. The planning process is too remote?

19. In this company issues never get raised or confronted openly.

20. People tend to stick to old-established rules and procedures rather than try and introduce new ways of doing things?

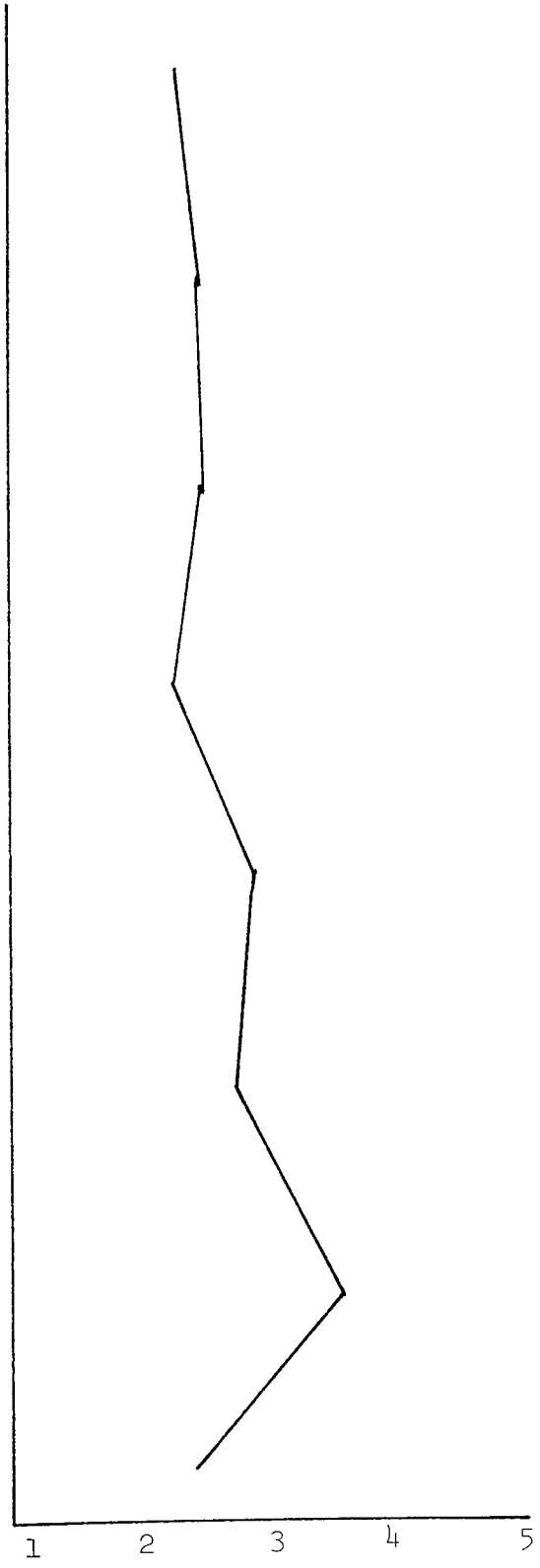
21. People tend not to see any connection between company performance and their own responsibilities?

22. This company is too conservative?

23. Senior management have too narrow an outlook?

24. People who get pushed around here are expected to fight back?

25. Senior management are too isolated?



26. Senior personnel are frequently jealous of their authority?

27. Senior management don't let people know what they're doing?

28. People give lip service to training and development without doing anything about it?

29. Planning groups operate in a world of their own?

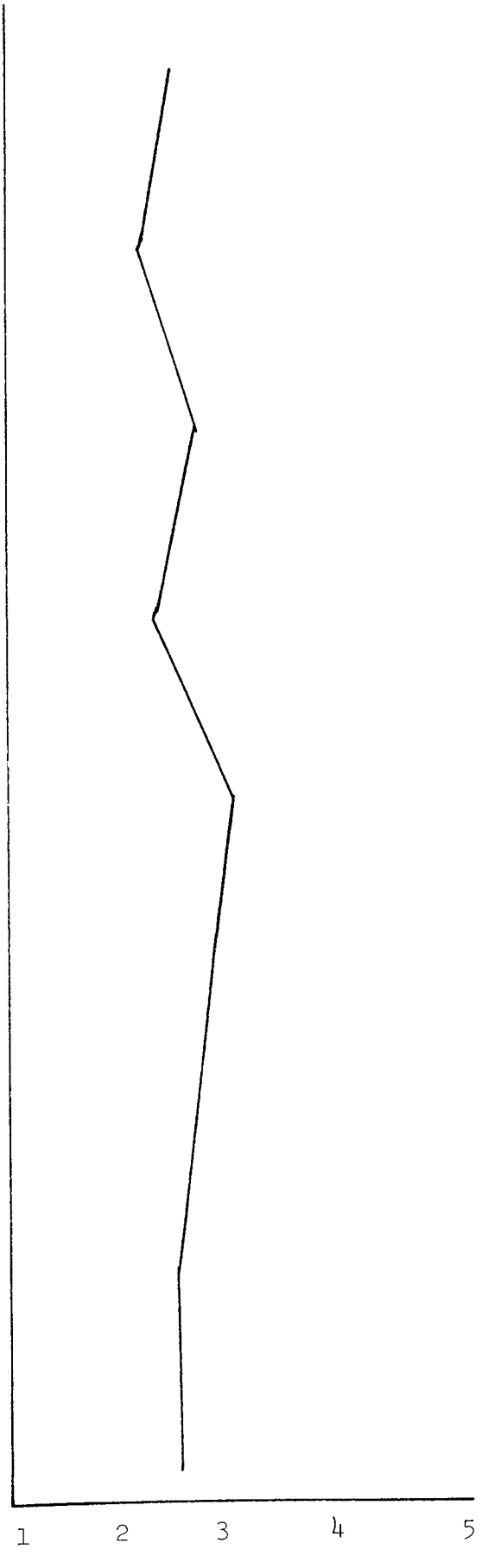
30. This company has grown too big for its own well-being?

31. Control of this company rests in the hands of too few people at too high a level?

32. Things are getting worse for this company?

33. People actively seek out the ideas and opinions of others?

34. This company lacks professional managers?



35. Senior personnel will go out of their way to help you with your work?

36. People here follow the maxim 'business before pleasure'?

37. To succeed in this company you need to prove yourself in pigments technology - nothing else matters?

38. Formal rules and regulations have a very important place here?

39. Few people here are stimulated by intellectual activities or problems?

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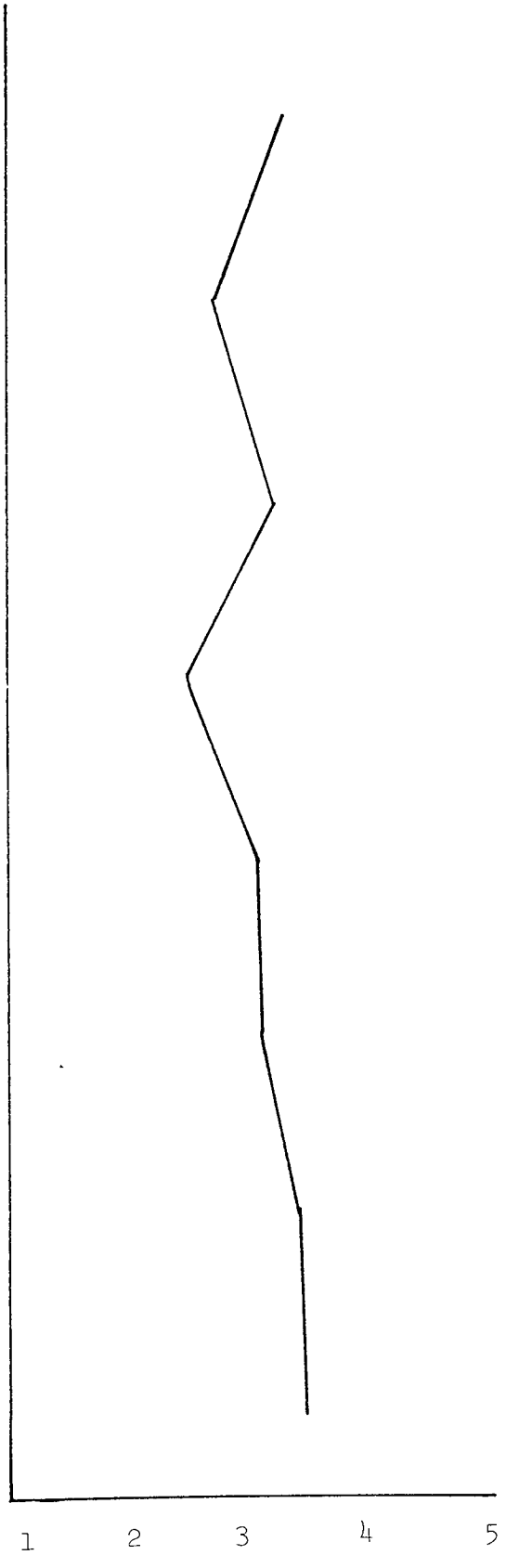

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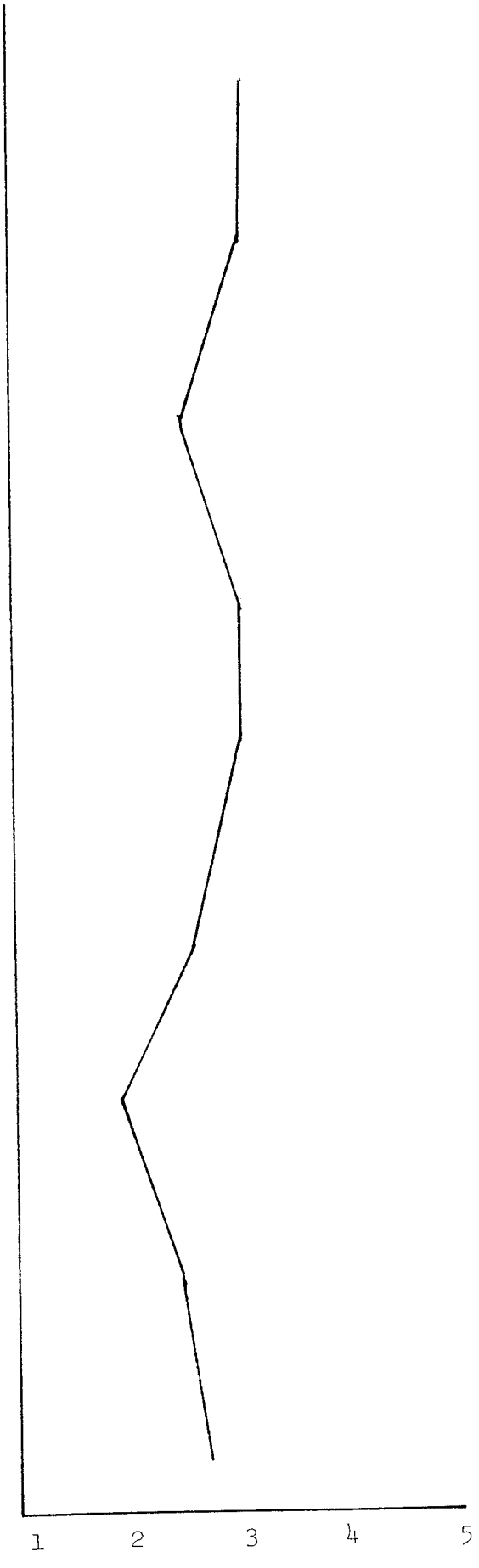

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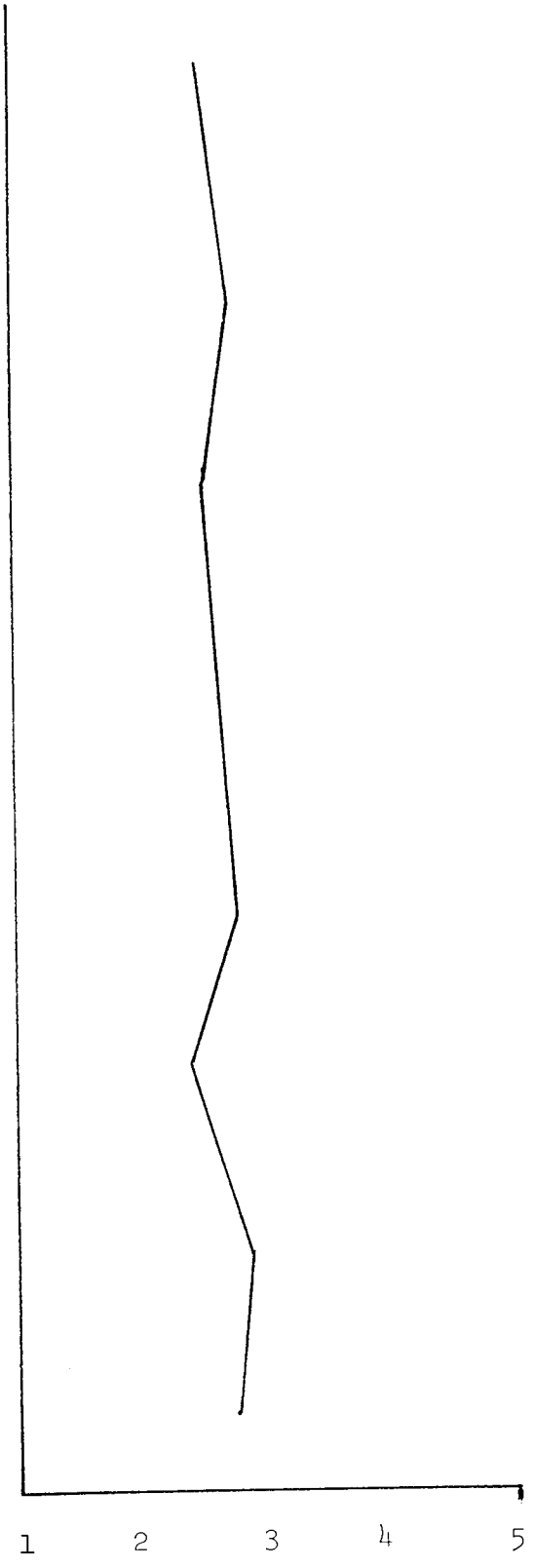

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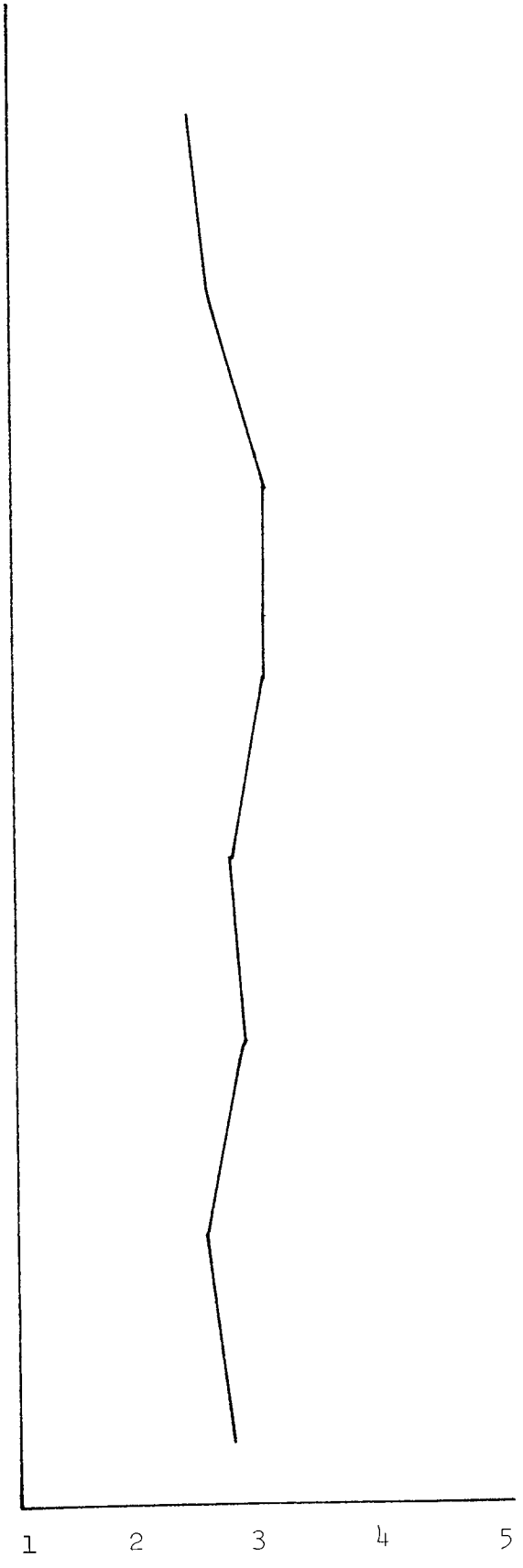

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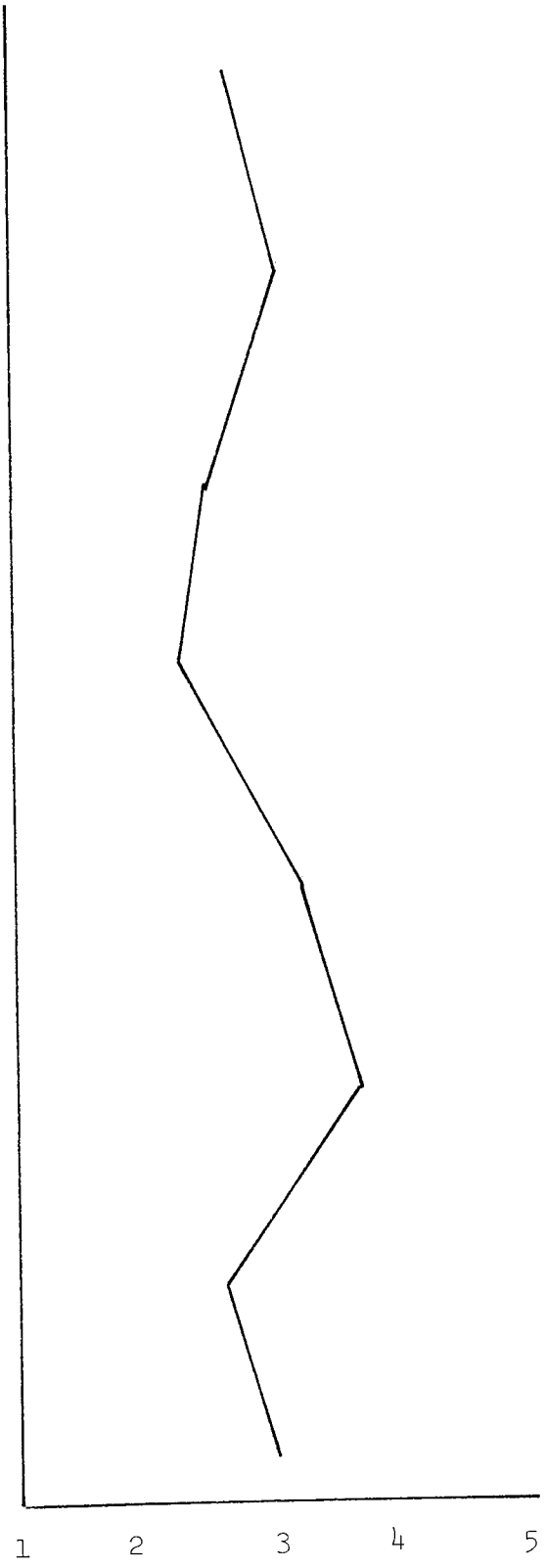

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EXHIBIT 37 : Organisational mapping questionnaire

This instrument was designed to identify key problem areas in different groups and across the whole organisation: these included:

- structure (2k)
- hierarchical integration (2l, 2m)
- information flow (3h, 3j)
- intragroup co-operation (5b)
- group task/role definition (5e, 5f, 5g)
- informal structure (5h, 5i, 5j, 5n)
- intergroup co-operation (5l, 5m)
- attitudes to innovation (6a)
- Research and Development policy (6c)

There is a high level of agreement between departments on the importance of the informal group: this theme emerges strongly in other surveys. Integration problems between levels and groups are also well-supported elsewhere.

Organisational Mapping Questionnaire

Section (1) Objectives

In the context of this department, how far do you feel that:-

(a) the objectives have been realistically planned?

(b) the objectives have been effectively communicated?

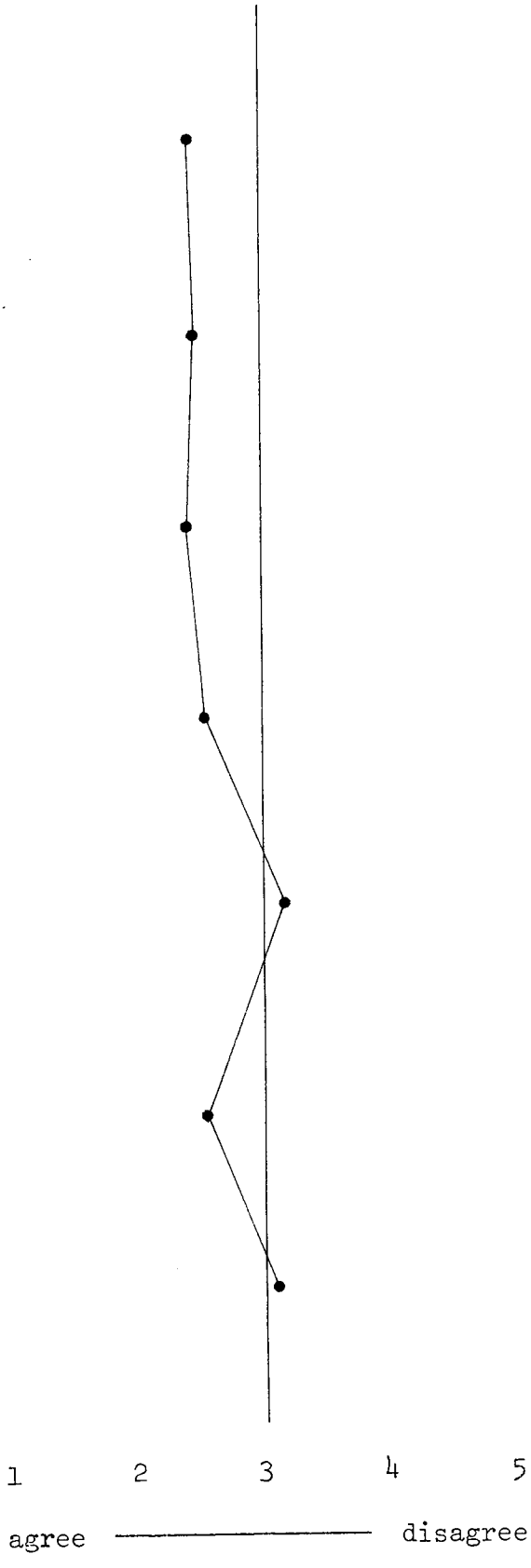
(c) the objectives have been clearly understood?

(d) the objectives have been successfully achieved?

(e) the objectives have been flexibly defined so as to be sensitive to changes outside the department?

(f) the objectives have been planned to make effective use of departmental resources (e.g. people equipment, etc.)?

(g) there is a high level of involvement in the development of a departmental strategy to meet these objectives?



Section (1) Objectives cont'd

In the context of this department, how far do you feel that:-

(h) there is a clear statement of formal R. & D. policy?

(i) the major obstacles to the fulfilment of these objectives arise from non-technological factors?

(j) the major obstacles to the fulfilment of these objectives arise from outside the department?

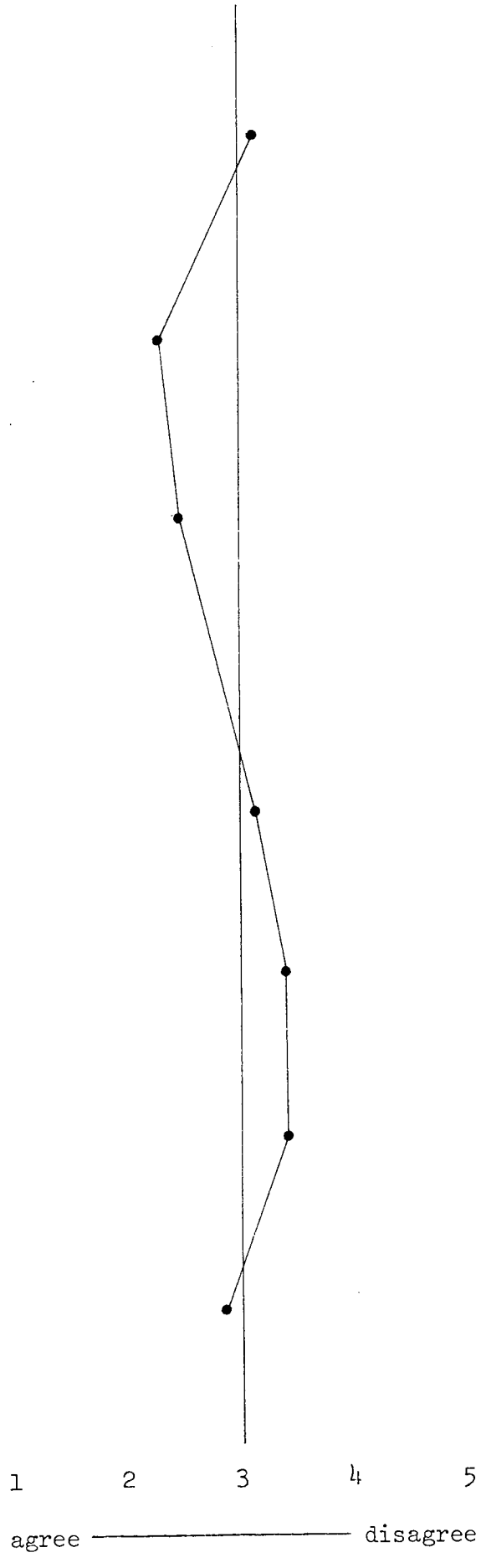
In the context of the Pigments Division organisation, how far do you feel that:-

(k) the objectives have been realistically planned?

(l) the objectives have been effectively communicated?

(m) the objectives have been clearly understood?

(n) the objectives have been successfully achieved?



Section (1) Objectives cont'd

In the context of the Pigments Division organisation, how far do you feel that:-

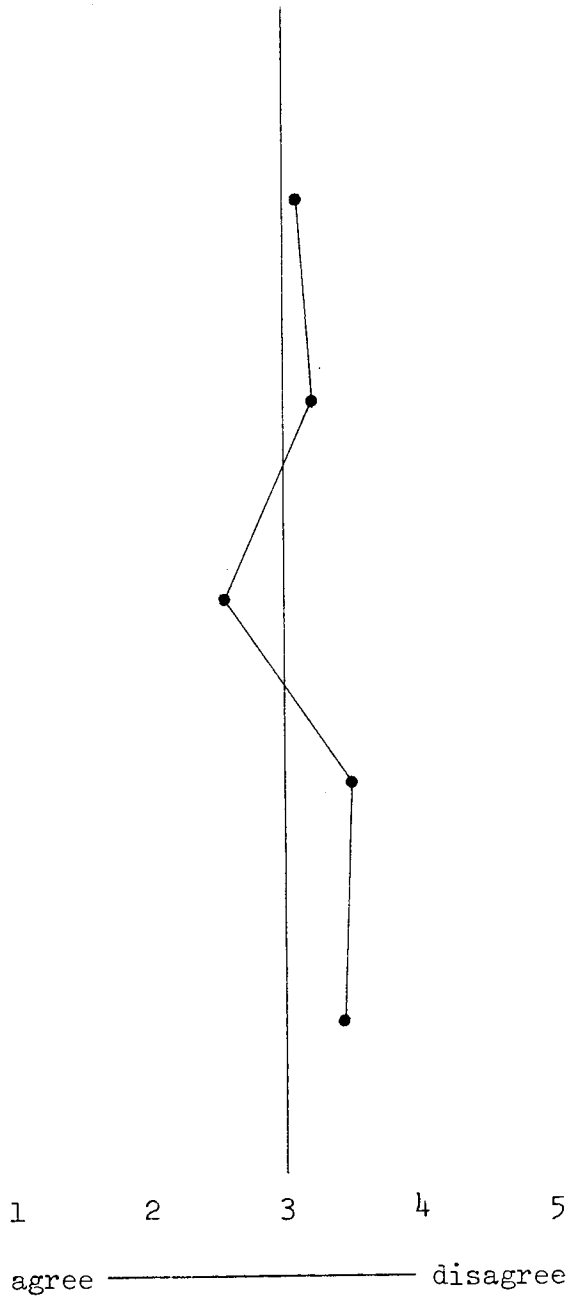
(o) the objectives have been flexibly defined so as to be sensitive to changes within the organisation?

(p) the objectives have been flexibly defined so as to be sensitive to changes outside the organisation?

(q) the objectives are too strongly influenced by Basle?

(r) there is a clear statement of formal R. & D. policy?

(s) there is a clear understanding of the role of R. & D. in the organisation of Pigments Division?



Section (2) Structural Factors

In the context of this department, how far do you feel that:-

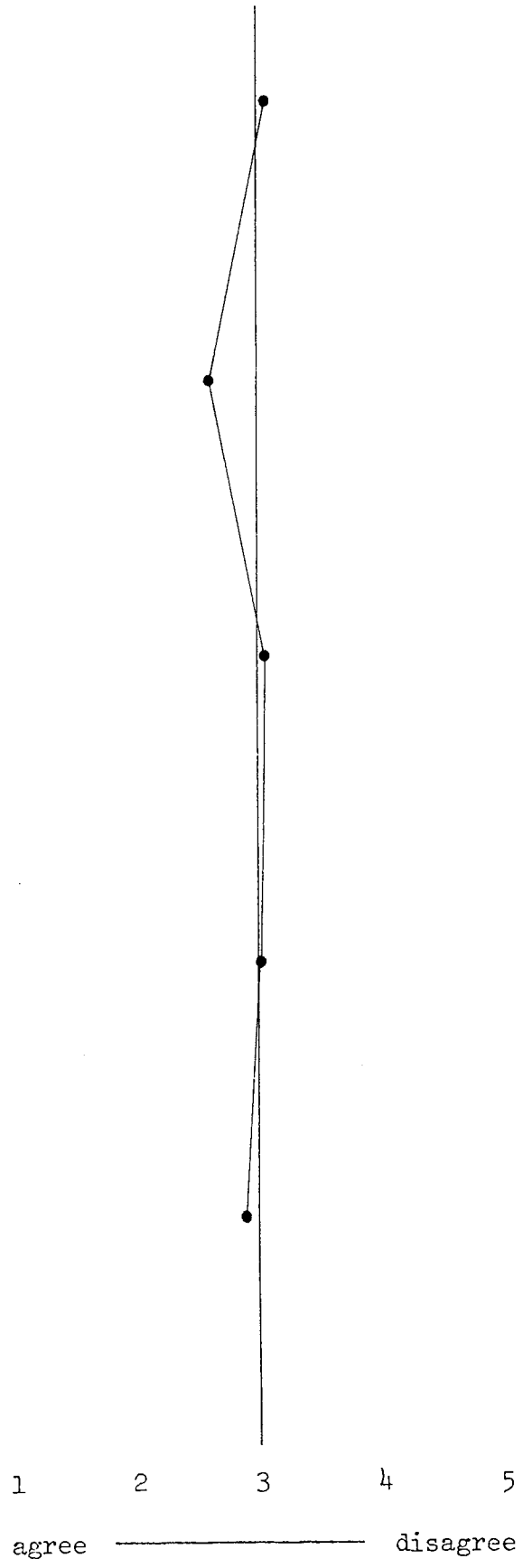
(a) the existing structure makes effective use of available resources (e.g. people, equipment, etc.)?

(b) the existing structure permits the use of individual initiative?

(c) the existing structure allows for greater delegation of responsibility?

(d) the existing structure permits each member of the department to make a significant contribution to, and to feel involved in, the life and work of the department as a whole?

(e) the existing structure is well adapted to the function the department has to perform?



Section (2) Structural Factors cont'd

In the context of the Pigments Division organisation, how far do you feel that:-

(f) the existing structure permits each individual to feel involved in and able to contribute to the life and work of the organisation?

(g) the existing structure allows for delegation of responsibility?

(h) the existing structure is flexibly defined to respond to changes in the outside world?

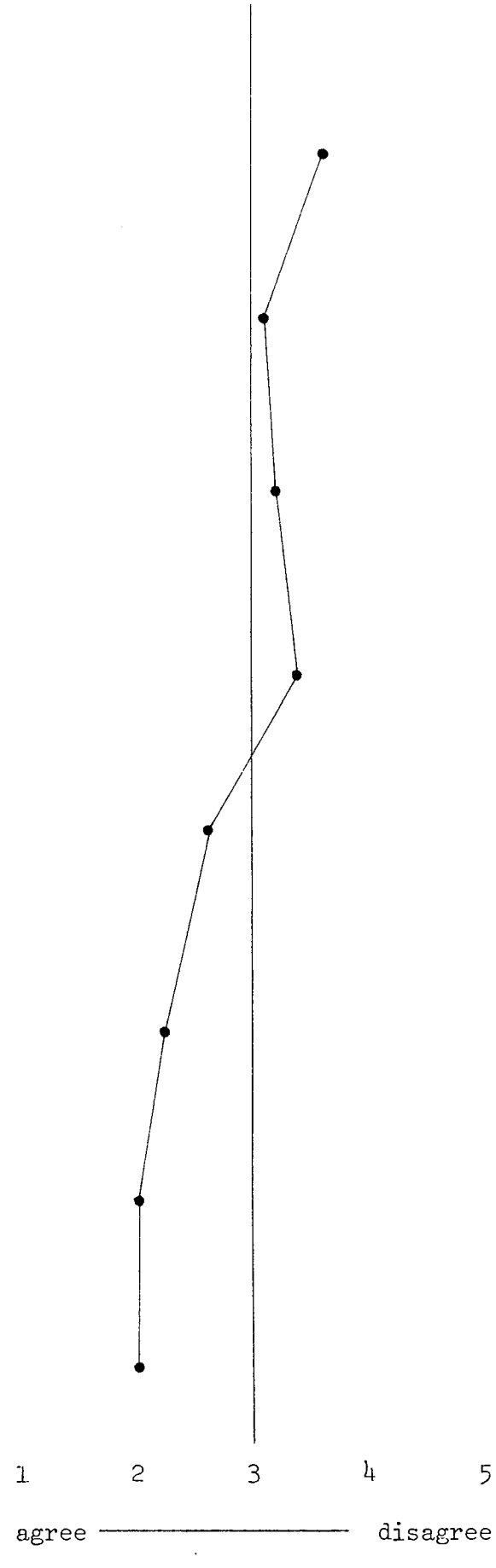
(i) the existing structure can quickly adapt to changes in the world outside?

(j) the existing structure is too far dominated by Basle?

(k) the existing structure is too rigidly defined to permit adequate contact between groups and departments?

(l) there is a gap between different levels in the management hierarchy?

(m) there is a distortion of perception across this gap?



Section (3) Communication

In the context of this department, how far do you feel that:-

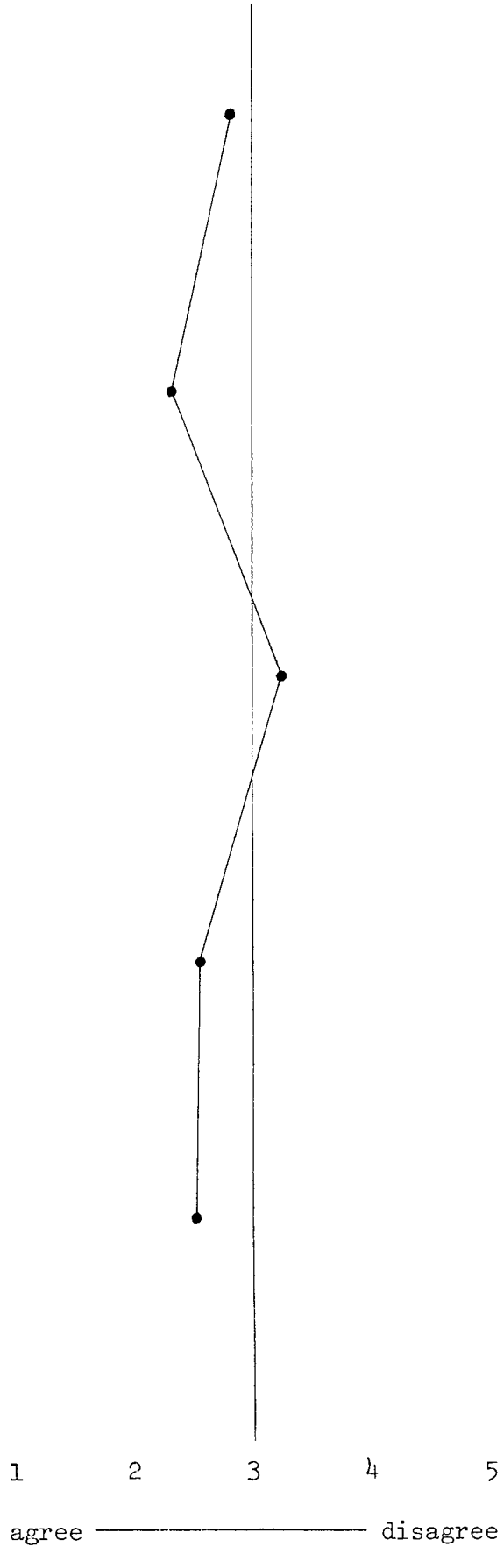
(a) information is effectively communicated?

(b) information is selectively 'filtered' before being communicated?

(c) information is communicated in a timely fashion, so that a sense of involvement and awareness is generated?

(d) information is more completely and openly communicated, i.e. that 'the whole story' gets passed on, by the informal network than by the formal one?

(e) information is more effectively communicated, and in a more rapid fashion by the informal network than by the formal?



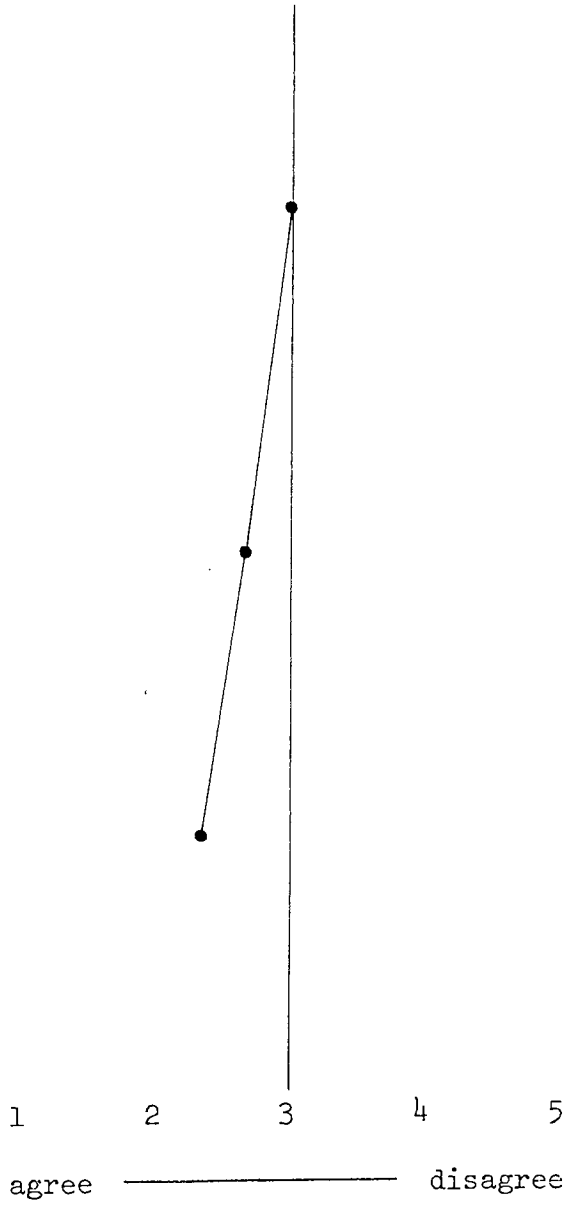
Section (3) Communication cont'd

In the context of this department, how far do you feel that:-

(f) the informal communication network is better adapted to keeping people informed and thus fostering a feeling of involvement and awareness?

(g) the informal communication network represents a distorting factor which contributes little to and may in fact inhibit the passage of correct information?

(h) the informal communication network reaches a much wider 'audience' with a much greater variety of information than does the formal?



Section (3) Communication cont'd

In the context of the Pigments Division organisation, how far do you feel that:-

(i) information is effectively communicated?

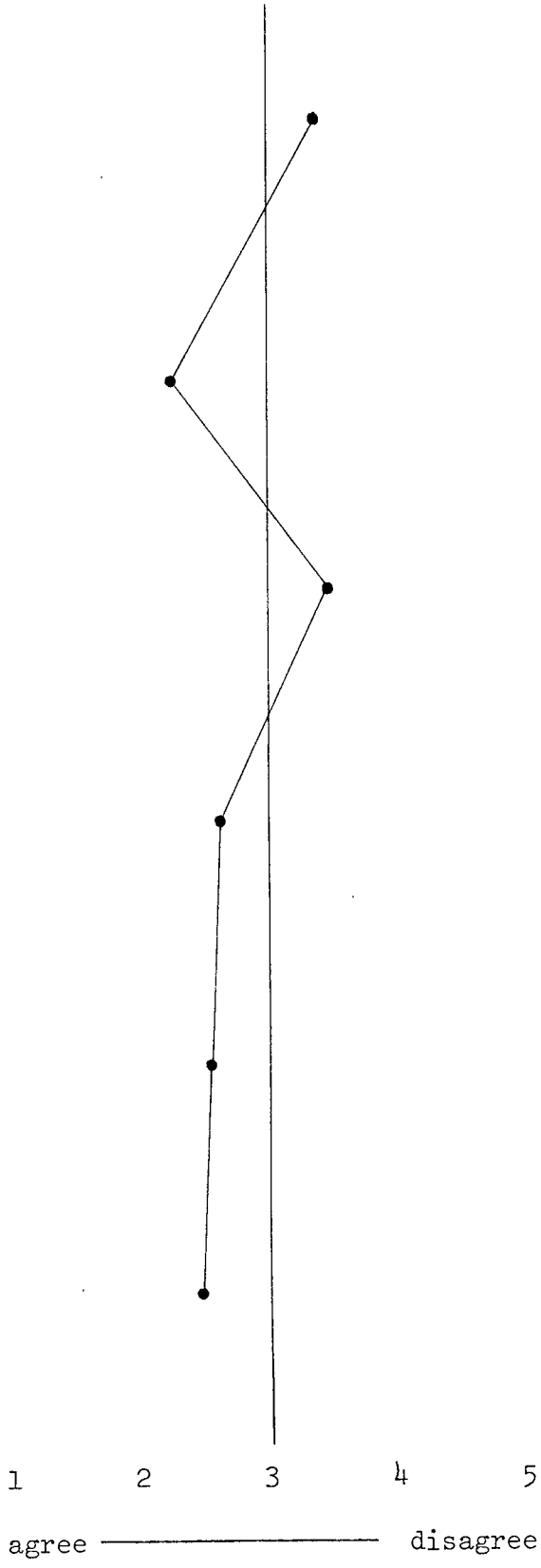
(j) information is passed on a selective 'need to know' basis rather than on a completely open 'telling the whole story' basis?

(k) information is communicated in a timely fashion such that a feeling of awareness and involvement is generated?

(l) information is more effectively communicated, and in a more rapid fashion by informal channels rather than by formal ones?

(m) the informal communication network represents a distorting factor which contributes little to, and may in fact inhibit, the passage of correct information?

(n) the informal communication network reaches a much wider 'audience' with a much greater variety of information than does the formal?



Section (4) Job-related factors

In the context of this department, how far do you feel that:-

(a) jobs are accurately defined?

(b) jobs permit a high degree of self-fulfilment?

(c) jobs offer a realistic opportunity for career development?

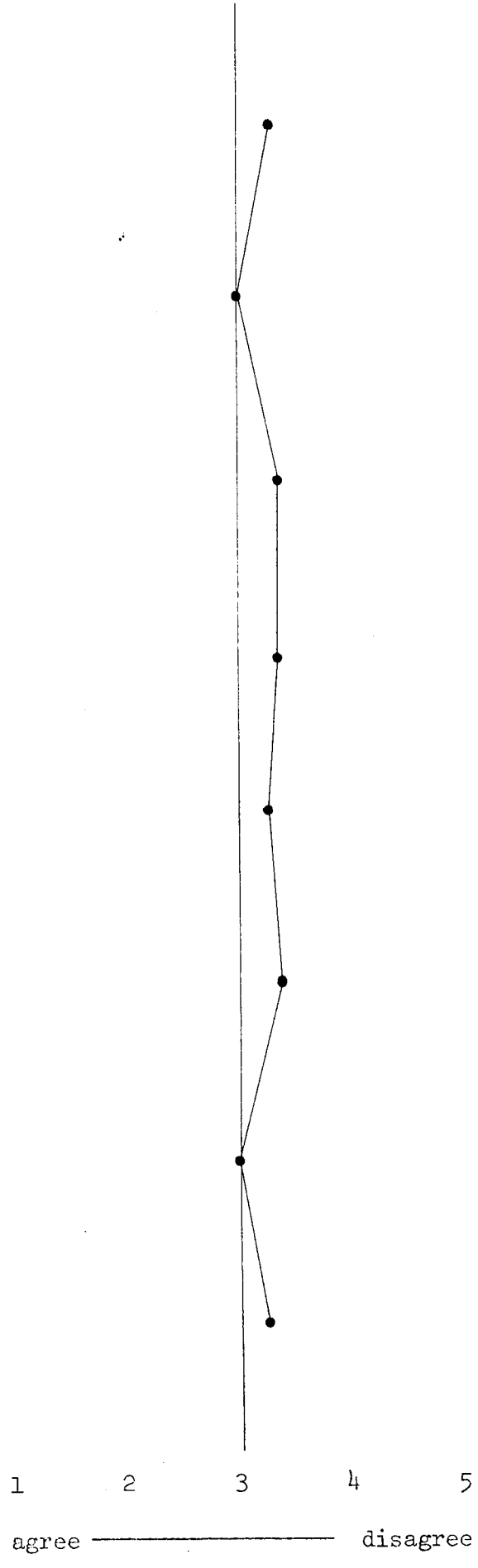
(d) the assessment procedures in use are effective indicators of performance?

(e) existing job descriptions offer the opportunity to contribute to the department as a whole?

(f) the assessment procedures are carried out in a uniform fashion?

(g) the assessment procedures permit an objective analysis of performance?

(h) promotions represent a meaningful change in job characteristics rather than an automatic 'step up the ladder'?



Section (5) Group-related factors

In the context of this department, how far do you feel that:-

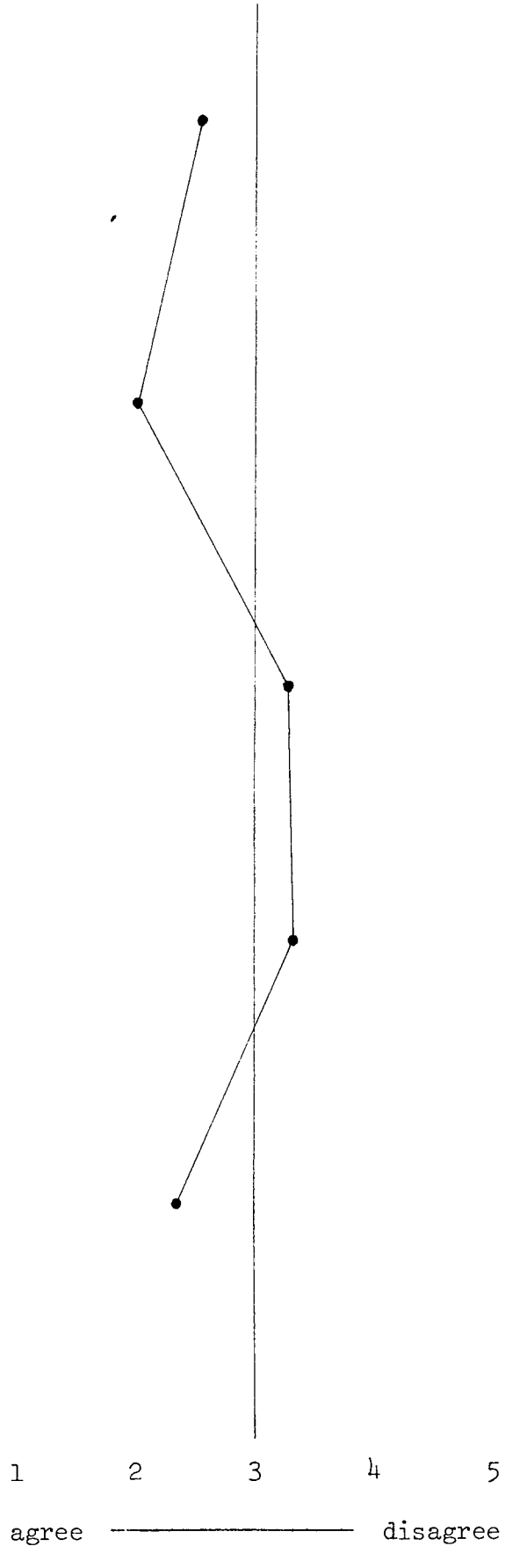
(a) there is good cooperation between groups?

(b) there is good cooperation amongst individuals within groups?

(c) there is a belief that conflicts and disputes can only be resolved in a win/lose fashion rather than by a compromise acceptable to both sides?

(d) there is good mutual understanding between groups and a clear appreciation of the problems and difficulties involved in other areas?

(e) there is a clear definition of the task(s) which the group has to fulfil?



Section (5) Group-related factors cont'd.

In the context of this department, how far do you feel that:-

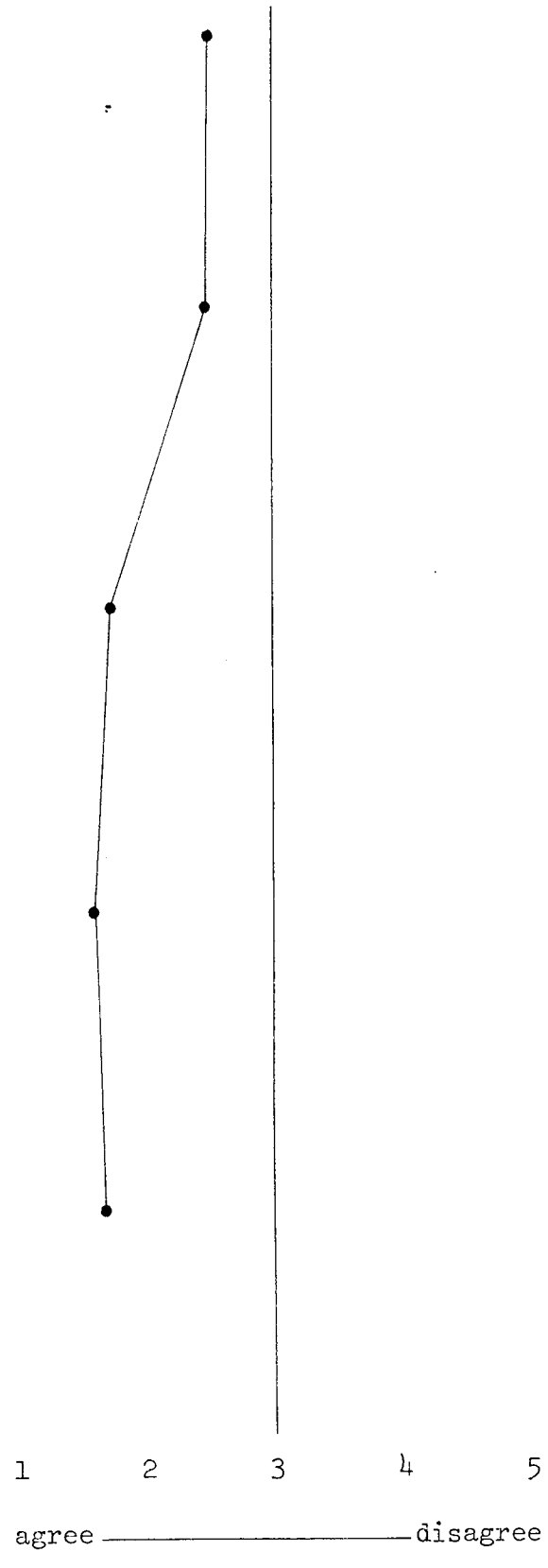
(f) there is a clear definition of the role the group has to play in the department?

(g) the clear understanding of role and task of the group leads to a sense of involvement, awareness and cooperation?

(h) that informal relationships help to strengthen a group from within?

(i) that informal relationships help to avoid confrontation situations between groups?

(j) that informal relationships help to foster a greater self-awareness and improve interaction with others both within and between groups?



Section (5) Group-related factors cont'd

In the context of the Pigments Division organisation, how far do you feel that:-

(k) there is good cooperation between groups?

(l) there is a belief that conflicts and disputes can only be resolved in a win/lose fashion rather than by a compromise acceptable to both sides?

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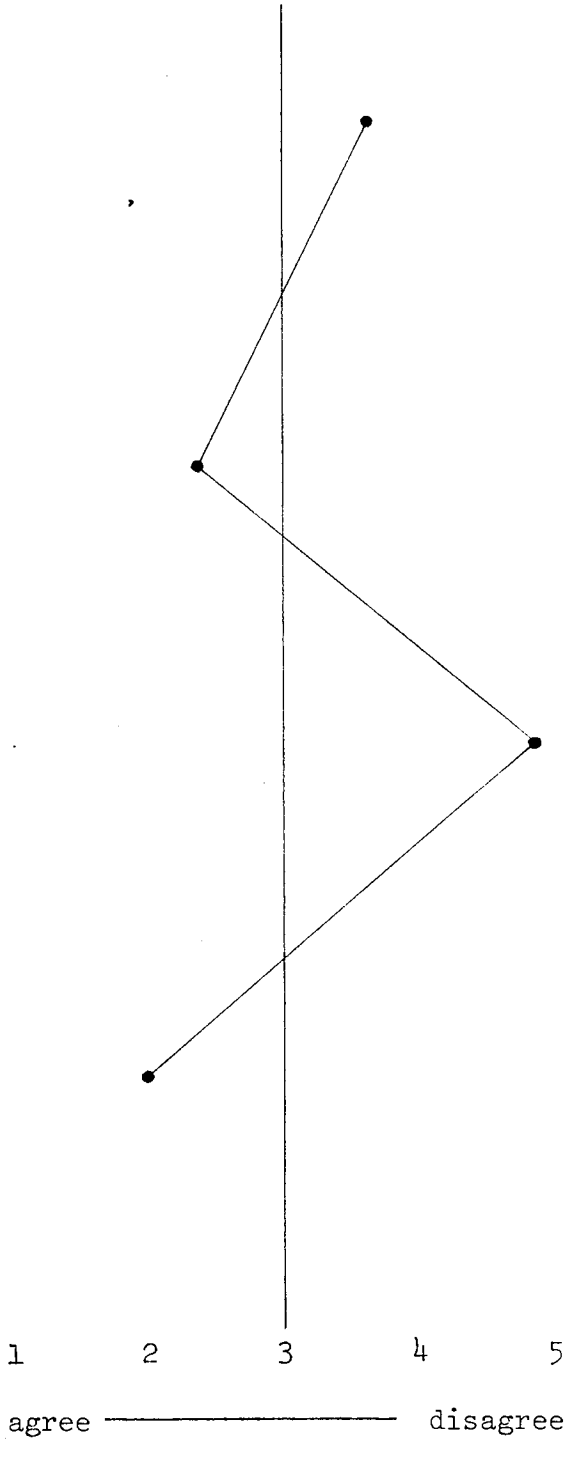


Section (6) Innovation

In the context of the Pigments Division organisation, how far do you feel that:-

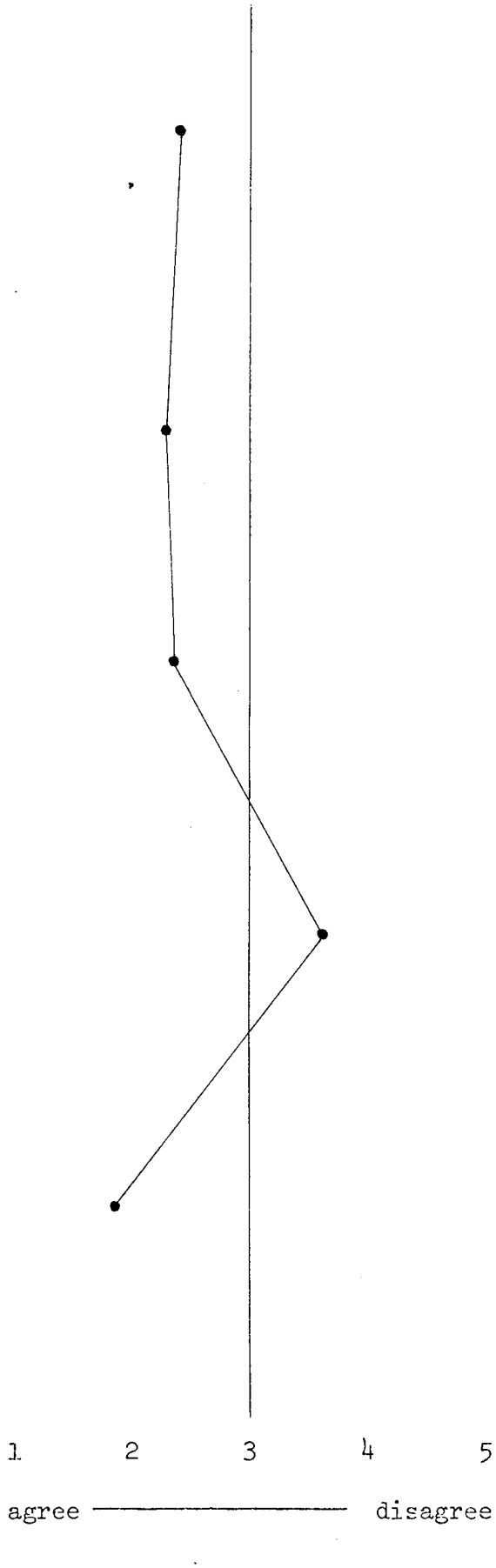
(a) attitudes towards innovation are too conservative?

(b) emphasis is placed on systematic work within procedure rather than on speculative, more radical work?

(c) the overall policy could be described as safe and sure?

(d) major departures from this policy would only result in major problems?

(e) the major barriers to innovation are not in the production of good ideas but in the process of carrying these into practice?



Section (6) Innovation cont'd.

In the context of the Pigments Division organisation, how far do you feel that:-

(f) these problems are not so much a function of the system itself as the personalities and behavioural factors involved?

(g) that the 'streamlining' of Meeting III has led to a 'gap' between functional departments in the innovative process and the R. & D. policy interpretation as performed by Meeting III.

(h) that the setting up of the T.C.G. has helped towards closing this gap by providing a link between functional departments and Meeting III?

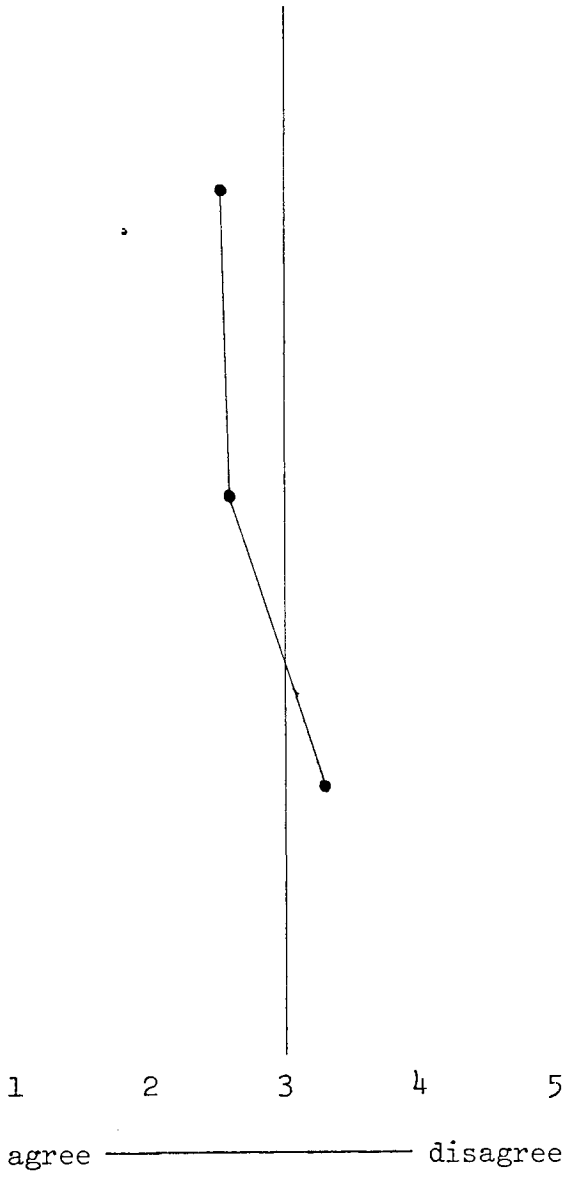


EXHIBIT 38 : Work preference questionnaire

This measure has already been discussed in terms of local results; however the absence of product champions and the low-level of risk-taking apparent in the organisation suggest that it may be useful to examine overall scores.

Statements of particular significance were:

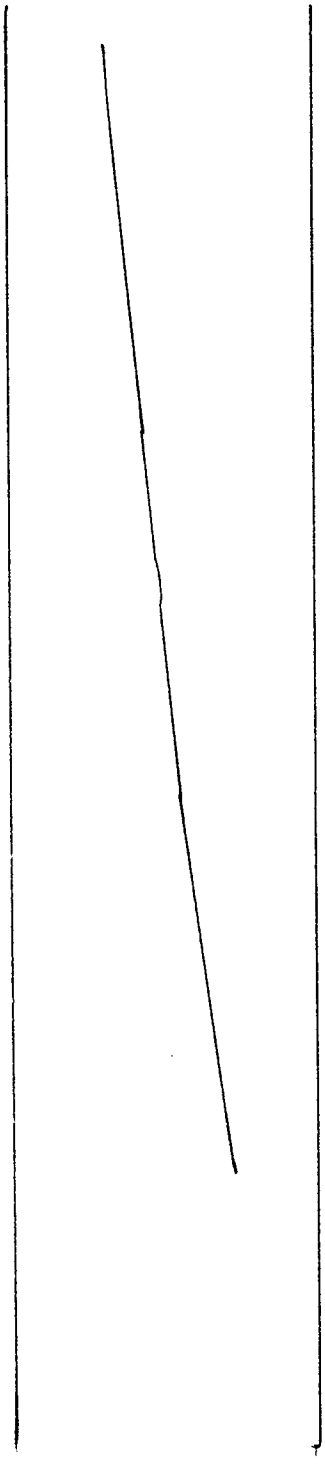
- job satisfaction as opposed to hygiene factors (q10)
- independence (q11, q17)
- challenging and interesting work (q12, q16, q23)
- support and leadership concern (q13, q20)

As has already been suggested, there is a strong emphasis on intrinsic motivation rather than instrumental approaches to work; this has been labelled a professional specialist orientation. The above scores support this view, and suggest that management of this type of employee needs to be based more upon facilitating his autonomous working than upon direct authority-based intervention.

The absence of risk-taking can partly be accounted for by the strong group orientation which most individuals report: few would put themselves beyond the group in pursuit of a personal goal. There are few high scorers on the instrument (so that the incidence of entrepreneurs (= high achievers) will be low. Nevertheless, it is strange to find such low-levels of risk-taking; it is suggested that organisational factors may account for this.

Work Preference Questionnaire

Would your ideal organisation be one...

1. Where a person's promotion is unpredictable and depends largely on his own good performance.		Where a person can see exactly how his career will progress after certain periods of time.
2. That regards special benefits, such as attractive bonuses, free pension schemes and a company car, as the prime incentive to remain in the job.		That concentrates on tempting new employees with interesting work, although it is not able to pay as much as other organisations providing less interesting work.
3. Where it is emphasised that the 'job comes first', therefore afterwork pleasures should take secondary importance.		Where it is very difficult to carry on work over a weekend period should someone so desire.
4. Where the few changes in tasks that occur allow people to perform one type of work with considerable care and proficiency.		Where there is constant pressure to complete a task well in a short period of time and to then become involved with another task.

5. Where there is a general attitude that, even if the working conditions are poor, much can be compensated by interesting work.

Where little that is favourable can be said about the work itself but where the attitude of management towards its employees' welfare is first class.

6. That gives people jobs that can very likely be done well.

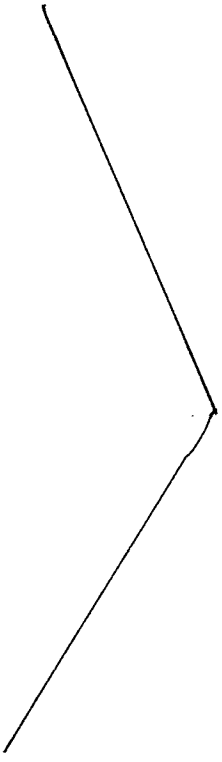
That gives people work which is not so difficult that they would have to rely on luck to do a good job nor so easy that they are bound to succeed.

7. Where it is expected that leisure time will be sacrificed if work pressure is great.

Where it is felt that working late is undesirable because eventually strain will be experienced in normal working hours.

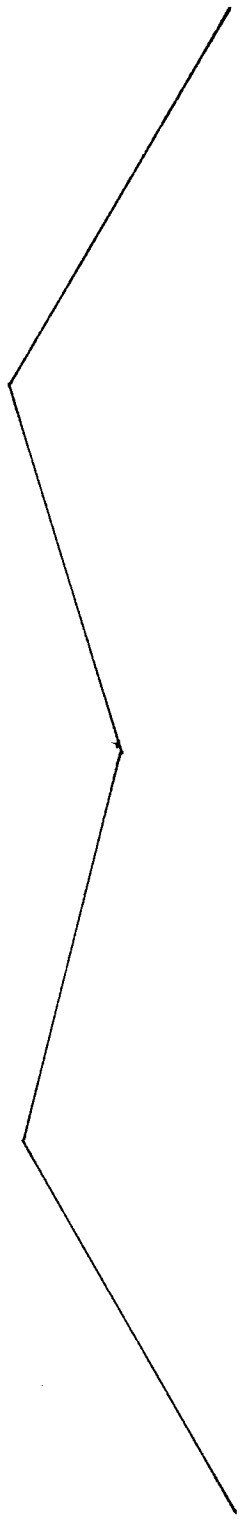
8. That believes that if a person concentrates primarily on working in a warm close fashion with his co-workers, good work must follow.

That regards the successful completion of an employee's assignment as more important than the feelings of that person's co-workers.

9. That expects individuals to help the organisation by fulfilling their own personal goals.		That expects its employees to strongly identify with the organisation rather than think of themselves as individuals apart.
10. Where good working companions and generous holidays are provided to make up for the tedious nature of the work.		Where there is more concern with employees' satisfaction with the actual work that they do than with their general conditions of work.
11. Where each employee is solely responsible for most of the work that he performs.		Where several people are always responsible for, and take the credit for, a particular piece of work.

Would your ideal boss be someone.....

12.	Who gives his employees work that they feel sure of doing well without too much effort.	Who gives people work requiring quite a lot of struggling to master.
13.	Who insists on finding out how worthwhile his employees see their work but neglects looking into the enjoyment that they get from their work.	Who regards the pleasure that his employees get from their work as more important than the actual worthwhileness of the work.
14.	Who emphasises the importance of the work group's responsibility for its decisions rather than particular individuals in the group taking the responsibility.	Who relies on a particularly efficient individual in a work group to control the group's activities.
15.	Who expects to be consulted only for very exceptional work problems.	Who encourages employees to follow set procedures in their work.
16.	Who attempts to provide attractive work for his employees even if it is not of great value to them.	Who would not give people work that they could view as of little value even though it may be highly attractive to them.



17. Who gives his employees general guidelines on which to base their own decisions about how to proceed with their work.

Who gives clear, very comprehensive instructions on how employees should carry out their work.

18. Who finds that for group morale it is better to try to preserve good co-worker relationships that may be spoiled by letting people keep working at a task to their own satisfaction.

Who feels that a certain degree of bad feeling amongst employees is worth tolerating if they are very much involved with their work.

19. Who looks for future employees who will be able to work independently of others.

Who looks for future employees who will primarily be good at getting on well with other employees.

20. Who would rather employees consulted him with work difficulties than struggle with them themselves.

Who will not interfere with work for which employees have responsibility.

21. Who expects an individual's work rate to remain relatively uninfluenced by his colleagues.

Who relies on the group as a whole to produce a given amount of work expecting the group to influence an individual's quantity of work done.

22.	Who views good employee relations as being most important and incompatible with competitiveness.		Who insists on individuals trying to achieve a better performance rating than their co-workers.
23.	Who gives employees work where they need to write fairly detailed arguments about problem solutions.		Who gives employees work that involves very little written reporting or problem discussions.
24.	Who feels that working late should be avoided.		Who encourages working late in order to meet a deadline.

EXHIBIT 39 : Personal Beliefs Measure

This was an attempt to identify dominant belief patterns about the nature of work; a full account is given in the methodology section.

Responses of significance were the following:

(i) strong agreement with statements:

- work can be made interesting rather than boring
- work can be organised to allow for human fulfilment
- work should enable one to learn new things
- the job should be a source of new experiences
- the workplace can be humanised
- work can be made satisfying
- one's job should give one a chance to try out new ideas
- work can be a means of self-expression
- work can be made meaningful

This represents a high degree of correlation with the humanistic belief system suggested by Dickson (1977) i.e. that 'work is to be taken seriously as the way in which man discovers himself and fulfils himself as a human being'.

(ii) agreement with statements:

- work allows for the use of human capabilities
- working with a group is better than working alone
- survival of the group is very important in an organisation
- one should take an active part in all group affairs

This cluster suggests, at a much lower level of correlation, the tendency towards group identity and loyalty. Study of the work preference questionnaire shows similar support for the importance of the group.

(iii) disagreement with statements:

- by working hard, a person can overcome every obstacle that life presents
- the trend towards more leisure is not a good thing
- one should work like a slave at everything one undertakes until one is satisfied with the results
- conformity is necessary for an organisation to survive
- work takes too much of our time leaving little time to relax
- to be superior a man must stand alone
- a man can learn better on the job by striking out boldly on his own that he can be following the advice of others.

This cluster represents a negative correlation with the set of beliefs labelled 'the work ethic', i.e. 'work is good in itself and bestows dignity on a person. Everyone should work and those who do not are not useful members of society'.

This set of results compares well with that reported by Dickson in his comparative study of managers in the USA and in the West of Scotland. As with his study, the humanistic belief system dominates the responses, a fact which suggests that 'Theory Y' thinking (i.e. people-orientated) may be a latent resource to be tapped in organisation development strategies in this company. Equally the work ethic is least strongly endorsed in his study as in this one.

Personal Beliefs Instrument

	Agree	Don't Know	Disagree
- by working hard a person can overcome every obstacle that life presents.	10	3	21
- working with a group is better than working alone.	5	0	29
- one should take an active part in all group affairs.	3	2	29
- the group is the most important entity in any organisation.	34	0	0
- management does not understand the needs of the worker.	34	0	0
- success means having ample time to pursue leisure activities.	8	2	24

	Agree	Don't Know	Disagree
- work allows for the use of human capabilities.	9	2	23
- work can be made interesting rather than boring.	28	3	3
- work can be organised to allow for human fulfilment.	23	3	8
- factories would be better run if workers had more of a say in management.	33	0	1
- work should enable one to learn new things.	11	3	20
- the job should be a source of new experiences.	34	0	0
- the workplace can be humanised.	14	1	19

	Agree	Don't Know	Disagree
- work is a means to foster group interests.	20	7	7
- one's job should give one a chance to try out new ideas.	34	0	0
- only those who depend on themselves get ahead in life.	34	0	0
- workers should be more active in making decisions about products, financing and capital investment.	31	1	0
- a man can learn better on the job by striking out boldly on his own than he can by following the advice of others.	9	6	19
- one must avoid dependence on other persons whenever possible.	20	4	10

	Agree	Don't Know	Disagree
- workers get their fair share of the economic rewards of society.	34	0	0
- one's contribution to the group is the most important thing about one's work.	15	6	13
- work can be a means of self-expression.	14	2	18
- one should work like a slave at everything one undertakes until one is satisfied with the results.	34	0	0
- survival of the group is very important in an organisation.	12	2	20
- the trend towards more leisure is not a good thing.	25	3	6

	Agree	Don't Know	Disagree
- conformity is necessary for an organisation to survive.	19	2	13
- leisure time activities are more interesting than work.	17	3	14
- it is best to have a job as part of an organisation where all work together even if you do not get individual credit.	18	0	16
- workers should be represented on the board of directors of companies.	14	3	17
- better decisions are made in a group than by individuals.	16	3	15
- to be superior a man must stand alone.	8	1	25
- work can be made satisfying.	25	4	5

	Agree	Don't Know	Disagree
- work takes too much of our time leaving little time to relax.	4	3	21
- work can be made meaningful.	7	2	25

EXHIBIT 40 : Short Course Observations

A short course in Technical Group Leadership was held at Aston in April 1977: which a number of Pigment Division managers attended.

The course itself was minimally structured, the aim being to provide opportunities for learning about group behaviour. Materials and resources were available but emphasis was placed on the group's own experiences as the principal source of learning. Observation and recording of the whole course took place using video and audio tapes and direct observation (by the researcher); feedback and discussion of this information was a central component of the course.

One of the dominant features which emerged was the low level of familiarity which participants had with the subject area; despite the wealth of published material, it is apparent that little has diffused into management thinking.

Perhaps there is a need for alternative information channels in this area.

Another important factor was the extremely low-level of risk-taking behaviour; since much of the course depended upon participants taking the initiative, the course was regarded by many as having been a failure. Subsequent interviews revealed that the lack of structure had been a major source of personal stess for everyone, but that no-one was prepared to initiate a structure of their own. Indeed, when one candidate was put forward by his colleagues as a leader, he refused to take on the task. It is suggested that there may be some correlation between this behaviour and the general low-risk attitude within Pigments Division.

Summary

A variety of data has been presented in this chapter; it is intended as representative of the range and quality of information collected over two years. The repetition of certain themes is significant in highlighting key problem areas. However the extent of variation in individual cases is also clear, and illustrates the complexity of the task involved in successfully managing innovation.

CHAPTER 8 : Discussion

The previous chapter was concerned with illustrating the wide variety of influences on the innovation process in an organisation. Evidence presented tends to support earlier statements about the limitations of general prescriptive theories and propositions in accounting adequately for the process.

An attempt is made in this chapter to bring out the key features of the reported case study. Problems appear to be classifiable into several groups which share the common characteristic of being related to the concept of integration.

This theme is treated from an analytical viewpoint and it is argued that organisations cope with growing complexity (in the sense of possible sources of variation) in the external environment by internal differentiation. The resulting internal complexity then needs to be integrated for optimum performance. Integration problems are most likely to occur at the uncertain least-programmed end of the organisation - which is what the research has shown.

It is argued that management may be under too great a pressure to cope adequately with increasing demands for integration and that a new specialist function needs to be set up. Characteristics of this specialist integrator are discussed with reference to the research experience as a simple example of an attempt at an integrating strategy.

Finally an integration strategy aimed at solving those problems described in chapter seven is presented.

Section 1

In the preceding chapter evidence was presented illustrating the complexity of the innovation process and the variety of factors which influence success or failure. It is suggested that the data supports criticism of so-called general hypotheses about innovation: from a management point of view there is too much contingent variation for simple prescriptions to be of any great value.

On the other hand, is each problem issue unique? If this is the case, then pragmatic management, dealing with each problem as it occurs, would seem to be the only available solution. Rules, procedures, systems and more sophisticated approaches to 'planned' management are only valid when there is some similarity between sources of variation.

It is argued that the problems raised in the case study are amenable to classification. Exhibit 1 offers a diagrammatic representation of one approach which sees problems as either reducing driving forces or increasing resisting forces.

On the basis of this general model, management activity may be directed towards strategies aimed at increasing driving forces and reducing resistances. Such a representation has the advantage of being applicable to any organisation: specifity only occurs in terms of the components of each element.

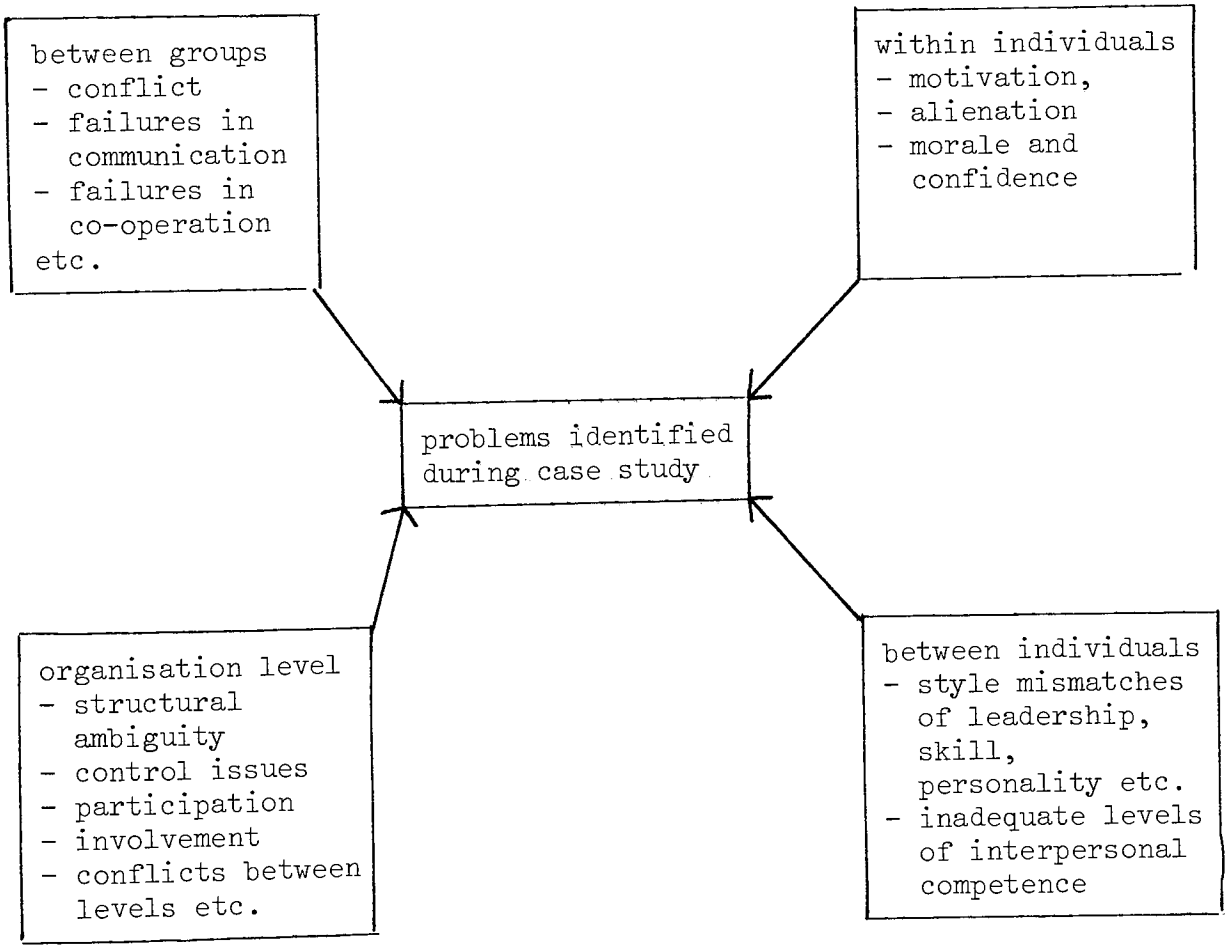
In this way organisations sharing similar components and operating under similar contingencies will be able to share experience of improvement strategies; what works for one is likely to work for the other. This corresponds to a simple probabilistic/contingency model; the more closely the contingencies in both cases correspond, the higher the probability of shared strategies working.

A more fundamental classification is suggested in the next section; this views all the problem issues raised as relating in some way to the concept of integration.

EXHIBIT 1 : Simple 'Force Field' Model

driving forces	improvement strategies	resisting forces
market pull	can be used as lubricants to minimise resistance	unproductive conflict - between individuals and groups.
knowledge push		
promoter figures (product champion and influence figure)	e.g. co-ordinating mechanisms - or as stimulants to enhance driving forces - e.g. improve idea generation or raise level of risk-taking	organisational inertia - system too slow to respond
risk-taking culture (entrepreneurship)		poor environmental integration - innovators not coupled well with adopters

EXHIBIT 2 : Categories of Problems



Section 2 : Discussion of Problem Issues

The research was conducted using problems as the basis for analysis: in one sense, the researcher actively went out looking for trouble. That so many issues arose should not in any way be taken as meaning that the company was a poor performer, but only that it was prepared to look more closely than is usual at ways in which things could be improved.

Having collected a vast number of statements of problems in many different ways, some attempt was made to sort them out. Were they all unique, or were there common elements? A number of grouping and sorting strategies were tried and it became clear that there were in fact a small number of general issues arising regularly.

It is argued that, at a certain level of abstraction, these issues can all be viewed as the consequence of a lack of integration. This causal relationship may be direct, as with groups competing unproductively instead of co-operating with each other. Equally it may be indirect, as with low-levels of risk-taking arising out of a climate in which people have little trust or confidence in others; this climate is itself the consequence of poor integration.

Exhibit 2 lists the problem groupings which appear to emerge and indicates how they might be broken down. The model of different, 'nested' levels of individual, group and organisation developed in an earlier chapter is used here; integration needs at each level will be different.

It should be clear from this approach that the dominant theme emerging from problem analysis is conflict - i.e. a state of non-integration. In itself conflict is neither good nor bad; it represents a position on the continuum of differentiation and integration. If we imagine two polar opposites corresponding on one hand to total disintegration with no contact or interrelationship between elements and on the other to total integration with complete harmony and stasis, then we have a picture of this continuum. In organisations, the principles of differentiation and integration are inversely related to one another and exist in a state of dynamic equilibrium. What is required is a fine balance which allows productive differentiation with its specialist skills and useful competitive edge to sharpen up interaction. Too much and energy is dissipated as 'friction': too little and the organisation stagnates.

Exhibit 3 attempts to clarify this hypothesis by giving examples of problems viewed as integration difficulties. These cover all the levels discussed in the organisation model.

Returning to the push/resistance model, it is possible to see that, in the case studied, almost all the difficulties encountered within the innovation process were of the resistance variety. The level of technological competence was high, the output of new product and process ideas always exceeding the resources available to develop them. Resource availability though scarce, was not a major restriction.

In fact the only area in which driving forces were deficient appeared to be in the levels of commitment and risk-taking.

As one individual summed it up, 'we don't have any problems coming up with good new ideas - it's getting them into practice that's impossible'.

In particular, the sources of resistance tended to lie in the 'behavioural' area. This supports the widely-held view that the bulk of variation in the innovation process is associated with the human element. As was indicated elsewhere, most of the literature on the management of innovation does not attempt to consider this element in any detail. There is a tendency to assume that innovation is a logical, linear process amenable to 'mechanistic optimisation': the evidence presented in the preceding chapter is offered as a contradiction to this proposition.

EXHIBIT 3 : Examples of Problems viewed as integration difficulties

(i) Individual Level: Issues here could be summarised as being concerned with how well an individual feels himself integrated with the organisation, his task, his group etc. Does it provide him with opportunities to fulfil his personal motivational pattern? Does it offer chances for his development, both in a career and a psychological sense? Are goals and strategies in line with his own? Does it make full use of his potential contribution?

We have already seen that technical specialists tend to be self-motivated rather than organisationally directed. Thus his performance is likely to be related to how integrated he is with the organisation. If he is not committed to it, there are very few effective sanctions which can be brought to bear upon him. Creativity and problem-solving behaviour cannot be controlled according to specification, so there is no way of telling directly whether an individual is contributing to the peak of his potential or simply 'working to rule' and satisfying the formal demands of his job description.

A model of this behaviour was advancec earlier by which the 'dynamics of commitment' might be illustrated. At one end of a continuum is a level corresponding to total commitment: beyond this point, the innovator starts to break the rules and change the organisation, so committed is he to its success. At the other end is a condition of alienation, characterised by withdrawal and minimum co-operation. The extreme in this case corresponds to the individual leaving the organisation. Most individuals will move around this continuum according to variations in task and other contingencies; the task of management is clearly to try and keep them as close to high commitment as possible.

The complexity of this task is clear when we consider how much individual needs and behaviour vary with time and across populations; under conditions of uncertainty this will be exaggerated further. Keeping specialists integrated is thus a major source of problems in innovation as many examples in the previous chapter showed. Some brief 'character studies' based on real examples may help to point up this principle.

(a) Dr. A is a highly qualified chemist with demonstrated flair for innovative problem-solving. He has worked on fundamental research work, developing new processes. During the course of this he found a promising new route which aroused high-level interest: he became the technical expert on a project team set up to investigate feasibility. After several year's work and apparent commitment to the target, the project was shelved. Whatever the high-level justification for this decision, he did not feel it to have been communicated to him in any clear form. Consequently, he felt that his efforts had been wasted by a short-sighted company who hadn't even got the strength to axe a speculative project at an early stage - they let it drag on and on, wasting everyone's time, and then didn't bother to explain why they finally decidied to drop it.

His response has been to remain committed to his pet project, and to withdraw into himself, nurturing his bitter feelings about the company. He cannot easily leave and join another company because there just aren't the jobs for chemists. Instead he relaxes his efforts and contributes a bare minimum. His creative energies are directed towards leisure activities and more particularly to criticising and grumbling about the organisation.

(b) Chemist B does not suffer from over-commitment to his own projects, but being involved with product development work, he is concerned about the high rate of failure. His confidence in his own abilities is threatened, but the real problem is a growing lack of faith in those responsible for strategic decision-making. It beings to appear that there is no clear vision of the direction in which the company is going. Consequently it becomes a waste of effort to commit oneself totally to a project - especially since it appears that the individual doesn't matter in such a large system. Perhaps a smaller company would be better able to use and appreciate his talents and abilities - and thus he begins to withdraw from the organisation. There is a very thin line between a healthy philosophical shrug of the shoulders at the failure of new ideas - after all, Research and Development is a risky business - and the destructively cynical, 'well, what did you expect.....' response.

(c) Manager C is a high flyer: he has risen rapidly through the ranks of the organisation and is one of the youngest managers at present. His problem is that he feels cramped: he wants to learn new things, make use of all his potential, feel stretched by the tasks facing him. He's not overkeen to leave the organisation but there'd be no problem getting another job. For the organisation there's a big risk of losing him because the system does not have any serious commitment to management development, nor does it have any suitable niches available at this time. Loss of experienced personnel is a major headache but to the individuals themselves it appears as if promotion and development are secured by personal influence rather than by their efforts.

(d) Chemist D is a very experienced and longstanding member of the group. What he doesn't know about pigments is hardly worth knowing and he has a superb reputation on the site for having earned the company a great deal of money. He feels, however, that his long years of service and experience should lead him to a senior management job with status, salary and control equal to his position in the organisation. However, whilst highly regarded as a technical expert, there is criticism already about his inability to manage people. As a consequence, he is promoted up a 'technical ladder' affording him similar salary and status to a manager but in a non-managerial role - an internal technical consultant. This does not satisfy him, nor does he satisfy the organisational requirement for managerial skills - and there is no provision for developing these skills within the organisation.

It would be possible to extend this list considerably and the preceding chapter provides extensive examples of problem statements at this level. The problem of integrating the individual into the organisation is of central importance if we are to improve the innovation process.

Almost all theories of risk-taking and entrepreneurial behaviour, accounts of climates and environments for creative research and models of motivation stress the need for basic lower-order needs to be fulfilled before higher level activities can take place. It is argued that integration is a key component in this and that unless individuals experience some measure of integration with the organisation, productive innovative output is unlikely.

Components of integration will include commitment to strategy, to the structural arrangements, to the social order, to the task organisation etc. Consequences will be a feeling of belonging, of confidence in self and in the organisation: from this base, the individual will have a greater propensity to take risks.

Of course, perfect integration is likely to cause stagnation and produce committed 'organisation men' who will not try anything new. The balance - and it will vary between individuals - needs to be struck between integration to support the individual involved in uncertain and complex activities, and integration as a restrictive matrix surrounding him.

(ii) Between Individuals: A variety of problems exist under this umbrella label, which are essentially concerned with mismatching. If we take the view that any encounter between individuals represents an intersection of needs, expectations and potential contributions etc., then, if these are in conflict, the encounter will be unsuccessful. Over time, the history of unfulfilled encounters will make the relationship between those individuals extremely difficult. Amongst mismatches which have been observed are:-

- leadership style - the pattern of behaviour offered by the leader is not compatible with that expected by the subordinate - e.g. too paternal, too distant, too rigid, too flexible etc.

- attitudes and beliefs - there is no set of shared beliefs, values etc. between two individuals, so they are essentially strangers and incompatible.

- personal style - the pattern of behaviour exhibited by one individual fails to match the expectation of the other - e.g. too dominant, too submissive, uncommunicative, indecisive etc.

- 'professional' style - the approach and philosophy adopted by different specialist groups differs.

The relevance of this kind of problem is clear if we view innovation as a process involving high levels of co-operative activity. Further the intrinsic uncertainty places stress upon working relationships; if these are already unstable, it will place a limitation on innovation effectiveness.

Illustrative examples of style mismatch problem areas which were observed include:

- project teams, where specialists with different orientations are required to work together in solving major problems. Skill conflicts may emerge over the best way to tackle the problem, over lack of trust in different group's abilities, over the allocation of resources and priorities, etc. Added to this may be personality clashes between individuals and the inevitable incidence of political manoeuvering by individuals representing different allegiances.

- functional groups in which key figures are inaccessible because of personal or skill style. Managers who are unapproachable, technical experts who are poor communicators, task or team leaders who operate in a world of their own, independent of their groups, etc.

- strategic decision-making groups in which political battles for control of resources, priorities etc. are fought out between individuals representing major 'empires'.

- different modes of working and ways of seeing the world because of professional orientation. For financial men there is the money, labour, resources as an economic system; for engineers this is a technological system; for marketing this is a strategic sales/competition system etc. Lack of experience of other jobs means there is often no common point of contact, not even a shared language, from which to approach problems.

Once again integration represents the dominant need - in this case, how to get people to work effectively together. This is a requirement which comes sharply into prominence as tasks become more complex and uncertain and different resources are needed; specialisation will increase, and with it the problem of integrating people.

As before, a balance needs to be struck; perfect harmony may be a pleasant ideal but it is not necessarily very productive. Healthy competition can be an asset in that it stimulates creative interchange. If individuals express strong feelings about the way a job should be done, this is a good thing because it indicates the strength of their commitment.

(iii) Between Groups: Conflict between groups is a well-known phenomenon; as French and Bell (1973) put it 'when there is tension, conflict or competition between groups some very predictable things happen: each group sees the other group as an 'enemy' rather than as a neutral object: each group describes the other group in terms of negative stereotypes: interaction and communication between the two groups decreases, cutting of feedback and data input between them: what intergroup communication and interaction does take place is typically distorted and inaccurate: each group believes and acts as though it can do no wrong and the other group can do no right.....'.

It is likely that conflict arises from natural causes in that groups have such widely different orientations that their frames of reference will be incompatible: they will genuinely experience the world in different ways. Specialisation is a valuable strategy in helping organisations cope with external complexity but it will generate a strong need for effective integration. In particular, innovation as a process will require the activities of a number of specialist groups working together in some kind of reciprocal relationship: unproductive conflict with inhibit this activity.

Examples of unproductive conflicts which illustrate the French and Bell point and which were observed during the research include:-

- non-co-operation or 'sullen assistance' in joint activities, e.g. production trials.

- duplication of effort - groups working on the same thing because of a lack of sharing information or a lack of confidence in the other group's abilities.

- competition for scarce resources leading to exercise of power and influence to 'swing' decisions in favour of the most dominant group at the expense of others.

- exercise of power by key groups (e.g. maintenance) to control other groups.

- mismatch of expectation: one group demanding too much or the wrong thing from another, failure to understand priorities and pressures of others, etc.

- ambiguity of role: groups again fail to understand the demands or limitations of their or others' role - this gives rise to role conflict, role overload, role underload and other associated phenomena.

- strategic mismatches: in addition to corporate strategic objectives, each group will have its own strategies to achieve goals: these may conflict with other groups. These strategies may incorporate ideological positions so that the conflict becomes one of deciding about the future on the basis of different beliefs and opinions.

- isolation mismatches: lack of integration may not always be purposive; some groups will become isolated because of the nature of their activities, their geographical position, their diffusion around a number of centres etc. These groups will not be well-plugged-in to the rest of the organisation in terms of information, informal contact, etc.

A number of negative responses which exacerbate disintegration were observed: these include:-

- demarcation of responsibility: sticking to the system so that in the end senior management have to come in and sort out who's to blame. Sledgehammer tactics needed because of lack of give and take.

- boundary definition: As soon as a project reaches a transfer point it becomes another group's responsibility - no continuity between them.

- 'buckpassing': when problems arise, responsibility is dispersed along the line, usually stopping at the weakest link in the chain, rather than at the point where blame might be apportioned.

- suspicion of involvement: attempts to bridge interfacial gaps by going over to another group or inviting them over - e.g. to participate in pre-transfer trials etc. - are met by suspicion and hostility.

- 'not invented here': the classic withdrawal into specialist groups so that 'exploration territories' become strictly defined and retained.

- withdrawal into isolated positions - e.g. Research and Development retreating into 'ivory-towered professionalism' or production becoming the 'plant operators - no more, no less' on trials of new processes by Research and Development.

- minimising information flow: keep the information to the statutory minimum, keep all contacts on a formal basis, enforce rules of confidentiality, circulation etc. Operate as close to a one-way strategy as possible - allow as much information in and as little out as possible.

In all these conflicts and negative responses it is possible to see the central problem in large differentiated organisations; how to maintain high levels of flexibility? As Sayles and Chandler (1971) put it:

'..... getting new technologies implemented requires, beyond any question, an enormous amount of give and take between the developer and the user'. This theme can be extended to cover all working relationships between groups, not just developer/user.

What is required is a more global view of the organisation and the group's role and relationships. When the target becomes something like 'overall corporate excellence' and groups become motivated towards this, then the interfacial problems can be overcome.

Alternative approaches, bending and remaking rules, using informal rather than formal structures, ad hoc information systems etc. are all ways in which the 'natural' problems of differentiation can be tackled.

Lawrence and Lorsch (1967) demonstrated the direct relationship between innovation performance and integration: studies like Project SAPPHO tend to support this principle strongly. They argue that differentiation and integration have a natural inverse relationship, and that in any organisation they will exist in a state of 'dynamic oscillation'. In other words, the pattern we have seen at individual and group level manifests itself here again. A balance between too little integration leading to isolationism, NIH, etc. on the one hand and too much leading to a condition of 'insulation' - inability to react to stimuli for change - on the other, needs to be struck.

(iv) Organisation Level Problems: Here the mismatching will relate to major variables like strategy and structure. Since organisations are purposive systems, they do not simply evolve, but are, to some extent, created. The questions raised here are whether the resultant organisation adequately fits the contingencies in which it finds itself - and whether it adapts successfully to meet changes in these over time.

Structural conflicts may emerge because what has evolved from past history is no longer tenable. An example of structural ambiguity might be the Research/Process Development split, where two similar functions are grouped under different line responsibilites. All the different orientations, strategic views, political allegiances etc. derived from two different line structures act to set the groups in opposition to each other.

Another common structural issue relates to the level of delegation and of participation and to the overall problem of control. Whilst there is strong feeling about hierarchical gaps between levels there appears to be a reluctance to take on participative responsibility.

Dissatisfaction with the vertical interfaces is extensive and could be interpreted as providing evidence for a major shift in attitudes towards organisation. Whereas before people were happy to belong to a paternalistic, authority-based organisation in which their role, task and responsibility was clearly defined, there is a growing demand for much more flexibility.

Control seems to be too distant and based on the wrong principles. How can senior management really know what's going on at operational levels? Why should professional specialists respect authority for its own sake as a control principle? Why should decision-making and strategic planning be carried out at levels far too distant from the actual operations? How can we continue to commit ourselves to a system which is no longer suited to the demands of the situation and which is consistently failing?

(v) Organisation/Environment Problems: at this level the pattern reflects a growing inability to cope successfully with a rapidly changing and uncertain outside world. Problems are not confined to technical and marketing ones only: a growing range of factors come into consideration and the rate of increase in complexity is considerably faster than that of internal adaptation to cope with it.

To borrow a current phrase, the organisation is showing symptoms of 'future shock'.

Innovation was traditionally linked to the market place and simple, causal relationships appeared to govern what went on. New technology developed via close links with customers and was based on providing excellent service in meeting their needs. However it is no longer possible to relate to the environment in this fashion; the market place has become bigger and more complex and contains competitors to add to the uncertainty. Expansion into overseas markets introduce another weak link in the coupling by involving another marketing group (Basle) to handle the work. The organisation begins to lose its clear role: it becomes too small to keep up with the giant firms whose leadership is based on economies of scale and too big to react as quickly as the small firms whose position is based on flexibility and speed.

Other problems such as legislation on ecology coupled with changing public opinion put increasing pressure on innovation patterns.

Technology has to take account of energy costs, labour costs, the problem of raising investment capital for process innovation etc.

Underneath these accelerating changes are the other societal changes which results from education and exposure to the media. People have radically different expectations and needs and these are growing less congruent with the principles upon which organisations have operated hitherto. Demands for participation, involvement, industrial democracy, the right to design and control one's own job are all typical examples of this trend.

Faced with problems of this kind, it is argued that there is again a need for the organisation to integrate itself with the environment. This is likely to be achieved by internal differentiation, but this will itself cause problems of the kinds discussed earlier.

Questions of this kind were common in the research data and indicate the extent of unhappiness with the existing organisation. Morale is low enough to be causing high level concern and the consequence is a corporate ehtos reluctant to take risks. The feeling is compounded by a strong awareness of the political climate at high levels (real or imagined) and of the general lack of openness or trust between groups within the organisation.

The integration problem seems to be a corporate alienation: 'the thing has got too big and it's lost all meaning. A lumbering giant, too slow and too specialised, weighed down with bureaucratic procedures. Communications are distorted because the lines are too long; those responsible at the top don't seem to know what's going on elsewhere in the organisation. Management style is out of date and people are still treated as pairs of hands rather than able to make a creative contribution. And if you leave no-one seems at all bothered. How can you have confidence in something as big and indifferent as that?'

(There is implicit in this an interesting reflection on the stage of integration within the company where people talk of 'us and them' although they belong to the same organisation. It is suggested that there is strong identification of the 'corporate ethos' with a few key individuals who are seen as leaders. The state of disintegration is thus between these opinion leaders and the people who believe they have lost touch with what's going on).

Contrast this with the highly flexible and integrated state of a small company, and many of these problems can be seen to relate to size. Arguably the various elements of structure - control, specialisation, differentiation etc. - are not sufficiently well-adapted to the demands of the current situation.

Apparently there is a need for delegation, for increased autonomy, for control by knowledge rather than authority, for management by exception of self-regulating systems, for greater input to strategy and planning by operation levels and so on. The gaps between what exists, what people want, and what will best suit the current situation need to be bridged.

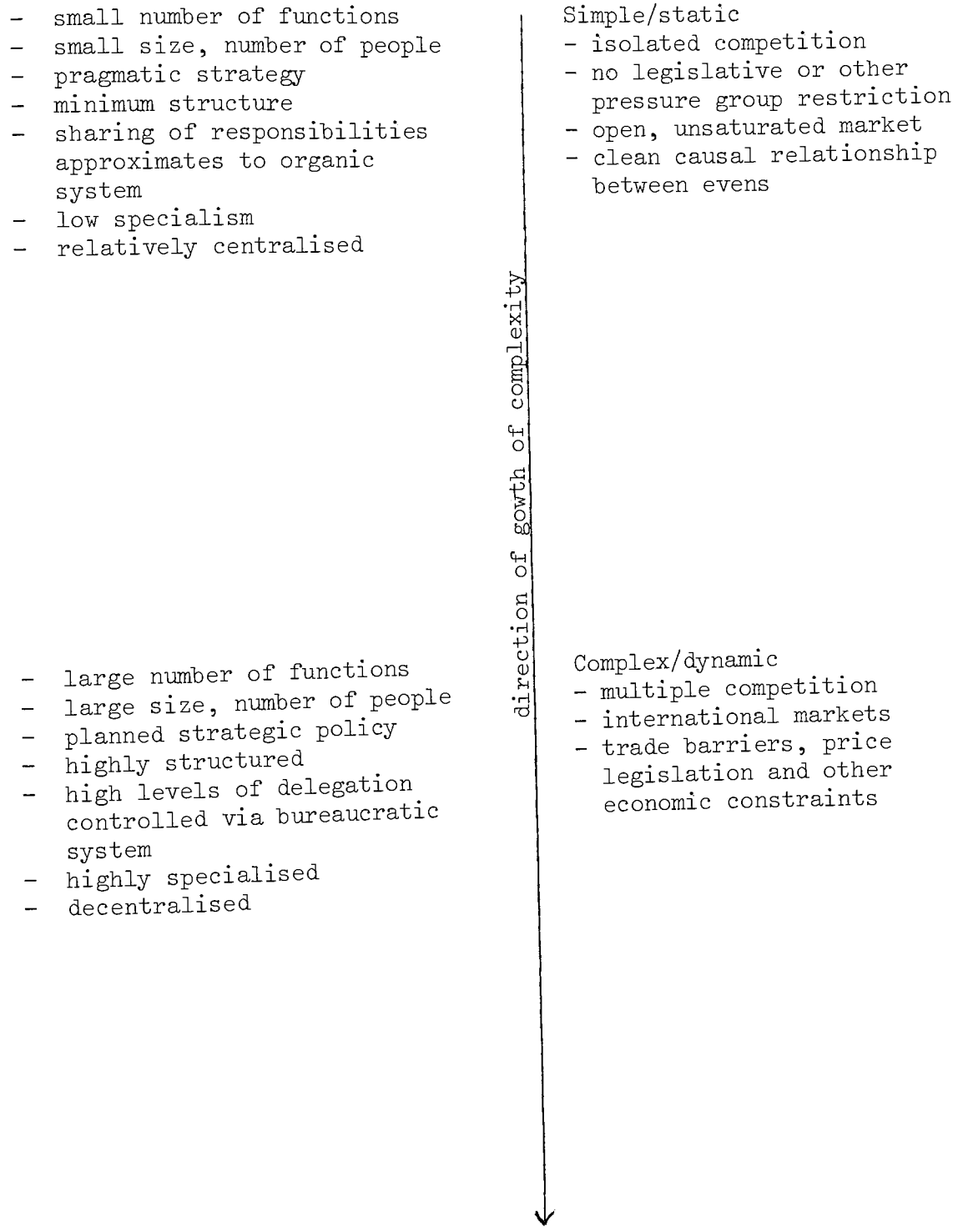
If the preceding argument holds and we can class innovation problems as relating in some way to integration needs, then we must develop an understanding of the concept itself.

The dictionary definition is 'to make up as a whole': if we think of a system of interrelated elements, then integration is the organising principle. On this basis, it will be the determinant of whether organisations grow successfully or not.

As organisations change in size, technology, wealth, diversity etc., and as the world outside changes, so there will be an accompanying increase in complexity. By complexity we are really talking about a growing number of potential sources of variation.

Duncan (1972) defines complexity in terms of an index, $I = F \times C^2$ where F is the number of decision factors and C the number of components (i.e. a measure of similarity and dissimilarity). Other writers (e.g. Glueck 1977) talk of 'volatility' as an index of the environmental quality which determines structure. It is argued that these are all expressions of the same thing: the number of potential sources of variation and their rate of change.

EXHIBIT 4 : Environmental Complexity and organisational response



This model can also be realted to Duncan's (1972) dimensions of environmental state.

EXHIBIT 4 : Dimensions of environmental stage (Duncan 1972)

	Simple	Complex
Static	low perceived uncertainty (1) small no. of factors and components in the environment (2) factors and components are somewhat similar to one another (3) factors and components remain basically the same and are not changing	moderately low perceived uncertainty (1) large no. of factors and components in the environment (2) factors and components are <u>not</u> similar to one another (3) factors and components remain basically the same
Dynamic	moderately high perceived uncertainty (1) small no. of factors and components in the environment (2) factors and components are somewhat similar to one another (3) factors and components of the environment are in a continual process of change	high perceived uncertainty (1) large number of factors and components (2) factors and components not similar (3) factors and components in a continual process of change

The diagram in Exhibit 4 may help to make this clearer: a small company working in a large and unexplored market under relatively stable conditions will find few sources of variety. By contrast, companies such as that described in the case study are surrounded by an environment rich in variety; to cope with this the organisation must make itself more complex to match the needs of the dynamic outside world.

The problem of managing variety is one of the central tasks of management; there are a number of control options available. The first of these is simplification: i.e. reduce the complexity by going back to a point where everything was less complex. In practice this would mean cutting down on size, structure, organisation etc.; as a philosophy it finds expression in the so-called 'alternative technology' movement. 'Small is beautiful' (Schumacher 1974) summarises their approach. This is not just an idealist viewpoint, however: many of those interviewed during the research, particularly the older members of the organisation, spoke wistfully of the 'good old days'. 'When you knew who you were and who everybody else was, when the market made sense, when you could see where the company was going, when you could feel proud to belong.....' etc. The major reservation attached to this strategy for variety control is one of practicability: it is unlikely that many firms will dismantle themselves to achieve better integration and control over variety.

The challenge of large-scale operations with their potential economic advantages makes other strategies more attractive. Dominant amongst these is the attempt to match the complexity of the outside world with an internal differentiation. This takes place along two dimensions, horizontally and vertically. Horizontal differentiation takes the form of ever-increasing specialisation so that functions become more and more focussed and skilful: examples include marketing, research, production, engineering and the newer specialisms of industrial relations, computers, operations research etc. Arguably there is a centrifugal tendency which causes even specialisms to split e.g. 'engineering' becomes maintenance, project, safety, chemical, etc. or personnel becomes recruitment, industrial relations, management and organisation development etc. At the same time as the organisation is adapting to growing sources of variety in the environment by matching them with internal units, it is involved in delegating control. Autonomy for decision-making etc. is decentralised to the point of operation, 'near to the sharp end' so as to speed up the response time to changes and variations in the environment.

The resultant effect of this strategy is that complexity in the environment can be coped with - but only if the internal complexity so generated can be brought under control. One option, open at least on theoretical lines, is to place a manager over every source of potential variation. In analagous terms, this would be like achieving law and order by placing a policeman in charge of every citizen twenty-four hours a day: guaranteed effective but hopelessly impractical.

What is needed is some way of amplifying the control that managers have over variety, and it is to these control amplifiers that we now turn. One type is the use of rules, regulations and procedures; in the case of traffic we can see a graphic demonstration of the effectiveness of this approach. If we drove cars at random, the resultant variety would bring chaos within minutes; order is by and large achieved by the simple device of the institution of the Highway Code - a set of rules and procedures.

In the case of those activities which are routine, largely predictable, taking place under stable conditions - 'programmed' to use March and Simon's (1957) terminology - this kind of control is ideal. When the operation - for example, production - gives rise to a situation not covered 'in the book', the manager can step in and take control until the system returns to control by the book. This'management by exception and rules' approach was identified and labelled 'mechanistic' by Burns and Stalker (1961) in their pioneering work in the field of innovation (Exhibit 5).

Where this approach breaks down is when we come to processes which are not routine, take place in uncertain, unstable conditions, involve risks - 'non-programmed' activities, again using March and Simon's term. Rules fail at this point because there are too many unpredictable contingencies to plan for. Paradoxically, at the point where rules break down, the interrelated complexity of the process makes most demand upon integration for effective performance.

Technological innovation is essentially characterised by this last type of process. Writers such as Lawrence and Lorsch (1967) have demonstrated convincingly that innovative performance is directly related to integration and further, to the type of integrative mechanism used. Burns and Stalker suggest an ideal 'organic' system (described in Exhibit 5): this places extensive demands upon management to bring about the necessary structural, motivational, strategic and process changes.

If we look at the current research thinking on the nature of management (e.g. Mintzberg 1973, Stewart 1976) we find that management is essentially a fragmented activity carried out under pressure. Problem-solving is characterised by a pragmatic approach and solutions based on strategies and rules of thumb developed from previous experience. It is suggested that managers may thus find difficulty

(a) in getting close enough to form an objective and realistic diagnosis of integration problems: they are more likely to recognise and try and treat at a symptoms level only.

(b) if they do get a correct diagnosis, they will only have a limited repertoire of solution strategies not necessarily applicable to the actual contingencies. Exhibit 6 amplifies this.

For reasons of this kind, it may be that in activities like technological innovation which involve high levels of complexity, management are facing problems of integration with which they are growing less competent to deal. The evidence of the case study is cited to support this.

The traditional management response to problems outside the accepted range of competence is to delegate responsibility for their solution. This delegation takes place where prescription is no longer possible; instead management specifies the limits within which the subordinate responsible may use his discretion - a condition of 'bounded delegation'. In the short term, and in the case of isolated problems, unlikely to recur in the near future, consultants may be called in. In the long-term an internal specialism is generated to take on the task as a full-time functional activity within the organisation. What is being suggested here is that there may be a growing need for a new kind of specialist to emerge; the integrator.

Whether this task is discharged by a specialist or by a manager is a matter for debate. Early managerial response to this idea has been to argue that whilst integration skills of this kind are lacking, the task is still their responsibility and should not be delegated. Instead, attention should be paid to developing these new skills in managers at the expense of other, less-relevant skills. In either case, the outcome will still be a need for a new range of specialist skills.

Current research (Price 1978) on the likely shape and content of manager's jobs in the 1980s suggests that there will be the following type of factors to cope with:

- crises occurring requiring immediate attention.

- the unexpected happening in spite of all preparations.

- agreement having to be reached among people of widely differing interests.

- the interrelatedness of technical, financial and human considerations.

EXHIBIT 5 ; Mechanistic and Organic Systems (Burns and Stalker 1961)

Mechanistic systems are characterised by:

- the specialised differentiation of functional tasks into which the problems and tasks facing the concern as a whole are broken down.
- the abstract nature of each individual task, which is pursued with techniques and purposes more or less distinct from those of the concern as a whole.
- the reconciliation for each level in the hierarchy of these distinct performances by the immediate superiors who are also in turn responsible for seeing that each is relevant in his own special part of the main task.
- the precise definition of rights and obligations and technical methods attached to each functional role.
- hierarchic structure of control, authority and communication.
- a reinforcement of the hierarchic structure by the location of knowledge of actualities exclusively at the top of the hierarchy, where the final reconciliation of distinct tasks and assessment of relevance is made.
- a tendency for interaction between members of the concern to be vertical, i.e. superior/subordinate.
- a tendency for operations and working behaviour to be governed by the instructions and decisions issued by superiors.
- insistence on loyalty to the concern and obedience to superiors as a condition of membership.
- a greater importance and prestige attaching to internal (local) than to general (cosmopolitan) knowledge, experience and skill.

Organic systems are characterised by:

- the contributive nature of special knowledge and experience to the common task of the concern.
- the 'realistic' nature of the individual task which is seen as set by the total situation of the concern.
- the adjustment and continual re-definition of individual tasks trhough interaction with others.
- the shedding of 'responsibility' as a limited field of rights, obligations and methods. (Problems may not be posted upwards, downwards or sideways as being someone else's responsibility).

- the spread of commitment to the concern beyond any technical definition.

- a network structure of control, authority and communication. The sanctions which apply to the individual's conduct in his working role derive more from presumed community of interest with the rest of the working organisation in the survival and growth of the firm, and less from a contractual relationship between himself and a non-personal corporation, represented for him by an immediate superior.

- omniscience no longer imputed to the head of the concern: knowledge about the technical or commercial nature of the here and now task may be located anywhere in the network; this location becoming the ad hoc centre of control authority and communication.

- a lateral rather than a vertical direction of communication through the organisation, communication between people of different rank, also, resembling consultation rather than command.

- a content of communication which consists of information and advice rather than instructions and decisions.

- commitment to the concern's tasks and to the 'technological ethos' of material progress and expansion is more highly valued than loyalty and obedience.

- importance and prestige attach to affiliations and expertise valid in the industrial and technical and commercial milieux external to the firm.

EXHIBIT 6 : Possible Limitations on Effective Management Response to Integration Problems

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- too far removed from some problems to get adequate feedback - they get a distorted story if they get one at all.

- too close to some problems to be able to evaluate objectively the issues or the best response to them.

- too far removed from operational levels to enable implementation and understanding of strategies aimed at reducing integration problems.

- too little time for reflection so that symptoms rather than root problems are dealt with - palliative rather than curative strategies.

Integration, as a functional specialism is recognised already in a piecemeal fashion. Most managerial job descriptions include responsibility for co-ordination at least of physical activities. Exhibit 7 indicates a range of common consultancy operations which can be viewed as supplying integration expertise. Equally, the growing demands which complexity places on integration systems are beginning to be understood. Sayles and Chandler (1971) in their study of NASA as a highly complex and uncertain system talk about the new management approaches which are needed. Particularly in large-scale organisations, there is growing emphasis on 'system' principles, with managerial attention being focussed on the interfacial relationships between systems. This leads to new kinds of managerial behaviour: instead of the traditional categories of planning, directing, controlling etc. we find things like bargaining, controntation, intervention, coaching and cajoling etc.

In giant'polyorganisations' the formal role of 'systems-integration contractor' already exists: this appears to be similar to project management, but on a much larger scale. Notably this task is usually performed by an outsider to the organisation: it certainly requires specialised skills. As Sayles and Chandler put it

'.....integration management is not a phenomenon unique to advanced technologies. It is part of the larger problem of exerting control and influence at a distance and without authority. Such problems are becoming increasingly typical of the modern social world in which a high degree of interdependence is combined with demands for autonomy and organisational and professional freedom'.

EXHIBIT 7 : Typical Consultancy Operations viewed as integrating mechanisms

operation	integrating activity
personnel consultancy	getting best 'fit' between needs of organisation (for skills, temperament, age etc.) and available individuals.
structural	getting best 'fit' between organisation structure and its ability to cope with the various contingencies involved.
organisation development	getting best 'fit' between members of the people sub-system - resolving conflicts, building teams, etc.
strategic planning	getting best fit between plans and policy and the contingencies in which firm is operating - and will be operating in.

As yet systems integration is largely a physical concept; the NASA example refers specifically to bringing together the various technical elements of a giant project. Nevertheless it is argued (and this extension should follow, being consistent with general system principles) that the concept can be applied equally well to the organisational and managerial systems.

Galbraith (1977) hints at the growing integrative role of managers in his work on organisation design. As he puts it:

'What factors can the organisation change so as to create a distribution of power and influence in order to arrive at high-quality decisions? Very briefly, the organisation

(1) creates a new role and

(2) designs enough power and influence into it to bring about high quality joint decisions'.

He is specifically concerned with decision-making under increasing uncertainty and in highly-differentiated organisations. His new role is characterised in the following way:

'The managers who occupy these roles do not supervise any of the actual work. Instead they assist those who do, so that the work is co-ordinated in the best interest of the organisation. <u>This is the general manager's job but he does not have the time when the organisation tasks become diverse and uncertain</u> (researcher's emphasis).

The integrator becomes a little general manager with respect to the particular decision process for which he is responsible'.

A growing number of management writers (e.g. Miles (1975, Glueck (1977)) are emphasising the integration role as an increasing component in the field.

What is being proposed in this research is the development of integration skills into a full-time task specialism for use in medium and large industries. (This specialism will be concerned with the entire organisation and its relevant subsystems, thus embracing Galbraith's'little general managers' and Sayles and Chandler's integration contractors.

Arguably this sector of industry is experiencing problems which used to be the province of giant organisations.

What is proposed here is a development of integration skills into a full-time task specialism for use in medium-sized industries. Arguably this sector is experiencing problems which used to be the province of giant organisations only, and which are arising out of growing internal complexity as the dominant response to external complexity. In Sayles and Chandler's terms, 'systems integration is a core function of the organisation engaged in developing advanced technologies': it is very necessary to the innovation process of the future.

The task of the integrator is complex, but based on the simple goal of building confidence in an organisation's functioning, level by level. He will be concerned initially with diagnostic activities, typified by questions like

- what is functioning at a high level of confidence already?

- what needs improvement?

- are all significant subsystem interfaces identified and properly defined?

His system interest will not be confined to task activities: political, cultural, personal, economic and other sub-systems will be studied to gain a truly contextual view of the total system dynamics. The 'neutral' role of the integrator is important here: he must be able to collect data from all sources and be free to come and go in all areas, accepted with a high level of trust by all concerned.

Thus if he is seen as grinding any particular axe, he will lose credibility (and thus information sources). Outsiders have this advantage, but for effective integration, the specialist needs to be fully participant in the organisation, aware of its dynamics and its changing character. So there is a very difficult role to be filled in being 'in the world yet not of it'. As Sayles and Chandler suggest, 'the integration contractor must possess an unusual set of technical and managerial qualifications'.

Interpretation of data will require high levels of skill in analysing from an organisational viewpoint, allied to an appreciation of the context in which it all takes place. The reality of this must be tested by feeding back to the organisation: a process of mutual education takes place where both sides become more aware of the reality of the problems.

Development of improvement strategies should also be a co-operative activity. The specialist will have expert knowledge (or know where to get it) on the current techniques and packages for improving aspects of integration. But he will also be aware of the problems of 'tailoring' them to suit the real situation; thus he will involve participants in the design of their own solutions where possible. In doing so he acts more as a facilitator than a change authority, and simultaneously strengthens his own credibility and improves the chances of successful 'normative' change (Bennis 1969).

Implementation should be a similar co-operative activity; people should be more willing to change if they have been involved in the design of those changes (Mumford 1976). Finally, the whole operation should be structured on a dynamic, cyclic basis so that the end point (implementation of one change effort becomes the starting point for the next.

That represents a simple view of the integrator; in practice many problems need to be anticipated. Exhibit 8 summarises the activity cycle of the specialist, and indicates guidelines for execution of the task.

Henderson and Horsley (1978) discuss the commissioning of two large chemical plants within I.C.I.'s agricultural division. This activity involves a number of specialist groups in a high pressure complex innovative project: we would expect integration to be a major problem issue here. They discuss the use of internal consultants with a variety of integrating skills as members of the project team:

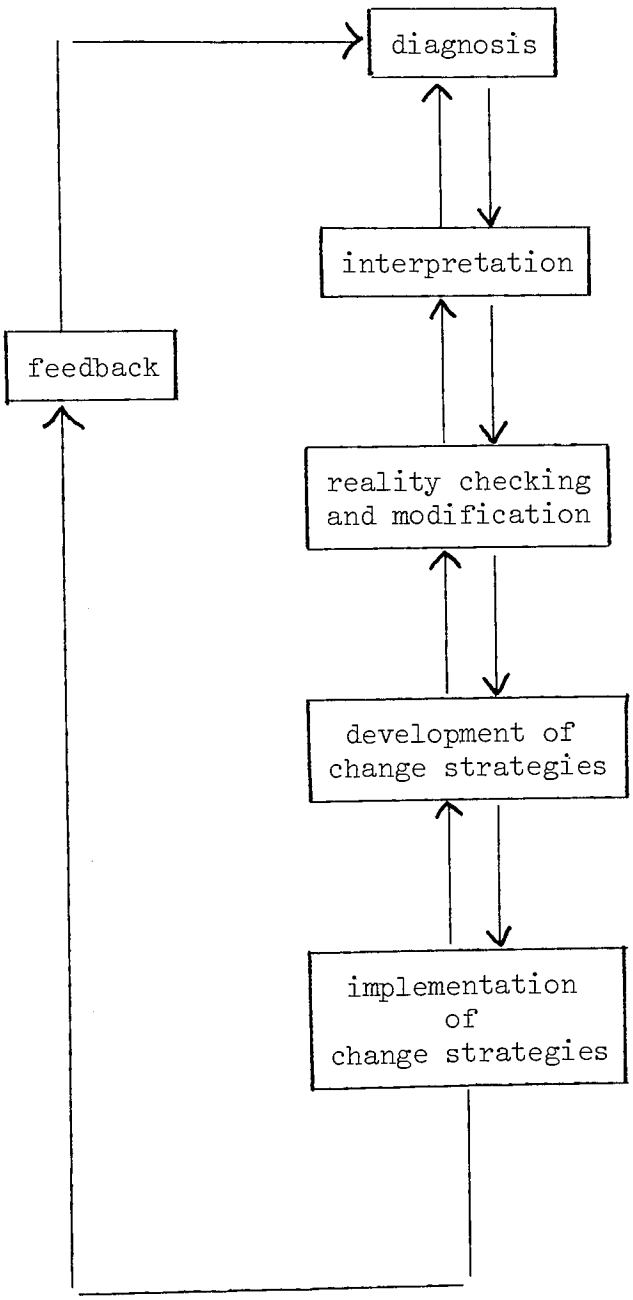
'As far as we were concerned, they just had another important technology to contribute to the group'.

They report that both projects were commissioned quickly and efficiently and that the incidence of after-start-up problems was lower than normal: on the basis of this experience they propose to use the technique in future. Integration specialism emerging as a normal procedure in innovation?

Exhibit 9 suggests how this capability might relate to the existing management metasystem.

EXHIBIT 8 : Integration Specialist Activity

(i) activity cycle



(ii) general characteristics

(a) he will be internally based, part of the system which he is involved in changing. One of the major criticisms of many consultancy operations is that they diagnose and implement without an awareness of the history and other contextual dynamics associated with an organisation.

(b) he will not confine his activities to structural changes or to organisational development of the people sub-system or to strategy or whatever but will instead operate a wide range of relevant integrating mechanisms, including all of these.

(c) he will be task-orientated, in that his brief is to improve the efficiency and effectiveness of the organisation; however, implicit in his approach will be the belief that major contributions to this can be made by having a high people orientation in the activities used.

(d) his approach will be based upon the principle of catalytic intervention. In other words he will facilitate rather than make changes; to do this successfully requires the involvement of members of the organisation in design and implementation.

(e) he will be concerned with improving overall task performance and thus his integration activities will be based on real working situations rather than on exercises. Emphasis will be on learning by doing, not watching, active experience rather than passive 'absorption'. Integration strategies will be purposive and task-oriented.

(iii) problem anticipation

(a) acceptance - getting into the organisation is a crucial step, staying there is another! Technical competence appears a useful aid in reassuring people, although other roles may be of value. 'Diplomatic professionalism' is the main requirement, so 'know-it-all' technical skills will not help. The specialist needs to be all things to all men and able to switch roles quickly. He also needs to strike a careful balance between passive acceptance and observation and aggressive activtiy aimed at cracking particularly hard shells or 'unfreezing' particularly stiff elements of the organisation.

'What's in it for me?' will be a standard response from members of the organisation. Why should he co-operate when it appears that the outcome will simply be to expose problems and perhaps make his own position less secure? Developing goodwill relationships, doing or facilitating favours for others, 'bending the rules', fulfilling other task needs etc. are all strategies aimed at showing the willingness of the integrator to help. This will help acceptance in the short term; hopefully the improvements arising from the integration strategy will do so in the long term.

(b) data collection - ability to penetrate all aspects of formal and informal organisation is vital; in this way the integrator resembles a journalist or social-science researcher. Where data is not offered or easily accessible, he must attempt to find out by other means; where it is generally accepted opinion, he must seek out original sources.

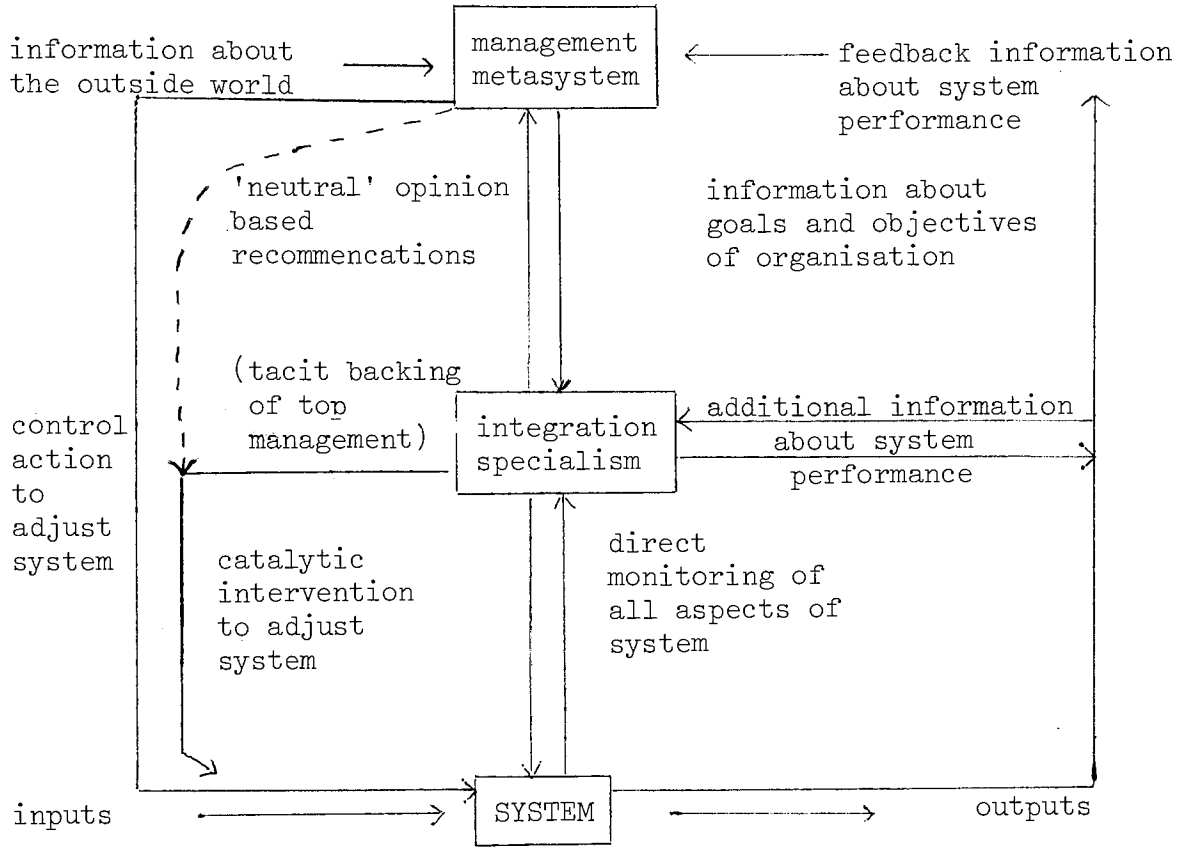
(c) interpretation - by interacting with the organisation in developing understanding of the data it is possible to secure co-operation for implementing improvements. One technique is to make visible as many problem issues as possible; everyone then knows about them and they can be discussed openly. For some individuals this may represent a subtle form of pressure to change: for others it may provide support to know that they are not the only ones worried about certain problems. In either case, there will be a change potential arising out of it.

Facts, however, do not always speak for themselves and the interpretation role may be more of a salesman or a missionary one, where the integrator is trying to achieve commitment to a central line.

(d) development of strategies - again, the interactive process can be used to help the integrator. By using internally developed strategies and informal procedures which may bend the rules and 'work around' obstacles in the system, he will gain insight into the most applicable methods. He can add to or modify these with external techniques, if necessary.

(e) implementation of strategies - if interactive and involved design was used, there should be enthusiasm and motivation for change. On occasions though, it will be necessary to use more pressure to gain implementation. Marketing approaches may help - so he needs to be a skilled salesman. Authority approaches will get the job done, but may damage his credibility or acceptability; best of all, an authority figure at high level as 'patron' will give him power without its formal status. It is likely that real authority can never be assigned in a task of this kind but only earned on the basis of success.

EXHIBIT 9 : The Management Meta-System incorporating integration specialism



- resources
  people
  money
  time
  skills
  materials
  etc.

- innovative ideas
- new products
- new plant
- new processes
- new services
  etc.

Section 4 : Integration Strategies: Some Field Observations

If the concept of integration as a specialism is acceptable, then we need to examine how specific strategies might be developed. The description of the integrator in the preceding section offered some prescriptive suggestions. However, the research project discussed in this thesis was of the 'action research' type, and some attempts at facilitating changes towards better integration were made. The experiences of these crude field attempts are offered here as information of a different kind about the integrator's task.

Acceptance was the first stage in the process; role was defined loosely or innocuously. ('a student looking at how industry works'). The technical background of the researcher also helped, especially in being able to 'talk the language' and to help out in real ways. Great effort was put into developing working relationships during the early months.

In a formal sense the project was always viewed as a potential intervention; the objectives were: 'to monitor activities connected with the development and introduction of specified new technology, to carry out relevant observations and surveys, to study and propose alternative courses of action, to assist the members of management so involved and, ultimately, to report on the utility or otherwise of available knowledge, techniques and models'.

However, the informal awareness of the change potential of the project took longer to emerge: most early work was based on simple data collection by observation. Gradually feedback of perceptions refined the researcher's own view and, at the same time clarified his role for members of the organisation. By the time of the third monthly meeting, there were a general set of improvement objectives which people felt the researcher could contribute to. These were that effective performance could be enhanced with improvement in awareness of self, of others, of the role of the group, etc. More colloquially, this task became 'finding out soul'.

Early activity centred around the concept of mirroring the organisation as seen by the researcher; this remained a dominant approach throughout the project. Marlow (1975) describes the process:-

'Many of the devices which are used for taking the temperature of an organisation rely for their success on the mirror principle: they reflect back to the participants a picture of the siutation as it is seen from inside and outside the organisation. Those within the organisation will have their assumptions and beliefs as to their own strengths and weaknesses. The first part of the learning process is the ability to view without too much anxiety the story that the mirror tells without the usual distortion caused by familiarity with the situation'.

The approach became popular as the researcher became more trusted: as one manager put it, it was almost the answer to Burns' prayer:

'O wad some Pow'r the giftie gie us
To see oursels as others see us!'

An early example of the effectiveness of this approach was seen in the resolution of a major style conflict involving the departmental manager. The department was relatively newly-formed and there was extensive dissatisfaction and lack of confidence about the leadership. Most criticism centred on his 'outsider' status - he had not come up through the company ranks, he was a chemical engineer (a new discipline on site) and his style was essentially different from the dominant organisational approach. He adopted a 'separated' style (to use Reddin's terminology (1970)) encouraging subordinates to use initiative and take decision-making responsibility. This conflicted strongly with the expectation of the stereotyped paternalistic approach, and was viewed as uncommunicative, indecisive and poor leadership style. Even formal attempts at involvement like a regular section leader's meeting did not seem to bridge the gap between expected and actual style.

Discussion of this mismatch, making use of the mirroring and interpreting functions, led to resolution. (It is interesting here to note that one of the interpreting aids an integrator might use is to translate the problem into a more easily understood language. In this case, whilst people found it hard to express what they expected of 'leadership style' the language of simple transactional analysis (parent, adult, child modes of interaction) made it easier to discuss. As one individual put it, 'now I see that what he (the leader) wants is to give us kinds long trousers so he can stop playing Daddy and we can get the job done as a couple of adults might'). Better understanding of the facts facilitated changes in expectation and behaviour by both sides of the interface.

Growing out of activities of this kind was a new climate of openness and critical introspection in which is was legitimate - even encouraged - to examine problems constructively and suggest solutions. Negative consequences usually associated with 'troublemaking' of this kind did not materialise, and thus levels of trust between individuals developed; with this came a greater self-awareness and self-confidence. This ability to examine and analyse 'warts and all' carried over into the research reports which were circulated outside the department. Early comment tended to be manipulative seeing the issues as more political ammunition but this fell off as the positive benefits of the approach became clearer.

Within the department, the move towards closer integration was not a painless process. In the second quarterly report, for example, the content was critical of structure and style - mirroring genuine concerns within the group. Responses at the lower levels were very positive; 'this is saying all the things I've wanted said for a long time'. At higher levels there was considerable hostility shown; the publication of facts which were 'home truths' in some cases made positions harder to defend.

Interest increased as a consequence of these activities and the researcher became used as an auxiliary communication channel through which people could freely transmit points of view, criticisms, justifications etc. without risk of being identified. Development of a more open climate meant that direct approaches could be made and the channel was less frequently used. (Exhibit 10 quotes from an early report in which the use of this channel was described; in part this was intended as an advertisement, inviting others to use this facility).

EXHIBIT 10 : Extract from an early report 'advertising' the use of an alternative communication channel.

'In addition to those channels normally used within the department, there is a growing element of communication via the research project. Because of its central, objective position, it is perceived as a suitable route for handling communication of a predominantly informal abstract and often sensitive nature - opinions, feelings, reactions etc. - and this process may involve both horizontal and vertical interaction. The 'depersonalisation' of the information input allows for a more objective respons from the recipient and, by virtue of the two-way process involved, helps to develop a better mutual understanding within the department.

In addition to this, there is a general tendency to reticence in formal communication situations: whether from motives of insecurity, shyness, lack of information, status or whatever, people are reluctant to say what they would probably express more freely in an informal, relaxed situation. Thus the existence of an alternative channel provides a 'mouthpiece' for the non-assertive and may help towards the solution of previously unvoiced (and therefore unperceived?) problems.

The increase in use of this facility appears to stem from a direct association between the input information and perceived changes within the department: the channel is <u>seen</u> to be effective, and growing trust makes subsequent usage a simpler and more direct process'.

Structural problems were also prominent: the general feeling was that whilst the 'old order' was not particularly well-adapted to cope with dynamic environments, high in complexity and uncertainty, there was no clear indication of how things might otherwise by organised. The 'organic' system of Burns and Stalker (1961) was a fine ideal: 'such a structure is adapted to unstable conditions, when problems and requirements for action arise which cannot be broken down and distributed among specialist roles within a clearly defined hierarchy. Individuals have to perform their special tasks in the light of their knowledge of the tasks of the firm as a whole. Jobs lose much of their formal definition in terms of methods, duties and powers, which have to be redefined continually by interaction with others participating in a task. Interaction runs laterally as much as vertically. Communication between people of different ranks tends to resemble lateral communication rather than vertical command. Omniscience can no longer be imputed to the head of the concern'.

However, how to realise this in practical terms, applicable to the various contingencies associated with the group was a different matter. Potential for change was apparent. In participation: 'what is required is both a willingness to delegate authority and a willingness to responsibly accept it'. In style, both leadership and task-related. In organisational attitudes to risk-taking - and so on.

In general, the feeling was that a system associated more with high levels of local autonomy and self-control based on information and less directly structured or controlled was a desirable goal.

Stage (1)

Introduction

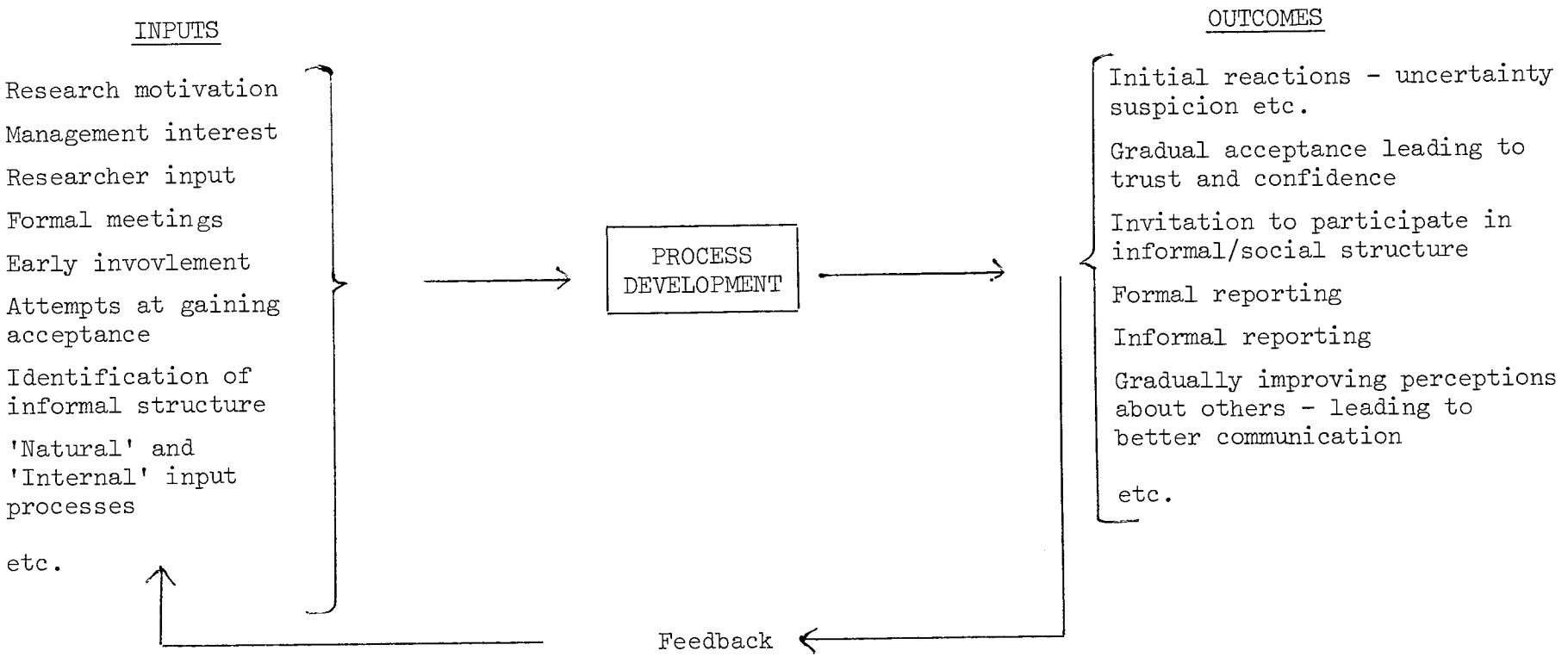
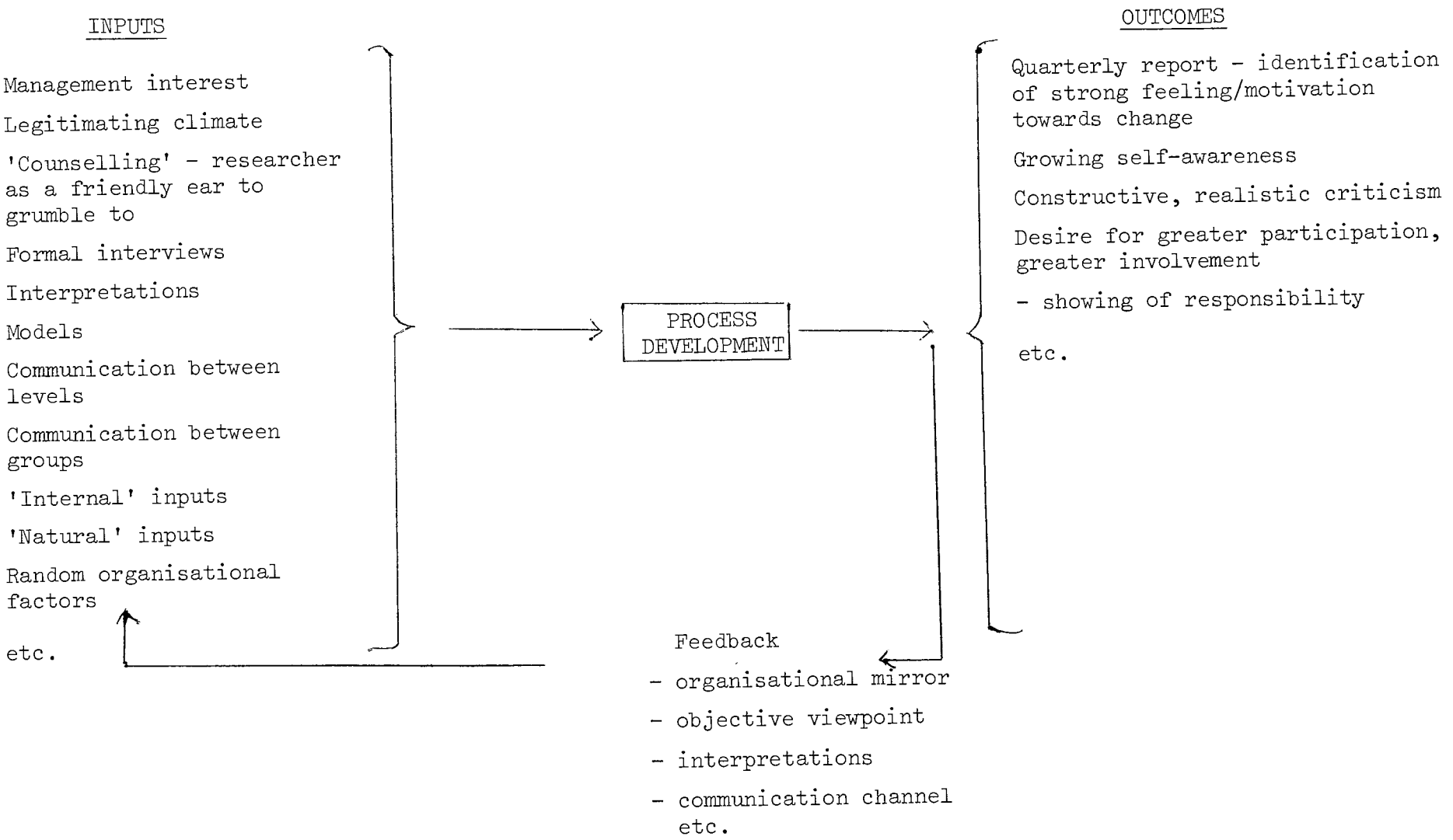


EXHIBIT 11

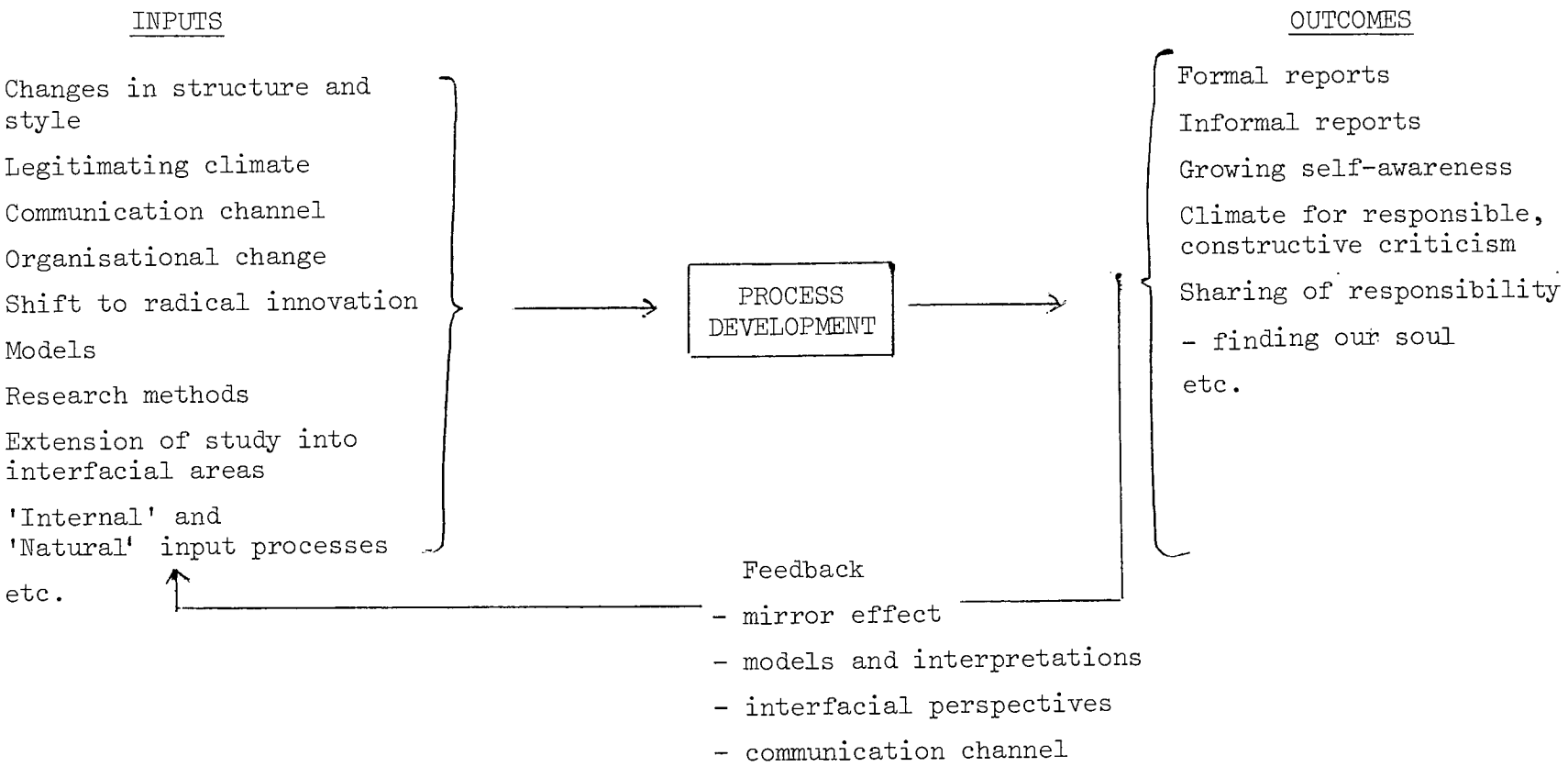
Stage (2)

Development



Stage (3)

Creative Interchange



Here the limitations of the integrator role as vested in the researcher can be seen: the catalytic effects of knowledge and self-knowledge were apparent in generating a change potential. However, there was not sufficient authority and power associated with the researcher - or with the departmental manager as an enthusiastic and influential 'promoter' - to carry through much in the way of a structurally based improvement strategy.

Small changes in structure were made when opportunity arose - as when people left or task demands changed. In this way a better match between many individuals and the kind of job they wanted to do was brought about. Reshuffles amongst task groups also opened up cliques and thus broke down more interfacial barriers - increased contact between different types of specialist.

A mood of 'cautious optimism' was reported later in that first year; people began to feel that changes could be brought about, that they could influence those changes, and that things improved as a result. Perhaps you could beat the system after all - by changing it yourself.

A report published at this time made the researcher's integration strategy explicit. Exhibit 11 presents some diagrammatic extracts from this. In particular, the philosophy was expressed by:

(a) 'the reaction to an input is proportional to the 'disturbance' it introduces: the degree of uncertainty which any input brings will affect the chances of its being adopted. Inputs represent change and change is most assimilable in incremental form.

(b) inputs have most chance of productive survival if they evolve from within and adapt to meet real needs of the organisation. The role of change agent should be catalytic rather than direct, encouraging the organisation to change itself and facilitating that process, where necessary'.

Expansion of the research into other areas made new interfaces accessible; studies of strategic decision-making by senior management helped in developing an understanding of the role and contribution of the department in terms of the whole organisation. Once again, variations in perceptions across the interface were mirrored as a starting point for activities aimed at closing the gap.

The next major activity was the assessment experiment; for some time one of the limiting factors in the research had been the absence of any kind of 'objective' evaluation of change. In particular, the relevant dimensions of behaviour were not clearly identified: it was generally accepted that some members of the group were better performers than others - but along what scales and in what respects was unclear.

An experiment was designed, aimed at providing a crude introduction to this area of interest. Arguably the best way to find out how an individual performed would be to ask his colleagues: collectively this information would provide a measure of the department's performance. Objective measures like how well it kept within budget, or how many new products/processes were introduced did not explain how the department functioned as a unit.

The subjective perceptions of those involved would provide a useful 'map' of the behavioural factors involved.

In addition to the observational value of this exercise it had a strong potential for change. The very activity of disclosing very confidential opinions about others even through a neutral third party required a high level of trust and openness. To this was allied an almost unanimous request for feedback: individuals wanted to know how they rated in others' eyes. Group norms could be identified from the average scores and group values from what factors were held to be important.

The measure itself is described in the methodology section: the important element in it was the choice of behavioural factors which were generally held to be significant in effective performance. These were:

- leadership
- communication
- interpersonal skills
- informal contribution
- task skills
- self motivation
- ability to motivate others
- innovativeness
- decisiveness
- co-operativeness
- delegation

Both the categories and the scale can be extensively criticised: it is stressed that the experiment was only a crude first attempt. However interest shown in it was so strong that it was made the central subject of the fifth quarterly report. Comments on how to imp ve the method were an indicator of interest in designing the next technique by those involved.

In general the method was felt to be a good first approximation to trying to identify strong and weak points in the department. By showing the gap between what was desired and what actually took place, development strategies could be worked out aimed at improving poor performance.

It was a useful integration aid insofar as certain individuals who might not have been aware of their 'faults' as perceived by others, received information to this effect in a non-threatening fashion. As far as possible when giving feedback the researcher tried to be conscious of 'rules' such as those specified by NTL in their organisation development activities (Filley 1977) i.e. feedback should be:

descriptive rather than judgemental
specific rather than general
deal with things that can be changed
given when accuracy can be checked by others
not based on personal criteria

Significant changes in some individual's behaviour were noted after receiving this information; they were making an effort to improve their 'scores'.

The report was widely discussed outside the department and had the added effect of legitimating research activity in other areas. It showed how far the climate in Process Development had developed in terms of openness and confidence; many people outside the department expressed the view that 'you'd never be able to that in this department - people would be too frightened of the results and of what others outside would think'.

A teach-in for members of the T.C.G. was held in February when the assessment procedure was still going on. On hearing details of the proposed strategy other departmental managers expressed considerable interest in the technique and were keen to see it applied in their own area. (The time constraints on the project unfortunately prevented this taking place). Their comments on the assessments as reported were equally enthusiastic e.g. 'this type of survey is very interesting in the results which are forthcoming. As a Manager I would find this sort of information very valuable in my own department but at the saem time I think it can only be handled by some external organisation or person such as yourself (i.e. the researcher). Reactions and interpretations placed on individuals by other individuals in the same group serve very well to point out anomalies within the group and areas where specific remedial action may be necessary'.

The general feeling expressed also criticised two aspects of the research:-

- the tendency to be inward-looking by focussing on one department only.

- the lack of clearly defined relationship between the aspects of individual, group and organisational behaviour and the process of technological innovation.

With regard to the latter, it was the intention of the project to highlight the behavioural issues involved and to suggest that successful technological innovation could only continue to take place where there was accompanying adaptation of structure, strategy, values, behaviour etc. This point was more explicitly brought out in later reports.

The first point was most encouraging: the original project orientation had been in Process Development only and the request from several quarters to investifate the wider organisation was welcomed as another sign of the joint 'ownership' of the research, and of interest in the results. Negotiations with the Science Research Council secured an extension of the grant enabling the wider survey to be carried out.

Intervention strategy was now aimed at the between group and organisation/group level and particular interest was shown in the interfaces between departments. One of the factors which the assessment measure had shown was that 'good' performers tended to have better relationships with outside groups - e.g. Production.

The effect of reputation appeared to have disproportionate significance; the less contact between assessor and assessed, the greater the influence of reputation.

Production was the first area to be studied since it was felt that the problem of getting new technology into production was one which was particularly dependent on co-operative working relationships. Research was conducted from this point of view: internal Production problems were not discussed because of time pressures, and instead attention was focussed on those activities such as plant trials which involved both groups.

The central strategy used was that of mirroring: it had quickly become apparent that the major problem involved was a conflict between two groups with radically different frames of reference. Critical incident data about the best and worst transfer of products/processes was assembled to try and identify the determinanets of successful technology introduction. Assessments were used again on both sides of the interface and in addition a pegboard device (described in the methodology section) was introduced. This was another very crude measuring attempt aimed at identifying the priority which Production people to some critical behaviour dimensions in new technology introduction.

A combination of these techniques, allied with interviews and discussions generated the material for the sixth quarterly report. This attempted to summarise the differential viewpoints by presenting problem statements side by side (see case study section).

In this way it was possible to show both groups as concerned about the same issues and to indicate that these statements were largely symptoms of deeper conflicts between the two areas.

An important feature of this report was that, in addition to the mirroring input, it also listed a whole range of solutions. These were aimed at specific and general issues, at symptoms and at underlying causes, intended as palliatives and as cures: most significantly the bulk of these suggestions arose from within the organisation. Exhibit 12 presents this list.

Responses to this report were favourable; it was felt that a contribution could be made to improving innovation effectiveness by the application of this kind of strategy. The actual adoption of inputs was difficult however; some ideas were impractical and in some areas there was strong resistance to change. Interest was shown at high levels however and closer discussion with those involved revealed the concern felt about some of the issues raised.

In particular it was pointed out that many of the suggested inputs had already been tried without success: this bears out the contention that applicability is an important element in the design of integration aids - it is likely that the reason for the failure of the inputs was due to their unsuitability for the problem involved.

The time constraints on the research prevented any activity beyond mirroring from being implemented, so the emphasis was placed on trying to stimulate input suggestions and their implementation.

EXHIBIT 12 : Reconciling the Two Viewpoints

Although the preceding sections have centred on the problems involved, innovation does take place and is often a smooth and efficient process. In fact a closer look at Table 1 will show that many of the major issues are cited by both sides as being important restricting forces, which supports the idea that the root cause is in the gap between two specialist worlds. Knowing what these problem areas are, and how both sides feel about them is the first step towards solving them effectively.

Most of the issues raised reduce down to a particular need - for co-ordination, communication, involvement, motivation etc. - which suggests that people are already aware that they are working towards a common goal and that they are looking for ways of doing this more effectively. Activities aimed at meeting this need already exist but it is obvious that these need to be increased in number and application, particularly to lower levels.

An example might be the Technical Co-ordination Group involving departmental heads. Within its membership and at senior level there is a feeling that this group is effective, particularly in co-ordinating planning efforts. A consequence of the small membership is that they can also resolve many day-to-day problems in an informal fashion - which helps to develop further trust and confidence within the group. The problem is that this group involves a few people at a high management level and, however efficient and valuable it may be, it is not seen as relating to lower levels - as the comments in Table 1 underline. Information flow and, more importantly, the sense of involved co-operation are seen as restricted to the T.C.G./Meeting III groups whereas the need for such contact is expressed strongly at other levels.

In the final analysis, the important issues are those of trust, openness confidence etc. but these are not built up overnight. Rather, they are the consequence of developing long-term relationships on both a formal and an informal basis - and only under these conditions can problems be openly confronted and solved. In Tables 2 and 3 some suggestions as to inputs to assist in this process are given: the lists are by no means complete and the real need is for continued addition to and development of these ideas.

Ways of improving the innovation interface between Process Development and Production (as suggested by members of the above groups).

- use of co-ordination groups like T.C.G. at lower levels.
- involvement of Production people in Process Development pre-transfer work and Process Development people in Production post-transfer work.
- setting up more project teams with wider and longer-term responsibility than for a single transfer into production.
- Production people getting involved in making pilot plant batches alongside Process Development people to get an idea of a new product or process before it officially comes to production.
- more consultation between Production and Process Development before and after handover. Making available of broader information background to new products and processes as well as providing more detailed specifications (perhaps prepared jointly) for the actual handover.
- wider and less restricted circulation of information about co-ordinating activities e.g. Meeting III, T.C.G. Minutes.
- longer-term broadening of people's outlook by seconding them to work in different areas and thus build up an understanding of different pressures etc.
- appointment of plant technicians to provide someone with a technical background and responsibility for Process Development to relate to.
- preparation of 'potted history' type information rather than the full T.P.R. for Production.
- longer-term feedback to Production about the outcome of transfers - e.g. 6 months to year afterwards.
- informal activities across the site aimed at bringing groups closer - e.g. social club, bridge, cricket, etc.
- appointment of 'innovation specialists' in Production whose task is to develop equipment, products and processes in conjunction with Research and Development i.e. someone with the time and without the direct pressures who still has the background to provide effective liaison between the groups.

Other Inputs to Help Improve the Innovation Process at Interfaces

- mirroring - providing an unbiased view of both sides of the situation (as in this report) so as to open up the subject for discussion. Let each side see themselves as they are seen by the others.

- legitimation - providing a climate in which people feel it is safe and good to make constructive criticism of the way things are done.

- confrontation meeting - bring representatives of both sides and all levels into contact around a table. Firstly clarify the issues involved so that the real problems can be seen and then, when everyone agrees on the priority difficulties, use the group to generate solutions.

- team-building exercises aimed at generating a broad experience of different areas.

- assessment and other evaluation devices - aimed at measuring the priorities for change, and providing information to one group about what the other group sees as strengths and weaknesses. These can be compared with self-assessments of strength and weaknesses to see if the group really is aware of how it appears and behaves towards others.

- formal training inputs, e.g. sales training
  creativity training
  organisation development
  understanding of group behaviour
  " " leadership
  " " communication
  " " effective meetings
  etc.

In the seventh quarterly report this principle was carried forward to relate to the whole organisation. The results of the creativity audit (see methodology) were published and discussed at length. This was a useful piece of information since it offered a comparison with a national sample of companies and thus indicated specific problems peculiar to the Pigments Division. Once again the problem discussion was followed by a list of input suggestions: these are reproduced in Exhibit 13.

One of the major problems which emerged across the organisation was the suggestion that senior management were unaware of many of the major problems and were doing nothing to try and ease what was perceived as a very difficult situation. On the management side it was clear that what tactics they had used had not filtered down to the operating level; there was a basic lack of integration between levels. Comments received at this stage suggested that the research project had a unique role to play in relaying information between levels aimed at clarifying the problem: a confirmation of the value of the mirror function.

The final report dealt in a similar fashion to the sixth with mirroring the interfaces with Applications and Research. Input suggestions were again made in the report: these appear in Exhibit 14. Publication of this coincided with the termination of the research activities so it is impossible to gauge its impact.

EXHIBIT 13

To get from the present situation towards the ideal requires a clear identification of real problems; lack of openness, lack of trust, lack of confidence, lack of conflict resolution, lack of risk-taking - lack of what Argyris (1965) calls 'interpersonal competence'. Commitments to resolving these issues requires acknowledgement that there are no easy short-term routes to change of this kind; it can represent a direct challenge to accepted values and beliefs about the organisation itself. Progress cannot be made in quantum jumps but must build up in a stepwise fashion, beginning at senior levels and supported throughout by effective leadership.

Starting points for change can be found in studies like that reported here. Areas where frustration and dissatisfaction appear indicate that whatever is already being done is either having no effect or else is not being seen to take place. For most of the issues criticised there is a counter-criticism, e.g. 'reluctance to delegate' gets the respnse 'reluctance to accept proffered responsibility'. What is needed is to establish a climate in which joint problem-solving of these issues can take place, and where effective solutions can be devised.

As with the previous report, a number of suggested inputs are presented as possible ways of dealing with some of the problems. Consideration of and addition to this list is urgently needed if the above issues are not to further restrict the innovative performance of the division.

Suggested Inputs

- 'management could raise morale if they'd show willing to do something - everyone knows the pay policy restricts the money, but there are other ways of regarding people - it's not an excuse to stop caring'

- '.....more money, obviously! But people are not leaving just because of that - it's the frustration of never being able to influence things. What's needed is to give people more freedom to act and to take decisions - give them responsibility for projects.....'

- '.....senior management could at least show their faces on site more - it's hard to believe they know what's going on when we never see them'

- 'managers should be less parental in their attitudes - we're adults and expect to be treated like them!'

- 'managers should declare their philosophies more openly - half the trouble is that you never know what their real motives are, or whether you've got the whole story from them - so you don't feel trusted and you don't trust them'

- 'managers should explain, and if necessary justify, their actions to subordinates as well as to their bosses'

- 'there should be more involvement - in planning, in decision-making, in the general running of the department - we feel left in the dark, no-one ever asks us, but we are the department!'

- '.....assessments should include a department assessing its manager'

- 'project teams carrying the responsibility for a product right through from start to finish. These would involve people for different areas as contributors and would need to have a great deal of autonomy if they're going to succeed'

- 'more co-ordinating groups between departments. There is a need for a formal and regular meeting, but it has to be at the operational level so that it brings togehter the people actually involved in the projects it discusses'

- 'more travel to and from Wythenshawe to help promote contact between Marketing, Product Management and the rest of the division. Better still, move Wythenshawe up here'

- 'an organised programme of job rotation which will give a broader background and experience - most of the problems of interfaces are because one side don't share the other's experience - regular job rotation would help to break down these barriers and help people think more on a company-wide basis instead of just their own little group'

- 'more training and development - particularly on the non-technical side - teach people skills like 'how to sell your ideas' - even 'how to manage!'

- 'set up a special working group, not just at senior management level but made up of people from different levels and departments. This group would look at problems like those at interfaces and would work out solutions which satisfy all members (i.e. different department interests etc.) - these solutions may then be applied to the larger organisation!'

EXHIBIT 14 : Inputs Suggested in Research and Applications

- 'testing should be centralised and the chemist should have a greater involvement, at least in the screening-type of test - this would help ease the pressure on Applications and cut down the delays and frustrations to the chemist because he'd get some of his answers himself'.

- 'if company policy is to continue with patents as a high priority, then the need is for a unit to handle all patent work'.

- 'opinions and feelings of staff at all levels should be sought - not necessarily leading to 'popular' decision-making but so that people are aware of what's going on and can feel involved in the process'.

- 'need for some way of improving the information flow and briefing process in decision-making - perhaps a lower level T.C.G., involving other departments'.

- 'need for overview/review meetings with everyone involved so that people are more aware of what's going on'.

- 'very strong basic need for centralisation and rationalisation of services, like testing'.

- 'need for more development and training at all levels and not just on the technical side - and for managers to take responsibility for this'.

- 'need for closer contact between Wythenshawe and Paisley - this might come now that Applications have an R. & D. Laboratory on site - could help enormously in improving co-ordination'.

- 'informal ideas sessions to generate and collect ideas - these involve everyone and often throw up new project areas, angles of attack etc. - as well as giving people a sense of participation. The cost in time is well worth this benefit'.

- 'greater attempts to anticipate and influence market needs - the more we can do this, the less the targets will move'.

- 'joint meetings before critical events in the launching of new products - especially greater contact with Basle - this is e pecially important to ensure that adequate technical service can be offered'.

- 'formal 'what's going on' meetings on a regular basis - centred around a presentation by one member of the group, but designed to get everyone together and to make them aware of the current work and progress - could usefully involve people from other groups as 'guests''.

- 'some kind of training to make meetings more effective, so that the facts matter rather than how articulate you are'.

- 'presentations by one group to others to help build up a sense of wider perspective - e.g. marketing trends, current project progress etc.'.

- 'obviously to have everything on one site is wishful thinking, but I would like to see more rationalisation and centralisation of resources - e.g. one central research agency, one testing group, one marketing organisation etc.'

- 'need to develop informal individual relationships - these are the ones which matter. Create more opportunities for this and you're on the road to solving problems better.'.

- 'interim testing reports to ease the delays and frustrations of researchers who are waiting for results - but it must be clearly understood that these are not final documents and thus bases for action - they're for information'.

- 'chemists could have more involvement with testing but they need to be clear about the object of the exercise - and not just from a Research point of view'.

- 'new chemists would spend a brief introductory period in testing and then, after a year or so of project work, return for a sustained period of time getting involved with all aspects of testing associated with that project'.

- 'could run 'refresher courses' for older chemists to up-date their experience of testing'.

- 'closer contact between the research chemists and the market-place - there's logistical and confidentiality problems to this but they need a closer appreciation of the business side of the company - perhaps joint meetings with Marketing on a regular basis, presentations about market trends etc.'.

- 'more Paisley to Wythenshawe traffic'.

- 'having a 'contact man' on site to co-ordinate testing is a good idea - it remains to be seen if it will work out in practice - I hope it does'.

- 'decrease the number of 'discussion' meetings - what we need are 'formalising' meetings which review and ratify what has already been transacted on an informal basis'.

- 'committees and communications could be better with more thought put into project teams'.

- 'need to fill in and define the currently vague notions Research and Process Development have of the market - we must have better information flow particularly from the business to the technical side'.

- 'there's nowhere near enough rotation or mix of experience in Pigments Division - if its done at all its in fits and starts and never carried out propertly - we need planned training and career development'.

- 'set up a small team in Paisley and one in Wythenshawe, have them meet on a regular basis and give them the responsibility for diffusion of information, fostering contact and co-ordination etc.'.

- 'need a much wider circulation of information on what the competition is doing - this needs to be drawn to people's attention rather than just hoping they'll read it somewhere'.

- 'need for constantly improving mechanisms for co-ordination and co-operation - it's no good just setting up one team and leaving it at that - we need a commitment to working better together'.

- 'continue Product Management involvement in co-ordination e.g. representation on the T.C.G. - they can bring an important general perspective to bear.....'

- 'regular issue of statements, bulletins, reports backed up with personal contact and the occasional 'forum' type meeting where people can raise points of difficulty'.

- 'need to have senior management put their own house in order before we can solve our differences - what we need is a change of emphasis from conflict to co-operation - and everyone committed to this'.

- 'reasonable personal contact does break down the artificial departmental boundaries - but it takes time!'

- 'build up suitable data bases to support specifications - provide market 'dossiers' for new products, to circulate to those concerned to put them in the picture - need to control the range of options available - this dossier should give, ideally:

  (a) judgement of threats and their real nature.
  (b) properties which need improving and optimising.
  (c) ways of assessing these - especially in an acceptable quantitative sense.

  - this needs regular update to cover changes in prices, product specifications etc. This should give an input to the development of strategy and eliminate the present apparently ad hoc inputs which allow panic or late reactions and with which people are unhappy.

- 'T.C.G. are OK for focussing effort on crisis issues, but there's a need for lower level co-ordination'.

- 'chemists should be involved right at the start of a project when the specification is written, and with the testing during the progress of the project - and they should be kept informed of any proposed changes in test methods etc. '.

- 'project teams - including a provision for handover of testing to production laboratories, when the project is nearing completion'.

- 'need to tighten up on Research groups - even the most speculative must contribute a service if they're going to justify their continued existence - need to be more cost conscious, aware of profitability considerations and of the business as a whole'.

- 'rotation breaks barriers, reduces 'us and them' conflicts, builds tolerance - there's a fund of stories in Research about Production mistakes - but those who have been involved in Production know what it's really like and how easily problems arise'.

- 'project teams are the short answer - but they're unwieldy, have different allegiances, don't involve each member in making an equal contribution and anyway current work is geared to ranges rather than single product developments. We need to think carefully of how to make such teams work effectively'.

- 'it's wishful thinking, but control over raw materials supplies would help enormously since we wouldn't have all the uncertainties associated with them to cope with'.

- 'because of the nature of their work, people tend to get blinkered views - they con't look at things in terms of the total organisation. We need to look at ways of changing this'.

- 'the rotation experience would be good for Research chemists - to have them spend a reasonable amount of time in Production of Process Development for long enough to appreciate the day-to-day problems involved' - they could then go back into Research with a fair idea of the limitations on site'.

- 'testing should be centralised and should allow for chemist involvement'.

- 'the level of co-operation between Research and Process Development has increased substantially over the past two years, but there's still a need for more joint projects and working together to break down the interfacial (and artificial) boundaries.

- 'low-level co-ordination meetings (like meeting 2) would give a regular contact bwetween opposite numbers on a formal basis - this would support the informal contacts which are the key to effective working together'.

- 'number of projects should be cut down and the criteria used in selection should be much more stringent - we can't afford to play games with long-shots'.

- 'project teams involving all the relevant areas are the only really effective way to organise for full commitment and minimum friction and misunderstanding between departments - but these groups need to have real responsibility and autonomy to succeed'.

- 'more frequent contact - directly, not just through Applications - with marketing'.

- 'set up a joint team from all the involved departments to investigate why it takes so long to get a new product out and ways in which this can be improved'.

- 'range of products should have a shorter life cycle - there'd be fewer shelved if more risks were taken putting new ones on the market to replace others'.

- 'rotation has been suggested and there is certainly a need for closer market place contact - even for Applications'.

- 'need for much closer, longer contacts with other departments'.

- 'need for more meetings, particularly semi-formal in nature and covering wider issues like how to match market needs with what's coming through from Research - need for more large seminars like those we used to have at the Cally'.

- 'perhaps an off-site group, made up from different levels and areas and with the task of devising solutions for problems - and of going back and trying to secure co-operation to implement these'.

- 'need for involvement and participation'.

- 'need for better understanding of the pressures on different groups'.

- 'need for ways of helping people identify better with the company as a whole instead of just with their groups'.

- 'projects originating as Research projects should be carried by the chemist responsible right through to launch - closer integration of Research and Process Development is badly needed, the present system sets up an 'us and them' situation for no good reason - what we need is a group which gives a range of specialist and generalist skills'.

- 'if you allow project teams, you get high commitment to the project, learning of new skills, broadening of attitudes - and if you operate it on a recycle basis, you'll build up a pool of people without a specific departmental allegiance, concerned with projects rather than politics'.

- 'one way of improving the information flow to the T.C.G. would be to call 'witnesses' as their project came under discussion - this would also make the individuals feel more directly involved.

- 'having all senior management on the Paisley site would really boost morale'.

- 'need for more long term thinking across the division - we're too preoccupied with the here and now'.

- 'greater autonomy, freedom of action and independence of Basle would be a great step forward'.

- 'improve the Research options for promotions - at present Production seem to dominate the ladder.....'.

During the final six months of the project, a staff development manager was appointed and a useful involvement with the research began. This new element made it possible to put into practice some of the individual development input suggestions: the involvement is continuing.

In addition to the interfacial work, a course on technical group leadership (discussed elsewhere) was held at which several managers attended. Evaluations by participants after the event suggest that it was not seen to have been valuable but observation on the course itself indicated that the experience did raise some important issues.

Exhibit 15 discusses feedback from participants evaluating this input.

Work is continuing on the input side of the project in that the research results have still to be presented in their final form to the company. This will represent the most complete kind of mirroring, reflecting observations made over the two year period and incorporating information from surveys whose results have not yet been published - e.g. on organisational climate, on beliefs and values, etc. Recommendations and input suggestions will also be made and it is hoped that some kind of discussion of the research will be possible.

To conclude this brief discussion of a real integration strategy, some evaluation. In Exhibit 16 a number of responses by Process Development members are quoted; to these may be added the 'evidence' that the department is certainly performing no worse than before, so the project has had no negative effects!

A number of criticisms emerge and indicate alternative lines to be followed if the project were undertaken again.

(a) the time period was too short to work effectively in more than one area: the logistical problems of actually implementing action research mean that it will be a very time consuming activity.

(b) many of the recommendations were too radical for the organisation to implement on the advice of a small research project. To cope with real change it would be necessary to have a full-time specialist with the requisite influence at least to get discussion of, for example, structural change.

(c) the emphasis in the work was not clear at the outset to either researcher or members of the organisation. Consequently the study of 'people' factors in the process of technological innovation placed too great an emphasis on changes in the people sub-system. The value of these organisation development activities is not disputed, but more work could have been done on other inputs - e.g. structural or strategic changes. A clear example of this might be seen in the lack of co-ordination between the Process Development and Research groups as a consequence of their different line management allegiances. From a task point of view, this state of affairs is disintegrative: since their activities are essentially related, they should be grouped together under one management line.

EXHIBIT 15 : Evaluations of Short Course on Technical Group Leadership

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'The immediate benefit of the course is not clearly apparent. Its immediate benefit, I find minimal, however, I feel that its values can only become apparent with time. If one's awareness of behaviour at meetings, or in fact, any other environment, is enhanced, then one must consider the course of value.

I shall attempt to make use of experiences gained on this course in the future although I am obviously not the best judge of the effectiveness of this training.

Regarding the course itself, it was entirely different to what I had expected.....'

'.....saw the course as adding to the work (the researcher) has been doing in terms of increasing awareness etc. - felt I had the edge on many of the participants because I've got used to observing things and viewing processes with a more 'aware' eye - I've changed my way of looking at things since the project began.....

.....I feel that the 'fault' lay in the people and not the course itself - there were no self-starters, no-one prepared to jump in - partly because of the Ciba-Geigy contingent and the presence of a 'bloc' inhibited others - certainly I know people were holding back and behaving differently.

.....it could have been more emotionally charged and revealing - the Friday session was most productive but earlier sessions were wasted....'

'.....I began by thinking that I saw an application for this knowledge of myself in that I might behave differently when confronted.....by vague situations with little structure. However.....my natural ability/instinct helped me more than the course. There might be 'degrees of experience' and for the younger members with less background training and experience this course may have been a novel exercise, providing some valuable insights into human behaviour.

.....I felt that I could not believe in the course as anything other than an artificial game with no intrinsic meaning - thus the learning potential was much less than for a real situation. When confronted with real situations, it becomes important that I <u>do</u> something - whereas when it was a game there was nothing at stake and no need to do anything.....I was aware of holding back'.

'.....nothing on technical leadership - could've had a bearing on any kind of leadership! .....far too much emphasis on demonstrating something that people would've expected at face value - the idea that people behave uncomfortably under uncertainty seems obvious.

.....no bearing at all on the formal leadership situation as a real context - might be of help to those involved with groups (e.g. voluntary organisations) without the normally imposed constraints of formal hierarchical operation where there is a strong task component'.

EXHIBIT 16 : Evaluations from Process Development Members

'I believe that the problems which you have clearly outlined in your reports have always been recognised as such by the management in Ciba-Geigy.

Your presence appears to have stimulated these same managers into a more positive approach to these problems with a definite intention in some cases of trying to solve some of the problem areas. In this respect your presence has acted as a catalyst in improving things.

However I still believe that the same people will revert to their old ways once your presence (catalyst) has been removed. This is a pity since it suggests that some of our managers only changed their management style with a view to gaining points in the eyes of their superiors during your presence.

Once a person's character has been moulded it is difficult for them to freely change their style and maintain this performance. However, for the much younger members of the company whose industrial character is still in the melting pot, I believe the work you have done during your stay will act as a useful guide to good management and improved industrial relations'.

'A gradual breakdown of the groups within Process Development has given increased co-operation and 'departmental identity'. By promoting discussion it has led to the release of frustrations and helped people to solve their own problems.

In the case of relations with Production department, it has provided an area of common ground - both groups being able to discuss problems (e.g. company organisation etc.) which are very important to them. This is in sharp contrast to the more normal situation where there is considerable conflict of interests'.

'Throughout the last two years I have seen the study on innovation as an invaluable exercise within Process Development, particularly because of the uninhibited expression of the views of all members of the department on this. The presence of a free agent with whom individuals could discuss problems on a more objective level has freed people from the worry of 'ratting' on fellows/managers/subordinates.

The most interesting aspect of the work, in terms of the department personnel, was the assessment of an individual by his peers, arguably the most objective assessment of performance one can obtain.

In a wider context, highlighting the paternal management style widely encountered on site has been a breakthrough. It h as been encouraging to see some managers within Process Development consciously trying to modify their management style to a more open one which attempts to embrace other people's views.

Other individuals, however, seem to have remained untouched by the experience and continue on a fairly rigid paternal style which has been disappointing.

A measure of the impact in this area is that I have openly discussed 'paternalism' with a senior manager outside Process Development. He freely admitted not only that it existed but also that the present slow trend away from this style was the right strategy.

The quarterly reports have all been very informative (and stimulating) although I have not always had the time to do them justice (what does that indicate?) They have obviously been digested by upper management who have agreed with enough of their content to feel that action is necessary on their part. There is no point in trying to discuss them in detail, particularly as the test of the work is the subsequent change for the good (if any) which is attributable to them. I feel the innovation study has at least initiated this process of change'.

'I think that the most important contribution of the research project has been to stimulate an awareness of the need to move towards a more relevant style of management, namely, more democratic, open, participating with more delegation of responsibility etc. (the researcher) has acted as a conscience of senior managers.

With his departure from the scene, I fear there may be a relaxation into more comfortable but less appropriate styles of old'.

'By your (the researcher's) presence and influence, barriers which existed with the department have been lowered but not removed.

Again by your direct presence, conversation and argument has resulted in people within the department having a greater awareness of each other.

Your work, I feel, has shown the major factor that personnel relations have in the performance of the department and the individual sections.

Finally I believe you have discovered the continent but it remains for the interior to be exploited'.

As a first attempt at an integrating strategy this was a qualified success. It involved a learning process for all concerned and was certainly 'pioneering' a relatively unexplored field. Positive responses suggest that the prognosis for development along these lines is good; that the organisation needs an integration strategy has already been indicated.

From consideration of the theoretical role of the integration specialist and the field experience of a simple attempt at integrating strategy, it is now possible to present a scheme for integration for the case study organisation.

In each case a distinction can be made between two classes of sub-strategies; 'practical' and 'desirable'. If we look at problem issues we find that they can be viewed on three levels. The first is symptomatic, and displays a whole range of expressions of the same problem: it was these problem symptoms that the research picked up. At the second level, the central problems as the affect the organisation occur; e.g. different types of conflict. Finally there is the causal level, at which the root problems exist and to which all solutions should ultimately be addressed. (This model appears in Exhibit 17 in diagrammatic form).

Although tackling problems at their root seems the logical approach, this will in fact be an area largely beyond the organisation's direct control. Individuals may be poorly integrated as a result of their particular psychological make-up, background history etc. - but the organisation has neither the moral right, nor the resources to devote to changing the individual. Some change strategies, e.g. education, will bear extensively on this area, but direct intervention is not possible.

However, at the level at which the problems affect the organisation it may be possible to implement improvement strategies which will do more than simply treat symptoms. It may not be possible to change an individual, but it is possible to change the way in which he fits into the organisation. Job design, enlargement, enrichment, rotation, career development, functional autonomy, participative management, functional autonomy, participative management - the list of options is impressive.

Bringing together various themes outlined in this chapter, the following view emerges. There are a large number of problems at various levels associated with the process of technological innovation. At a certain level of abstraction these can all be viewed as integration problems. Increases in integration needs arise from the growth of internal complexity, itself a consequence of external complexity; these needs will be felt most strongly in uncertain and complex areas, e.g. associated with technological innovation. Integration has traditionally been a management task but it is argued that the size (and prospective growth) of this problem area makes it one in which specialist skills may be needed.

A further consideration is the fact that emphasis is often placed on 'technical management training' - which by its nature is highly prescriptive. Integration skills are not easily acquired either by experience or education: certainly 'plug-in' types of training are unlikely to develop them. The integration specialist is described together with the approaches he might make to developing an integration strategy. Practical experience of crude attempts at a partial integration approach are described.

To relate this argument to the case studied and to the wider context of innovation management, a scheme for an integration strategy is offered. This is built up from the models already advanced elsewhere: for each level of the organisation a set of sub-strategies based upon 'driving force' and 'lubricant' approaches are developed.

EXHIBIT 17 : Multi-level analysis of problem issues

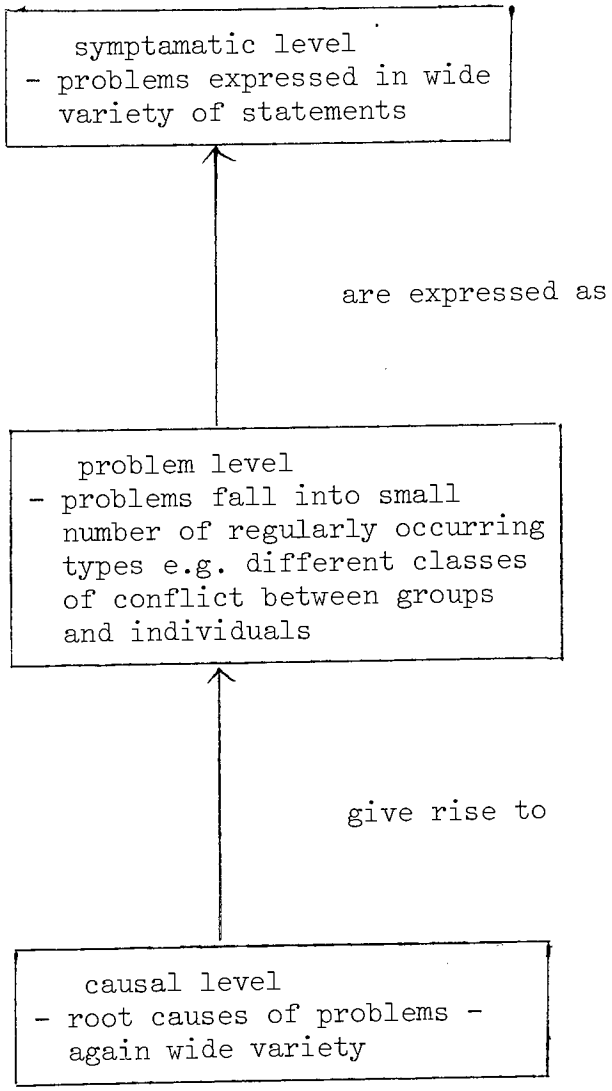


EXHIBIT 17 cont'd. : Example of Analysis Applied to Individual Level

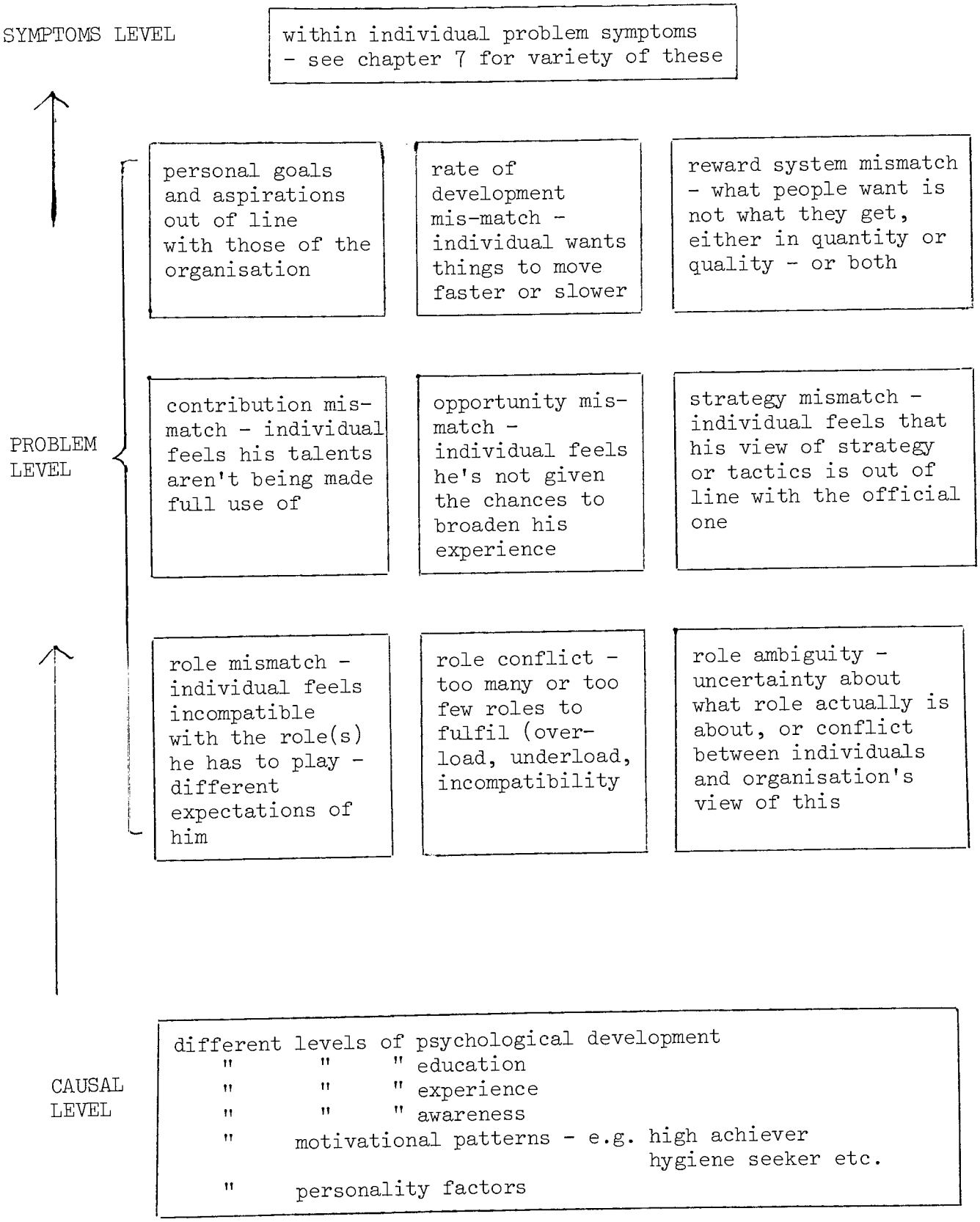
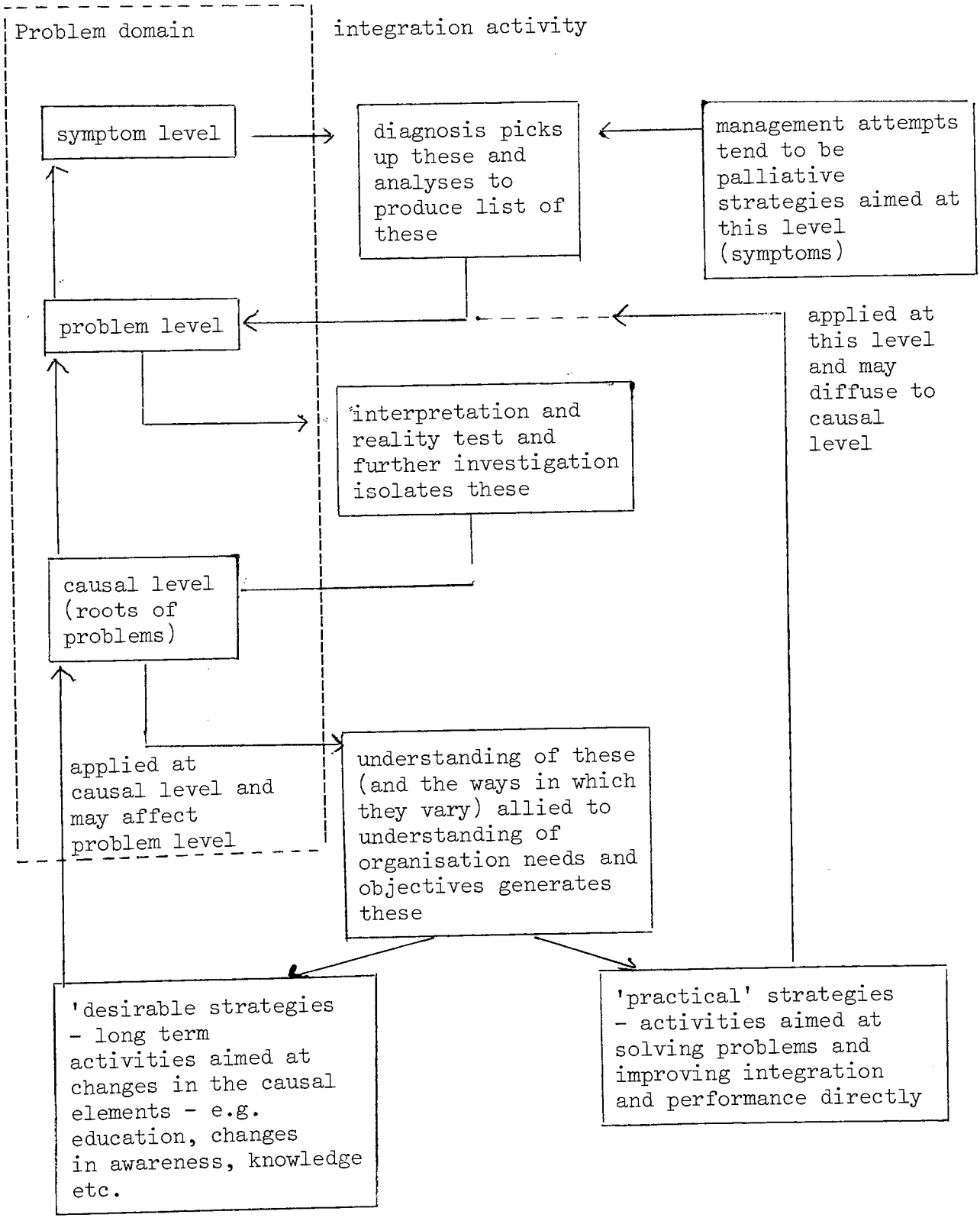


EXHIBIT 18 : Problem Analysis Linked to Integration Strategy



The same principle applies to groups and organisational level problems; where they affect the organisation, they can be dealt with at a fundamental level.

Thus short-term 'practical' strategies can be used to improve effectiveness by treating problems issues directly. 'Desirable' strategies are aimed at moving the organisation towards a more ideal state with higher levels of awareness and self-knowledge - a state of which integration is a natural consequence. Changes at the causal level are the objectives of 'desirable' strategies, at the problem level of 'practical' strategies.

All that is being argued here is the notion of planned vs unplanned change. In Exhibit 18 traditional management responses to integration problems are shown as acting largely as unplanned reactions providing palliative relief at the symptom level. These are contrasted with the planned (and expert aided) strategies of the integrator; also built into his approach is the element of dynamic interaction with his subjects. Flexibility in the face of a changing world is thus achieved and strategies can be modified and updated without losing their planned quality.

What is being argued for is thus an inversion of the logic of innovation. If technological change inevitably brings with it changes of other kinds - social, psychological, structural etc., then two responses are possible. Either these changes are accepted as consequences, desirable or otherwise. Or they are anticipated and innovative strategies implemented aimed at planning the consequences to the organisation's advantage are used.

Basic Model

Reference has already been made to the model of Dale and Payne (1976) which they offer as a combination of theories and views on development. Using this simple device we can identify both the state of development and also the needs for future development at any level.

Recalling the model, we have three dimensions of will, awareness and resources: these are arbitrary distinctions which are in fact strongly interrelated. 'Ideal' states of development are thus defined as being at the ends of each axis.

On this basis we can develop our strategy against this kind of evaluation model. Diagnostic knowledge of what the situation requires in terms of broad aims is very important. Our appreciation of the contingency nature of the innovation process tends to support the general view that no structured instrument could suit everybody. Thus prescriptive methods are likely to be limited by the extent to which they assume everyone to have attained a similar level of development. Research (e.g. Smith (1970), Mangham and Cooper (1971)) indicates that responses to standard methods are extremely varied.

More attention needs to be paid to those strategies which offer a variety of choices to those involved, in terms of levels of development applicability (e.g. 'Blocks to creativity' Danzig and Nevers (1971)). Another approach is to facilitate self-design of strategies within the organisation.

The scheme is presented level by level corresponding to the model developed in Chapter 3.

I. Individual level

At this level we have seen that problems centre on issues like motivation and alienation which account for the degree to which the individual feels integrated with the organisation. Secondary consequences of poor integration include a reluctance to take risks or to strive for excellence: these factors will naturally inhibit the innovation process.

(a) Driving force problems have the lower apparent priority: there is no shortage of technological capability and the production of imaginative and creative ideas does not appear difficult. If anything, there are difficulties involved in getting ideas into practice: the system tends to act as an obstacle course. The real requirement in this area is for risk-takers - 'champion' figures who will push their ideas forward, breaking and bending rules if necessary to get them trhough.

Inputs to assist here might include the following:

(i) improve 'creative' performance

individual 'creativity' can be enhanced by the use of training aids from simple 'lateral thinking' approaches (de Bono (1970), Adams (1974)) to/

highly structured methods (e.g. described by Rickards (1974)). The advantage of improving problem-solving capability is not confined to idea generation in research. Non-technical problems will also benefit from more open-minded approaches to solution. In innovation adoption open-mindedness is an importan determinant of success, so again resistances might be broken down using this approach.

- manipulation of environmental variables has been shown to affect performance - e.g. the Pelz and Andrews work on productive climates for R. & D. Mars (1969) (on the basis of an extensive literature survey) lists some seventy elements: these include

- independence and freedom of action.
- flexibility about organisational demands and constraints (e.g. working hours, rules and regulations etc.)
- recognition and status for creative performance
- awareness of contribution to wider organisational goals (via feedback, direct contact etc.)
- opportunity to influence policy and strategy related to innovative activity.
- decision-making autonomy at an operational level (within prescribed bounds).
- awareness of organisational capability (i.e. that the organisation has the necessary resources and the willingness to commit them).
- support and security.

- challenging and interesting tasks.
- adequate information base and availability.
- external freedom (to relate to professional contacts, new knowledge sources, the 'invisible college' etc.)

Probably the most effective inclusive term for the kind of climate required would be 'democratic' (as opposed to 'authoritarian'). In the former, many people participate in communication, decision-making, problem-solving etc. and everyone's inputs are valued. Authoritarian approaches, by contrast, concentrate on decisions made at the top and enforced below.

There is an organisational problem here: those conditions required for creativity (arguably a quality required throughout the innovation process, not just in the research laboratory) are incompatible with control principles. Yet effective control of development factors has been repeatedly identified as a key determinant in innovation success. In the short term, the strategic question here is one of balance: how far can technical specialists and others be allowed self-control and how far must they be organisationally controlled? It is suggested that the intrinsic self-motivating capacity and the professional orientation of this group should push the balance to a minimum of external control. 'Bounded autonomy' in which personal freedom is high within certain organisationally prescribed limits could be attempted as an extension of current

/'management by objectives' approaches.

This may generate something of the elusive spirit of confidence which the company lacks: the 'champion ethos'. As de Tocqueville suggests:

'Democracy does not confer the most skilful kind of government upon the people, but it produces that which the most skilful governments are frequently unable to awaken, namely, an all-pervading and restless activity, a super-abundant force, and an energy which is inseparable from it, and which may under favourable circumstances beget the most amazing benefits'.

(ii) <u>improve need pull/knowledge push</u>

- market pull accounts for most of the driving force in product innovation and thus a greater individual awareness of it will enhance its effect. At present contact with the market-place is confined to Marketing and some Applications personnel; everyone else receives their information second or third hand and via informal as well as formal channels. For individuals to be able to relate their creative contribution to a real outcome has already been mentioned as an important environmental factor. To this should be added the view that a greater knowledge of what the customer wants may give better understanding of the problem and its peculiarities.

The value of this process appears to be high, in motivational terms even if it does not affect performance directly.

A couple of real examples may illustrate this. One of the more radical projects being carried out in the research area involved some young chemists working directly with a customer company (the details of this are confidential). Levels of motivation reported were very high: as one of them put it, 'this is the only worthwhile thing I've done since joining the firm. It's our project, if we mess it up, we carry the can'. This sense of risk, autonomy and responsibility coupled with a direct working relationship with the market-place had obviously been of great value to the individuals involved.

In the second example Process Development people commented frequently on the fact that they derived a great deal of motivation, encouragement and satisfaction from the contact they received with the market-place. In their case, contact was informally via one of the Product Executives who became for them a 'window on the world'. Notably the formal channels through which this information was supposed to come were criticised as being too slow and as offering very little information, almost on a 'need to know' basis only.

A more general point which illustrates how isolated organisations may become from their markets was raised by a production manager. He suggested that it was very hard to indicate to process workers etc. what the products were used for - but that it mattered a great deal when the men were able to see a particular model of car with a colour scheme they knew they had contributed to.

In general closer coupling with the market place so that individuals have a greater awarensss of trends, needs, problems etc. can only be good. Ways of achieving this may be more difficult to find but it appears that existing methods are insufficient. Internal seminars, circulation of market reports, increased contact with Marketing and Product Management, even accompanying sales representatives on their visits are all possible suggestions. In the longer term more projects involving direct contact with customers could be investigated. Job rotation or experience-gaining sessions which provide individual chemists and engineers with experience of working in Marketing or Product Management might also be tried.

- need-pull is the wider term of which market-pull is a special product innovation case. It will account for most of the process innovation currently taking place within the Company since this follows a planned replacement with new technology approach. For this reason individuals engaged in process innovation should be given a clearer understanding of what the needs are: as with closer market contact, so here the need is for closer user contact. Working in production areas for a short time, commissioning new equipment with user area personnel, meetings with potential users are all ways of improving his awareness of what is really needed.

Similarly needs for safety and ecology will also contribute as innovative stimuli. In each case what is being suggested as an improvement input is devising systems whereby individuals can have a closer and broader contact and experience of what they are working in.

This is really an exercise in broadening the horizons which educational and functional systems (from a very early stage) have tended to narrow in creating specialists. Its value in terms of improving creativitiy must be clear, since it is opening up new sources of creative stimuli to the individual.

- knowledge-push is the other major stimulus for innovation and relates to the level of new knowledge which an organisation can both generate and make practical use of. At individual level this will be associated with the level of capability amongst specialists (which is high) and with the way in which new knowledge diffuses from the environment to the company. To keep abreast of developments in science and technology, information is channelled into the organisation via journals, information systems and most importantly, individual contacts. Research has shown that for scientists (and to a lesser extent technologists) frequent informal meetings, visits, conferences and seminars will help to establish membership of the 'invisible college' - that informal web of relationships responsible for the diffusion of new knowledge. Thus the benefits from conferences and other trips should not be evaluated only in terms of direct information contribution: it may be that the indirect benefit from the informal contacts made proves much greater in the long run. Contacts with universities and professional institutes will also contribute here.

Within the organisation, diffusion of knowledge has been shown to be associated with certain key figures known as 'technological gatekeepers'. The characteristics of these opinion leaders can be studied and attempts made to enhance them in the organisation - for example by working through the informal rather than the formal social structure.

(iii) improve general capability

As has already been indicated, differentiation is a principal adaptive response for organisations working in complex environments. Thus there will be a constant demand for highly skilled specialists in a growing number of fields. Strategies to maximise innovative driving force should include provision for the continued recruitment of specialists and the 'updating' of existing ones. Research tends to indicate that age and experience in innovative work has a slight relationship to creative output in that older members will have more wisdom about what can and can't be done. A balance between 'young Turks' who will challenge accepted ways of doing things and 'old guard' who know the technology intimately and can save fruitless activity being started, needs to be carefully struck.

Training of technical skills (and their updating) will ensure a high level of diffusion of knowledge into the organisation (as has already been indicated). However, it is likely that other kinds of training will also contribute to improvements in this area.

Creative thinking techniques have already been mentioned; to this list could be added subjects like economics which will enhance awareness of the way in which the world outside works. Sales training might be a useful option if we remember that innovation adoption tends to rely heavily on the persuasion function. (In this respect it is interesting to note that those individuals associated with 'good' performance in transferring technology across the Process Development/Production interface used many sales-type techniques and often saw their jobs as 'selling' rather than transferring).

(iv) Improve risk-taking

Entrepreneurial behaviour seems largely absent from the organisation and this is a major limitation on success in innovation. There appear to be very few individuals prepared to take risks: what is needed are strategies aimed at breeding 'product champion' or 'promoter' figures.

Some attempts to train entrepreneurial spirit via achievement motivation techniques have been made (McClelland 1965, Patel 1977) and these appear to be successful. However, it is argued that the real problem may not be individual motivation but organisational constraint. If we think of entrepreneurs as expert gamblers taking calculated risks, then they will not play if the odds are

/against them - as they might be in a restrictive organisation.

Once again we are back to high levels of individual autonomy as a strategic need. Examples from other organisations suggest that a policy of giving 'bright sparks' enough support and backing for new venture management often produces successful innovation of a radical nature. The 3M company is a typical case.

As was indicated earlier, those chemists and engineers interviewed when working on projects for which they had a high level of personal responsibility tended to be much more highly motivated. By contrast, many individuals engaged upon more incremental research expressed feelings of immense frustration with the system and the limitations it placed on them. This suggests that the capacity to take risks may be one of the elements of potential which so many people feel is not being tapped in them.

As a strategy it might be possible to allocate more individual project responsibility. This would again move the organisation away from direct authority control to self-regulation by individuals.

(b) Integration Problems, by contrast, are of key importance and thus there is a need for lubricant sub-strategies. These might include:

(i) motivational aids

- reward systems under 'normal' circumstances might not be expected to influence technical specialists unduly because of intrinsic motivational characteristics of the job. (However evidence suggests that recognition of creative contribution is an important factor). With present economic conditions on a national level, the salary restraint programme has left this group as unhappy as others within industry. Whilst there is little that can be done directly, it is suggested that alternative incentives (company car, cheap loans etc.) are regarded by many people as indications of how much the company really cares about the reward system. Comparisons with other companies by individuals often show up the alternatives open, and thus people begin to feel that 'the company doesn't care, it's just taking us for all it can get'. Whilst the problem is obviously not so simple, the dissatisfaction with the current reward system points to an urgent strategic need. In particular there is a feeling that more could be done to investiate non financial ways of rewarding people. Perhaps the strategy mentioned earlier for enhancing knowledge-push by sending people to more courses and conferences could be used here to give people a feeling that the

/company valued them and their contribution enough to want to develop them. (In this connection an often-voiced criticism by younger, more junior members of the organisation was that their superiors always attended the courses and conferences).

- career development is closely associated with this principle and reveals an area of major discontent. Most individuals interviewed felt that the existing career development arrangements were very poor and that 'if you wanted to get anywhere, you had to do it yourself'. This is probably a valid criticism, but not because of company inaction so much as a combination of circumstances. The national position for chemists and technologists is not very healthy; there are too many available for the jobs which exist. So mobility and choice of a professional specialist group is restricted- this is likely to frustrate since it conflicts with the values of this group. Secondly the expansion of the company has all but ceased - and any future growth will be on a much more cautious basis. Thus there are young men in senior positions and little chance of internal mobility unless people leave to join other firms. Competition for any vacant post illustrates the lack of potential succession 'slots' in the organisation.

Faced with this limitation, there is little real career development which can be accomplished in terms of promotion. Job titles and descriptions and technical status structures can all be manipulated but there is a growing lack of belief in these. 'All you do is change the name and the salary - but the job is still the same!'

It is suggested that one aid to solving this problem miht be to re-examine the notion of development. As it stands, people are largely evaluated for their contribution via a system of performance appraisal. The value of such an approach is not questioned, but it may be that it limits evaluation to a series of technical performance criteria. Effective task performance is likely to involve behavioural and other elements as well; indeed the general belief that most problems in the innovation process are people-centred was very well-supported.

So alternative evaluation, whether formal (as an extension to existing systems) or informal (as developed from the informal assessments described earlier) might be a possibility. A cy clic feedback approach whereby the system is not fixed but developed from criticism of each previous operation would add to flexibility here. Self-assessment rather than superior or peer-assessment is another option.

The general purpose of all these strategies is to arrive at a more complete evaluation/diagnosis of individual development needs.

Following logically from this will be a new series of development options, moving into relatively unexplored areas in some cases. Skills of a non-technical nature can be developed via training options which range from simple courses of lectures through 'personalised' programmed learning interventions to direct experiential learning. What each individual responds to is likely to vary with his needs and with his general learning style: as a general proposition it is suggested that task-related inputs will have most value to the organisation. That is, any learning which the individual might acquire will only assume relevance if it can be applied and developed in a real situation.

Another development need is for a wider view of other frames of reference; this has value in promoting open-mindedness (of significance in invention and adaption) and of integrating different specialist groups. Again, this training can take place in a number of ways: job rotation offers a notable example of the 'learning by doing' approach.

One major implication in alternative skills training is the need to recognise that this process must be handled in a systematic fashion by full-time specialists. As yet there is only limited acknowledgement of this. Management development is a case in point.

If the organisation depends largely upon the managerial system for its adaptive action, then deficiencies in capability or experience here will have serious consequences. The need to constantly upgrade managerial skills, especially in new areas is emphasised repeatedly in most recent work, practical and theoretical, on the subject of management. In discussions with middle and junior managers in the study, dissatisfaction with existing provision for development was a regular theme.

So far the need for management and staff development has been acknowledge to the extent of appointing a manager with special responsibility for this area. His work largely involves simple succession planning and course administration - yet what is needed is a much more fundamental commitment to development in a real sense rather than the special case of promotional structures.

Development programmes should move towards individual centred approaches so that variations in needs, expectations and existing development can be taken into account. At present a wide range of structured and semi-structured approaches of this kind exist: in time it would be better for the organisation to develop its own training systems related to real tasks but dealing with new skills.

(ii) participation aids

- involvement of individuals in the planning and decision-making process is a subject of discussion; throughout industry in view of proposed legislation on industrial democracy. We are back to the 'democratic' climate suggestion advanced earlier to improve creativity with this topic. The fact is that people feel increasingly isolated in the organisation, unable to influence or affect things in any way. Their frustration is increased when decisions taken in this non-participating fashion turn out wrong. The individual feels that he has a stake in what is going on and it will be an integrative move to involve him more: the alternative is likely to be withdrawal and lack of commitment.

Strategies need not be directed to giving more power to individuals; the problem is more concerned with providing a sense of involvement. At present there is a strong belief, for example, in the irrelevant nature of the T.C.G. at the operational level ('T.C.G.? - what's that?!'). Although the central task of T.C.G. is to co-ordinate operational activities, the lack of contact or involvement minimises its apparent effectiveness - it isn't seen as valuable. Criticisms include the belief (well-founded or otherwise) that the briefing system (whereby the departmental manager finds out what is going on) is unlikely to represent the facts about a project. For an individual to feel that his project is being discussed on an incorrect basis is frustrating: it also limits the value of any decisions taken. Appraoches like the calling of 'technical witnesses' to T.C.G. meetings are likely to have value both as motivational aids and in improving decision quality by providing better information.

Summary of individual level strategy

(a) Central problems:

- motivation, especially of 'professionals' under high uncertainty

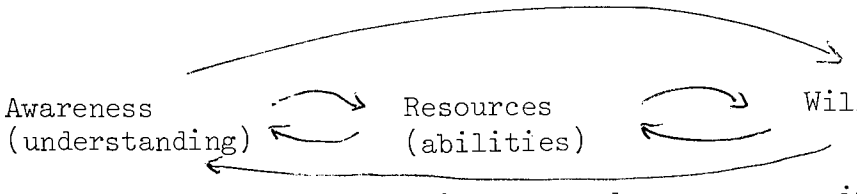
- alienation - belonging and commitment

- skills and abilities - broadening required, appreciation of others viewpoints. New skills and understanding e.g. in behavioural areas needed.

- confidence - develop risk-taking behaviour

- restrictive 'sets' - closed mindedness, 'it can't be done' etc.

(b) Development needs:



- improve self-awareness and understanding of relationships to others and to system

- improve and up-date technical skills.
- broaden experience of other skill areas
- acquire new skills e.g. behavioural and economic
- improve general approach to problem-solving via open-mindedness

- improve level of self-confidence
- take more risks, be more go-getting
- develop the 'gamesman' approach

(c) 'ideal' aimed for: 'integrated self-actualiser'. A highly-skilled individual with experience in a range of technologies and an understanding of how they relate interdependently. Self-motivated and essentially concerned with a 'professional' set of values which govern his commitment: to the task not to the system. He makes his own decisions and rules and will only conform to a larger system when he shares basic goals and objectives with it. For this reason he will have a high level of control over his job which he has designed for himself to take advantage of all the potential he feels he has. His awareness extends beyond the technical domain and his learning style embraces concrete and abstract dimensions. He is open-minded in outlook with a minimum of internal 'sets' which might inhibit creativity or adoption of new ideas: his background is 'cosmopolitan' as opposed to 'local'. For this reason he is a good communicator and relates well to the information system.

(d) general approach: emphasis should be placed increasingly on self-management options, where individuals have a high degree of control over their own immediate tasks. Learning should also be self-centred and related to the task in hand - on-the-job development. Self-assessment should lead to improvements in the individuals own design of his job. Where possible 'plug-in' training should be avoided in favour of specific project activity, so that all development is purposefully linked.

Individual Level Strategy

Driving Force Promoters →	← Resisting Force Lubricants
- 'creativity' training	- manipulation of reward system
- improved contact with external world, market-place etc.	- education and development of new skills and experiences
- development of informal structure	- development of informal structure
- improved information availability	- improved assessment/evaluation system covering more factors
- development of entrepreneurs via training via venture promotion	- career development and planning
- improved capability via development of new skills and updating of existing ones	- job rotation to broaden outlook and understanding
- productive climates for creative performance - as prescribed - as self-designing	- management development
- risk-taking encouraged via interpersonal competence training	- job design opportunities - by organisation - by individual
- 'role excellence' training to broaden understanding and improve performance	
- allow individuals to follow projects through from start to finish	

II. Group-Level Strategy

At this level problems appear to centre on mismatches of various kinds. These result in friction, in wasted effort, in gradual erosion of confidence and trust, lack of risk-taking etc. - and will all affect processes like innovation which require extensive co-operative activity.

Driving force inputs will again have a lower priority: typically they might include:

(i) improve 'creative' performance

- as for individuals, creativity can be enhanced by a range of techniques and training interventions. Some are specifically aimed at groups (e.g. Synectics) and build on the principle of improved idea output by maximising the 'group mind' type of synthesis (by breaking down interpersonal barriers, by using process leadership etc.) Once again these are widely available in structured or unstructured form, and may be applied to problems of a non-technical nature, and in non-Research and Development areas. Any increase in creative thinking about problems is likely to benefit the organisation. (Some internal expertise in this area already exists within Research and Development; the researcher observed a well-conducted Synectics session during the latter part of the study. The major limitation to this approach is the difficulty of process leadership in a climate in which task considerations have always been dominant).

- similarly, environmental conditions for enhancing creative performance as for individuals will apply. However, emphasis is placed upon the contingent variation in individual needs: no one set of conditions is going to suit everybody. Where possible within a general framework, attempts should be made to permit self-design of environments etc.: this is moving again towards individual rather than organisational control.

- style matching is a special consideration in problem-solving behaviour (style being defined as a pattern of behaviour). Saward's (1976) study revealed that certain combinations were more effective than others in Synectics groups but the principle is likely to apply elsewhere. Selection of problem-solving teams on a basis of personal style as well as functional skill may be a useful approach to adopt.

(ii) <u>improve need pull/knowledge push</u>

- as for the individual case, expansion of awareness and contact will enhance driving force for innovation. In particular, strategies based upon developing the informal structure of the organisation will improve the communication system and hence promote information flow.

Allen's extensive study of this phenomenon has already been referred to and reveals a number of useful strategic options. Architectural rearrangement of offices etc. can be used to promote contact: one character interviewed during the research commented that he liked to move office every year 'to keep getting fresh ideas from talking to new people'. Opportunities for informal contact over coffee, lunch etc. can be augmented, perhaps by providing communal areas where people can all get together during breaks. Off-site activities might be promoted; the departmental night-out or sporting activities (e.g. the cricket team) all offer ways of increasing informal contact and exchange. (They are also valuable integrative mechanisms).

(iii) improve general capability

- as the influences section suggested, groups with a wide variety of specialist skills are more effective in general problem solving than groups of similarly skilled people. The organisational problem for innovation is more complex; here the need is for a number of skilled specialist functional groups and for occasional interdisciplinary project teams involving mixed expertise.

In both cases high levels of competence are required and this will involve commitment to training and upgrading relevant skills. Apart from traditional approaches to the development of skills, newer on-the-job training interventions might be applied. These are structured along the lines of 'how to do what you do better' and are based on the concept of role excellence.

Usually this begins by a learning process whereby clarifications and definition of the role is carried out - possibly for the first time. Here a technical specialist might become aware of the fact that his role is not just to have creative ideas but to 'sell' these to others, to motivate others with whom he is working, to relate what he is doing to the world outside, to corporate objectives etc.

The experience of broadening role awareness is important; it leads on to setting up standards for critical behaviour dimensions for that role. Who is 'good' and who 'bad' at fulfilling it, and what is the difference between them? Can it be identified? Can it be trained?

Rackham and Morgan (1977) describe this approach as applied to the airline industry, but it is equally applicable elsewhere. Its major advantage is that the individuals themselves do all the development and it builds in a norm of excellence; the consultant role is purely as facilitator.

(iv) <u>improve risk-taking</u>

- as with the individual case, risk-taking behaviour might be developed using training inputs or by setting up special venture groups where high levels of autonomy and responsibility are vested in teams of innovative specialists prepared to take the risks and try and push through more radical ideas than those covered by the traditional organisational portfolio.

There is a more fundamental problem associated with risk-taking behaviour which really begins to emerge at the interpersonal level; Argyris (1965) describes it as 'interpersonal competence'. He presents a detailed model of the deterioration of the innovation process based on low-levels of interpersonal competence, and summarises in the following way:

'Low interpersonal competence leads to the participants experiencing low feelings of essentiality, psychological success and confirmation on the interpersonal level..... participants react by overemphasis on desks, space, technicians, travel and status as well as by developing norms to minimise openness, conflict and risk-taking..... As problem-solving effectiveness decreases, the need for people, materials and time increase as do the researcher's frustration and rigidity towards change. At the same time the researcher's commitment to work and aspiration toward high quality research decrease. These factors tend to increase costs.....this, in turn, may lead management to tighten budgets, research schedules, capital expenditures and to give the customer increased influence over the research.

The researchers react by decreasing the long-range risky research. The organisation feels increasingly the need to shift researchers to projects according to the customer demands. The researchers become more frustrated and experience a decrease in their feelings of success, essentiality and confirmation of technical competence. This feeds back to increase costs as well as to lower researcher morale, involvement.....there is increased management dissatisfaction and emphasis on cost cutting, project evaluation, project control, 'witch hunts' etc... these factors feed back to increase research costs which dissatisfied management and the cycle becomes circular'.

The end result of this cycle sounds remarkably familiar: 'units begin to fight one another and to protect their sovereignty by developing boundaries; co-operation and mistrust and lack of communication leads to a feedback activity that supports and reinforces a relatively low interpersonal competence.....we have a self-maintaining system becoming slowly less effective and innovative'.

The reason for extensive quotation from this research is that it does offer a possible explanation for many of the behavioural problems discovered during the case study. Practitioners of organisation development and the 'human relations' movement have argued for a long time for a greater consideration of behavioural variables as determinants of task effectivensss. Argyris' work is one of the few attempts which have been made to relate innovation effectiveness to behavioural as opposed to economic or technical determinants.

It is suggested that his diagnosis is at least partially valid for the case studied. So how do we increase interpersonal competence? Argyris' own research during the subsequent thirteen years since his book appeared has involved developing ways of increasing this via training inputs of various kinds. He particularly stresses the need to introduce change from top levels of the organisation downwards.

In general what is needed are developmental activities involved in improving working relationships between individuals. Some strategies for this are covered in the next area.

(b) lubricant inputs

The requirement here is for inputs aimed at getting people to work together more effectively. This will be related to 'improving understanding and compatibility of individual behaviour patterns - 'style integration' - of various kinds. Emphasis is on the style problems encountered in real task situations: examples include:

(i) skill integration

- in the case of skill conflicts, the problem is to develop sufficient awareness in both parties that they need the other's skills and experience in addition to their own, that they interpret problems in different ways (which may be valuable), that they have different frames of reference, etc. Contact, preferably of an informal nature, is one simple way of developing a working relationship and strategies based upon this can be used.

Project teams, joint ventures and matrix organisation all offer task-oriented ways of bringing different specialists into contact. Longer term strategies could include job rotation wherein the individual learns about another frame of reference through direct experience.

Examples suggested during the research include:

- allow for overlap in project handover so that different specialists work alongside each other on the same problems.

- set up a common pool of generally-experienced specialists who have had a taste of many different working orientations.

- appoint specific liaison personnel of the plant technician type.

The important thing to recognise is that strong skill opinions often indicate a high level of commitment to the project in hand: resolution of the conflict should not lose this element.

(ii) leadership style integration

- leadership style conflicts are another common example of poor integration and illustrate well the problem involved. There is no one best style suited to all individuals - but neither can most managers be all things to all men.

One simple approach (described earlier) is to at least make the style offered and expected by leader and subordinate explicit. Congruence is likely to be largely a matter of luck if neither leader nor subordinate are aware of what is going on. It may be difficult to talk about and the use of alternative 'language' (for example the simple 'parent, adult, child' jargon of transactional analysis) can help in this context. However it is argued that a greater understanding of the meaning of leadership is an important educational need. How to teach it is another problem in itself! Direct lecture or prescriptive book-based methods are unlikely to be successful - but the Aston course illustrated the problems of experiential learning in this field. Several management development courses have also been held within the company but seem to have met with similar problems.

What is required is a major commitment to developing general understanding of group behaviour of which the leadership function is one element. Organisation development grew up out of extensive work with group training and offers an enormous range of possibilities: some examples are offered later.

Another approach which is again based on using real situations and learning by doing is the 'managing change' approach which Marlow (1975) developed from Reddin's (1970) 3D model of management style. This takes the contingency theory of leadership and tries to teach recognition of relevant styles and how to shift between them. However 'plug-in' approaches are still limited in their applicability and it may be necessary to use more individual-centred and controlled methods.

Whatever approach is used will depend largely on the overall level of understanding of the whole concept of management and leadership. It is argued that this is not clearly understood as yet and that educative inputs are urgently needed. These would be best designed around real tasks and projects so that the subject is presented as another dimension to a familiar experience.

(iii) General style integration

- personal style conflicts are undoubtedly the most significant but the hardest to handle, at least in terms of developing strategies to cope with them. The range of conflicts alone is daunting - opinions, values, beliefs, in fact, the whole psychological make-up of individuals may conflict. And because of this, the effects of this kind of conflict are found throughout the organisation.

To begin with, there is the problem of accepting that there is a problem. Many people believe that it is not possible to resolve conflicts of this kind in anything like a systematic fashion, and that their various pragmatic approaches are the only tools which can ever be brought to bear. In fact conflict resolution has been an extensively studied field: Filley (1975) in a typical summary indicates the range of options for conflict resolution and the reasons why most of them will ultimately fail (see Exhibit 19). Lawrence and Lorsch (1967) talk extensively about the relationship between conflict-resolution mechanisms and integration (and hence performance) success: their conclusion is that joint problem-solving in open confrontation is the most effective solution.

EXHIBIT 19 : Types of conflict resolution (after Filley 1975)

There are 3 basic strategies for handling conflict between parties:

win/lose
lose/lose
win/win

Examples of the first two are common e.g.

win/lose:
- 'railroading'
- use of power and coercion
- threat
- voting
- minority rule

lose/lose:
- compromise
- side payments
- use of neutral third party to adjudicate
- resort to rules

Both groups emphasise on us/them rather than on us/problem orientation. They also

- use energies towards total victory or defeat
- use single viewpoints not mutual needs
- emphasise the solution itself, not the better definition of values, beliefs, goals etc. within the solution
- are personalised
- emphasise the conflict in the short term rather than the relationship in the long term.

Win/win methods based on integrative problem-solving are far more effective in that this joint problem-solving approach requires a longer term approach and a mutual learning process.

Burke (1970) reports five common methods observed in industrial situations, which he ranks in order of effectiveness as:

(1) confrontation
(2) 'smoothing'
(3) compromise
(4) 'forcing'
(5) withdrawal

These results compare with Lawrence and Lorsch's study in which they found that top performers used confrontation significantly more than other methods, and that medium performers used it more than poor performers.

Henderson and Horsley (1978) identified three possible approaches similar to the above in their task-related study. They found conflict managed by:-

- power forcing others to go along with a certain decision

- smoothing or covering up. This leaves conflicts open and uncertain and allows people 'to do their own thing' which is likely to be ineffective

- confrontation and mutual problem-solving. People get together to talk about their tasks, come to a shared understanding and agree some action.

This may seem an axiomatic conclusion, but in fact is rarely the practice in most organisations. Blake and Mouton's 'Managerial Grid' approach to organisation development highlights this area as important and illustrates prevailing wisdom by referring individuals to the common beliefs they hold. For example 'least said, soonest mended' is a common response to conflict - but it does not make for effective conflict resolution.

What can be done in practice? We are really talking about an overall development strategy for individuals and groups, and the range of options is enormous. Learning about behavioural aspects of groups and roles is a crucial element in the process and beyond this, application of the knowledge. Most organisational development activities talk about team-building which is an umbrella term to cover various kinds of shared learning experiences - reference to the Pfeiffer and Jones (1977 for example) handbooks will reveal the extent of possible exercises which can be applied.

However, we are back to our general education problem, and once again it is suggested that the learning involved be as task-related as possible, so that the experience has some meaning in organisational terms.

Reference has been made on many occasions to the projects described by Henderson and Horsley (1978) and since these provide excellent examples of the use of organisation development technology in a real task situation, they will be offered as guides to a group level integration strategy.

Their work relates to commissioning activity but it is argued that it is equally applicable elsewhere. Further, whilst different specialist team considerations in a project of this nature are significant, it is argued that functional groups will also benefit from approaches of this kind. The key to this whole approach is a consideration of what has been termed the 'socio-technical system' i.e. the total people/technology/resources arrangement whereby goals are to be achieved.

As they put it, describing their 'People Plan': 'Here, perhaps for the first time in the Company (I.C.I.), there was a clear notion that the people and the organisation were just as important as the technology. In essence this meant that the Division's technology and expertise could only be expressed and produce a successful plant via an organisation which lifted people to the same status as technology.

Their starting point was to provide a clear understanding of the tasks which had to be carried out. Commitment from senior management allowed almost complete freedom in the way in which the project organisation was set up: the responsibility was held by a Group Manager.

The process by which the organisation was formulated involved extensive negotiation and modification with frequent confrontation and feedback involving everyone connected with the project. Role negotiation in which people described their tasks and the relationships to achieve them led to clarification of responsibility. 'Contracts'between individuals setting out who would do what helped to build in confidence that things would be done. Particularly in the situation where roles changed or new roles appeared, this role negotiating procedure had immense value in cutting down confusion. The norm emerged that 'if there is something we want to do, let's work out what it is and not leave it to chance'.

Thus the task organisation was not a preconceived design but evolved to fit people, tasks and problems. Commitment was high because it was developed from within: even if it wasn't perfect people had a will to make it work.

Parallel to this, formal organisation development was used aimed at team-building in particular; this intervention and the consultants who carried it out was simply considered as 'another technology' to add to the pool of expertise on the team. Emphasis was placed on working relationships and involved:

- making sure individuals understood each other's views
- agreeing and clearly stating roles and responsibilities
- ensuring the necessary degree of commitment to the task

This was achieved mainly through extensive meetings containing a high level of confrontation around issues of uncertainty and disagreement. Training in effective conflict resolution allowed issues to be thrashed out in highly productive fashion and built up strong informal relationships based on high levels of trust and openness.

Participation was another area which received attention: this included:

- finding ways in which people were able to communicate with each other those things important in their jobs

- being involved in decisions which would affect an individual's job or to which an individual had a contribution to make.

- getting greater clarity in terms of an individual's job, his role and responsibilities.

- obtaining individual and group commitment to decisions that needed to be taken by their direct involvement.

Management style was participative but this did not mean a reduction in decision-making responsibility or relevant authority.

Once the projects were underway, effective systems for their management were developed. These included problem solving via formal sensing, recording, assignation of solution responsibility etc. backed up by training in problem solving and management of the process.

They summarise the achievements (apart from technical success) thus.

'By putting a lot of effort into team building and organisational development, it was possible to minimise the risk of interface and interpersonal problems inherent in such an organisation'.

Theirs is not the only example of team development of this kind; many others exist in the literature and serve to illustrate the basic applicability of the concepts. Even within the research case study simple activities like 'mirroring' to improve mutual understanding and 'legitimating' to give a sense of organisational commitment to new approaches have been used.

What is being argued strongly here is for the organisation to move extensively in this direction. Internal design of inputs related to task situations - perhaps by projects - and use of experts purely as facilitators is recommended.

It is hard to present a coherent case for organisation development of this kind in a short space. Suffice it to say that the 'technology' exists: something can be done in this field given management commitment. Integration problems are likely to be the principal restriction on driving force (no-one wants to take risks when they don't feel they can trust each other) and both are related strongly to behavioural issues.

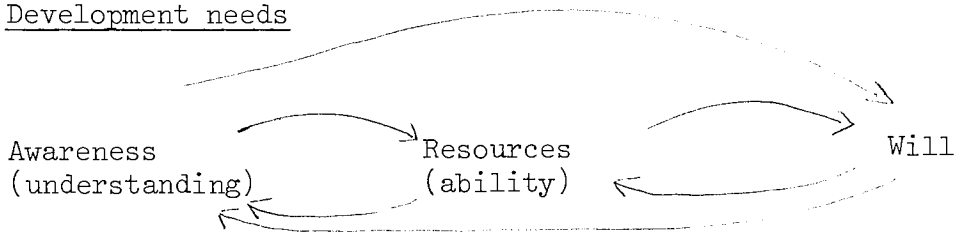
Overall the emphasis is again on creating adaptive mechanisms for the organisation to use to identify, understand and solve their own special problems, rather than general, possibly inapplicable, prescriptions.

Summary of Group Level Strategy

(a) Central problems

- motivation
- alienation and isolation
- lack of unifying principle
- communication/information flow
- style mismatches (leadership, skill, personal etc.)

(b) Development needs



- improve self-awareness and understanding of relationship to others and to system (with particular reference to style variations)

- improve and update technical skills
- broaden experience of other skill areas
- acquire new skills e.g. behavioural and economic
- improve approach to problem solving via open-mindedness

- improve self-confidence
- take more risks
- become positive initiators of change

(c) ideal aimed for: this will vary with the kind of group under consideration. Generally a well-integrated group with high levels of interpersonal trust and confidence which allows risk-taking. Interpersonal competence is high; where there is conflict it is openly resolved. A wide range of technical and non-technical skills are available: in the functional group there is a high level of specialist expertise. In the project team there is interdisciplinary competence ensured by the presence of integrated task specialists representing various technologies.

In all cases the group will have a high level of autonomy and responsibility for its task. Control will be via shared values and beliefs rather than by external sanctions. Motivation will consequently be high.

(d) general approach: again the emphasis is on self-management; autonomous work groups who are largely responsible within constraints for their own activities. Development should again be based upon allowing groups to work on task-related, project-based training. Self-assessment and internal regulation leading to improvement from within should be the control paradigm.

Group Level Strategy

Driving Force Promoters →	← Resisting Force Lubricants
- 'creativity' training	- improved broader outlook via job rotation via informal relationships via internal project teams via matrix structures via generalist 'pools'
- improved contact with outside world, market plact etc.	- experience of other orientations
- improved contact with other groups and specialisms - 'creative interchange' via seminars etc.	- improved style match in management via feedback and discussion via process consultation via simplifying languages and discussion via alternative communication channels via structured consultant interventions
- development of informal structure	- improved personal style match
- use of gatekeepers and architectural rearrangement	- interactive skills training via OD approaches via task-oriented learning via programmed learning via self-designed learning
- enhanced capabilities via new skill acquisition and existing skill upgrading	
- entrepreneurial training	
- interpersonal competence development to improve risk-taking	
- new venture groups	

III. Organisation Level Strategy

Here the problems are concerned with:

- getting groups to work better together

- promoting closer contact between hierarchical levels

- motivating the organisation towards a more confident risk-taking climate.

- encouraging higher levels of participation and involvement

- coping with the world outside (by means of strategic choices).

(a) Driving force inputs

Once again these will have a lower priority than those concerned with integration. Posible options include:

(i) improve creative performance

- as for individuals and groups, so organisational 'creativity' can be enhanced - indeed, this is the stated goal of many organisational change programmes.

Open-mindedness and a willingness to consider new and difficult ideas is a characteristic which can be bred into an organisational climate by means of training and development along lines already indicated. The 'not invented here' approach which characterises inderdepartmental boundaries should be broken down by using more interdisciplinary teams.

- environmental manipulation is likely to be the most effective way in which creativity can be enhanced at an organisational level. As has already been indicated, moving the balance between individual autonomy and organisational control may yield results. A general 'loosening of the reins' may help to remove some of the frustration which individuals report at the 'organisation obstacle course'. Reliance on rules and procedures and mechanistic principles may not be the most apposite approach to innovation management
From the point of view of creativity
management most prescriptive theorists suggest an organic and flexible structure. However control of the process requires the above conditions: again it is a balance which needs to be struck.

(ii) improve need pull/knowledge push

- the strategies outlined at individual and group level will be applicable here. However, the problem is really to ensure closer organisation/environment coupling so as to increase the anticipatory power. One way of achieving this is via forecasting, whether technological or marketing and a number of options of this kind are available.

Information flow is important: ways of coupling individuals and groups have already been discussed. At organisation level the need is for a reliable information base which is constantly updated: a range of management information systems are available from simple informal arrangements to highly complex ones involving computers etc. The principle remains the same, however - providing the management meta-system with information on which to base strategic decision-making.

One area where information flow is patently a problem is in the market-place. Uncertainty is inevitable in this area but its effects are exaggerated because there is no formal information gathering function. Marketing as a group has a sales function and collects information as a by-product.

The system works well enough in the UK market but the added complications of communication chains and general integration difficulties with Basle make the export market very hard to control. For this reason strategic decision-making quality is not as high as it might be with better information input - and this has serious consequences like erosion of confidence.

One possible option here is the setting up of a special market intelligence group, perhaps related to Product Management. Galbraith (1977) and other organisation design theorists express increasing concern for improving information processing capability to reduce uncertainty and increase decision quality.

(iii) <u>improve general capability</u>

In order to continue to cope with external complexity we have seen that organisations develop by internal differentiation. This is the most viable strategy and attention needs to be paid to monitoring what specialist needs are emerging and ensuring that provision for these is made in planning. Upgrading of existing expertise is also important: in all cases care should be taken in planning considerations to allow for the problems of integrating new specialist groups.

Capability can also be enhanced by structural design; this is a major proposition advanced by organisational theorists. Galbraith (1977) for example, is very concerned with uncertainty and decision-quality and suggests a number of ways in which the organisation can adapt either by increasing its information processing capability or decreasing the need for it. (This is based on the assumption that uncertainty represents a lack of information). These include:

- create slack resources (usually by lowering the critical performance levels, making it easier to achieve goals and hence 'liberating' resources).

- create lateral relations (integration, as discussed later).

- create self-contained tasks (e.g. by having autonomous groups at the environmental interface, decentralising and delegating).

- environmental management (e.g. by co-opting, co-operating or coercing rather than competing with other suppliers, or by securing monopolies etc. with customers).

- create better vertical information systems (could include use of computers etc.)

(iv) improve risk-taking

Here the emphasis must be on corporate risk-taking. The climate of the organisation has reached a level where 'defeatist' talk is common: the general belief is that the company has slipped from being a strong leader in the first division to a struggling second division side, beaten by the giants and by the smaller firms in the business. Organisational self-confidence is at a low ebb.

How far low-risk strategic decisions are influenced by factors such as dependence upon Basle for investment capital is difficult to say. Certainly the trauma of the 1974/75 recession, coupled with experiences like the failure of the publication gravure strategy must push in the direction of caution. Nevertheless there is a feeling that little consideration is given to what might be viable radical proposals.

An example might be the apparently short-sighted approach to future plant design. At a time when project time scales are lengthening and technological efficiency accelerating, it ought to be a major priority to have some group trying to work out what long-term major process innovation is required.

(b) lubricant inputs

Four classes of input seem important here:

(i) functional integration

- on the assumption that groups have the necessary specialist expertise and capability, the organisational problem is to bring them together in the most productive fashion. The st fundamental input available at this level is structural change via planned organisation design. As the discussion in chapter three indicated, modern thinking on this subject tends to support a contingency approach, i.e. one which depends on a number of variable factors.

Galbraith (1977) is typical of this school and of interest to us because his suggestions are particularly concerned with increasingly uncertain environments and tasks. He suggests that lateral relations are a key option in improving information processing (hence uncertainty reduction) ability. Amongst options open are:-

- direct contact between functions (formal and informal)

- liaison personnel with specific responsibility for this

- task forces, project teams, other interdisciplinary experience

- problem teams whose task function is to solve integration difficulties

- linking managers whose task function is to solve integration difficulties

- integration specialists whose task function is to solve integration difficulties

Experience in activities like project management indicate that on a task level integration can be achieved using this kind of approach. However, in the longer term it would be advantageous to build in integrative capability by mechanisms which reduced the gap between groups who may have totally different values, beliefs and general orientations.

(ii) vertical integration

As much of the data illustrated, there is concern about the growing gaps which are felt to exist between hierarchical levels in the company. This is partly an inevitable consequence of increasing delegation and decentralisation, themselves valid responses to increasing environmental demands.

However, there is a need to build back into the system some feeling of vertical integration. Some of the symptoms are simple - for example the often-expressed view that senior management aren't seen enough, particularly at Paisley. Some are highly complex, such as the concern about the planning and decision-making process.

- 'Involvement in decision-making and planning is a crucial requirement at organisation level. Apart from the evidence of strategy mismatch, loss of confidence, unproductive conflict etc. cited in this study, the work of Mumford and Pettigrew (1975) is offered as further illustration of management's need to cope with human problems in innovation. In particular adaptive mechanisms need to be created to account for the following types of situation.

- conflict between different levels and groups which allows for negotiation and bargaining. Mechanisms needed to accommodate this process within the planning operation.

- autonomous power and influence of informal kinds at operating levels, whereby these groups make their views known on decisions from which they have been excluded. Mechanisms needed to involve these groups at every level.

- decision-making process needs to take into account personal values and interests of individuals and groups concerned. Planners need to be aware of those solutions which will prove personally acceptable to the managers who have to operate the innovations.

- attempts at what is seen as rational decision-making frequently become distorted and overlaid by political issues which are not always recognised and made explicit. The planner should try and identify those participating in the decision process and the different roles they are playing.

- for many strategic problems there is no one best or correct solution: the choice is often based upon 'strategic mobilisation of power resources' (i.e. politics). Technical and financial evaluations of feasibility are limited in their application: other ways of doing this are needed.

- management tend to concentrate on financial and technical matters and human consequences to operational managers and their staff are largely ignored. Mechanisms needed to make management aware of these factors'.

Within the organisation a number of demands for greater contact between levels were made and input suggestions regularly appeared in quarterly reports. Notable in these comments was the absence of information flow: people at the top had no way of knowing directly what was going on and being thought at lower levels and vice versa. Hence the belief that 'senior management aren't doing anything about our problems': in fact, what senior management were doing was not communicating itself to lower levels because of this hierarchical gap.

What is needed are mechanisms to bridge the gap: at best these should be informal and people-centred on the basis of direct contact. Other alternatives include management seminars, more open circulation of minutes and details of decisions, more management visits etc. As Miles (1975) suggests:-

'Innovative planning recognises that the process of producing plans is rather more important than the plans themselves.....It is participation in the process...which is critical, not only because the nature of the process of production will crucially affect the degree of commitment to the plan but also because the process is an important mechanism for learning to learn, and without this no system under change could hope to develop the adaptive capacity to cope with future organisational uncertainties'.

(iii) environmental integration

As indicated elsewhere, coping with the outside world is of critical importance at organisation level. Choice is governed by the strategies the organisation uses (which may be themselves related to the level of dependence on other agencies - e.g. the parent company). These strategies need to be developed on the basis of the best possible judgement rather than on the mobilisation of power resources in a political fashion. Ideal though that statement is, (since strategy is a matter of informed opinion and judgement which will vary), there are mechanisms (described earlier) for productive conflict resolution etc.

'Boardroom development' is as important as any and every other project or task-related strategy. Once strategy has been fixed, there is extensive evidence (e.g. Chandler 1962) to support the proposition that structure should be adjusted to fit it in the effective organisation. For this reason, we return once again to the concept of flexibility. In the innovation process, strategy must take account of a volatile environment and this will require a liberal, flexible structure to adapt with. Evidence for this is very strong (examples already cited, also Pennings (1975), Harvey (1968), Keller et al (1974)). Galbraith's interpretation of the organisational design problem and his proposed actions are also relevant here.

The principle is once again one of changing the organisation to suit the demands of the situation whilst building in the adaptive capacity to respond to changes in the future. This approach is likely to put more emphasis on autonomous groups operating at the organisation's interfaces with the environment. It will require decentralisation and delegation whilst maintaining the integrity of the whole system by more sophisticated and flexible mechanisms than rules and hierarchies. Once again the concept of integrated self-controlling, self-regulating units emerges.

(iv) 'cultural' integration

This is an immensely complicated issue but one which underlies all the preceding discussion. If organisations consist of individuals with personal beliefs, values, goals etc. then two propositions might be advanced.

- the effective organisation is one in which values and goals are shared (or at least in constructive conflict, helping to adapt the organisation).

- the effective organisation is one in which there is an adaptation process of changing goals and values etc. which has a rate acceptable to all concerned.

These are both ideals, but they indicate the direction in which 'cultural' integration (by which is meant the complex of values, beliefs, norms, attitudes etc.) should take place.

Organisation climates can be influenced, particularly at the top; if conflict is the norm here, it will become so lower down.

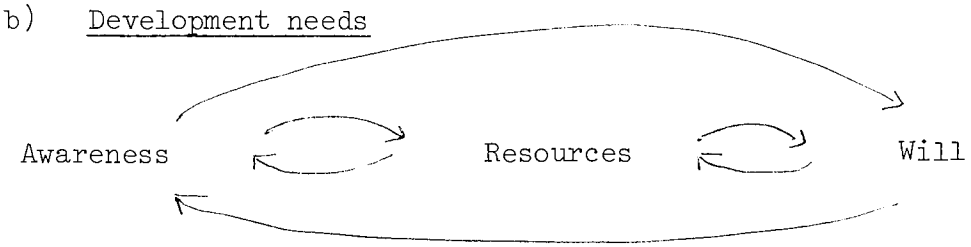
Examples of the growth of 'mythologies' have been advanced: it is argued that a climate based on openness and interpersonal trust rather than on political conflict must be established at high level in order to permeate the cultural structure of the remainder of the organisation.

Summary of organisation level strategy

(a) Central problems:

- structure
- style mismatches
- motivation
- strategy(conflicting views)
- political climate
- control patterns
- intergroup conflict (communication, co-operation problems)
- alienation/loss of confidence
- failure to cope with environmental variation

(b) Development needs



- improve understanding of the way in which the organisation and its sub-parts interrelate and of its relationship to the world outside
- improve understanding and sharing of common values so that control moves from a crisis stumbling around to a self-deciding, self-directing operation based upon strategic choice

- improve capability to process information and to cope with environmental complexity by developing new specialisms
- improve behavioural and other non-technical skills

- improve organisational confidence
- restore the risk-taking 'first division' image
- improve long-term vision and orientation
- improve commitment to organisation

(c) ideal aimed for: this will be the highly-integrated organisation with all elements understanding, sharing and commiting themselves to corporate objectives. Control will tend to be by 'self-management-by-standards' rather than by rules and procedures: because everyone shares common values, people can work to 'limits of acceptability'. Skills are highly developed across a whole spectrum including relevant behavioural understanding. High levels of decentralisation, differentiation and specialisation allow the organisation to cope with environmental variety but these are well-integrated so that there is a minimum of energy lost through internal friction. The climate is open and constructive criticism is a legitimate activity: feedback to all levels ensures that people know what is going on. Self-renewal (Gardner 1963) is an operating principle whereby the organisation is constantly assessing and improving itself via flexible internal development processes.

(d) general approach: again the pattern is one of self-control and management which will be based upon high levels of integration in the organisation. The various components will be autonomous and flexible enough to react quickly to external stimuli but self-regulating and improving. Development options should again be aiming away from 'plug-in' approaches and towards project oriented task-related learning.

Organisation level strategy

Driving Force Promoters →	← Resisting Force Lubricants

- increased specialist capability by
  - recruitment of skilled personnel
  - development of existing personnel
	- integrative mechanisms
	  - co-ordinating groups
	  - job rotation
	  - project teams
	  - matrix structures
	  - autonomous groups

- improved external contacts and relationships
  - with market
  - with competition
  - with community
  - with science
  etc.
	- improved participation via
	  - involvement of lower levels in planning (or information input to planning)
	  - decentralisation of control
	  - decision making autonomy at lower operational levels
	  - increased discretion

- development of information system via
  - market intelligence group
  - information base build-up
  - access via M.I.S. or similar
  - improved informal networks
	- improved communication patterns via feedback arrangements mirroring

- increased risk taking and long term commitment and planning	- legitimation of internal organisation development
	- resolution of high level conflict-establishment of an open

Conclusion

Summarising these strategies the point is again made that they are representative ideas only. In very few cases are the problem issues specific enough to be handled by a once-for-all solution. Nor is there space to list all possible options.

What is needed in the short-term are flexible approaches which the organisation can adapt and manipulate to suit the particular problem demands. In the longer term the capacity for self-designing, self-improving approaches should be acquired. Most important, organisational learning needs to take place to understand the mechanisms whereby problems arise and how they might be avoided in the future.

For this reason, cataloguing likely inputs is not going to prove very useful. It has already been argued (and demonstrated in the case of the later quarterly reports) that the capacity to generate possible solutions and problem-solving approaches lies in the organisation. The blueprint here is offered purely as a guideline, suggesting some areas which might be fruitfully investigated.

Another consideration is the fact that these examples are offered to illustrate elements of a co-ordinated integration strategy which is envisaged as the province of a full-time specialist. They are not advanced as 'plug in panaceas' for the problems identified in this research. Equally no mention is made of the extensive options for improving the technological or economic aspects of the innovation process (e.g. project selection, evaluation and monitoring techniques).

This is deliberate: the belief is that the organisation has sufficient capability in these areas to solve these problems internally. Integration, by contrast, has been presented as requiring new kinds of skills and understanding possibly not within organisation's existing capability.

CHAPTER 9 : Conclusions

This research began with a number of questions about the process of technological innovation. It was argued that, despite extensive study, understanding was still limited to a few general propositions. Guidance for the effective management of the process was restricted to prescriptive suggestions which were of limited value because of the extensive variation between elements involved.

Throughout the thesis an attempt has been made to examine this argument. Surveys of the literature on the process and on the influences which act on it in an organisational context are combined with extensive reporting of a case study.

The length of the resulting document suggests in itself that there was a great deal to study. In general, the main conclusion is that the multivariate nature of the process is confirmed. What, then, are the implications for managing innovation in an increasingly complex and varied environment?

From the research it appears that integration may be a central concept; nearly all the problems identified were concerned with some facet of this. It is suggested that differentiation is a 'natural' organisational response to environmental increases in variation, and thus integration will become an increasingly pressing issue. Arguably in highly uncertain and non-programmable activities such as innovation integration will be a major determinant of performance; most general theories of innovation support this view.

What is not so clear is our understanding of the dynamics of integration - how it affects the process, how it may be developed etc.

Traditionally it has been one of the responsibilities of managers to ensure integration in their organisations but it is argued that it is rapidly becoming an activity for specialist attention.

The idea of a full-time integration specialist is advanced. This individual would have the responsibility for diagnosing integration needs and developing and implementing suitable strategies to cope with these. However, to delegate responsibility for this task does not really solve the problem of integration.

Ultimately what is needed is the building up of an adaptive capability within the organisation. Systems need to be devised which are flexible and fast in their response, and self-regulating in their control. Integration must evolve from a higher level of organisational development.

Technological change has always been associated with other kinds of change. The central argument of this thesis is that improvements in the effectiveness of technological innovation can only be made with accompanying organisational innovation.

It is claimed that this research has contributed to the body of knowledge about the innovation process by:-

- developing suitable methodological approaches for the study of innovation and other organisational processes.

- identifying some of the influences which affect the way in which processes are carried out within organisations. Whilst attention was paid specifically to innovation, it is argued that the parallel model for individuals, groups and organisations might form the basis for developing a general theory of action.

- development of a system model which attempts to account for innovation as a key adaptive response in organisations.

- development of an analytical framework for analysis of problems within innovation.

- presentation of a detailed case study which was carried out with a participant perspective.

- development of the concepts of integration specialist and planned integration strategies.

- development of a proposed integration improvement strategy for the case of the company studied.

Much research is still needed, however. In particular, attention should be paid to:

- more research of the case study type which provides detailed information about the dynamic variations associated with the innovation process within a specific organisation. Although the general value of single studies of this kind may be limited, it is argued that additively they will contribute to the development of a contingency/probabilistic model of the process.

- development of adaptive capability within organisations via internal learning rather than by use of 'plug-in' techniques.

- investigation of the concept of integration and its relationship to performance as a specialist activity in its own right. In particular, practical experience of planned integrative change (not just along organisation development lines) needs to be reported.

- investigation of the relationships (if any) between size, technology and other contingencies and the integrative demands in processes like innovation. Is it just a problem of growth or is it a function of the environment and an issue which all firms will ultimately have to confront?

- more emphasis on the behavioural dynamics of processes in organisations, and an improving general understanding of these elements.

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Appendices

(1) Methodology appendix

(a) examples of:-
- Q-sort measure
- Work preference questionnaire
- Organisational mapping questionnaire
- Organisational beliefs measure
- Personal beliefs measure
- Creativity audit
- Peg-board measure

(b) overview of participant observation.

(2) Results appendix

(a) Q-sort measure
(b) Work preference questionnaire
(c) Organisational mapping questionnaire
(d) Organisational beliefs measure
(e) Personal beliefs measure
(f) Creativity audit

(3) The Aston Index

(4) List of documents etc. not included in thesis

Appendix 1 : Methodology

(a) examples of:

- Q-sort measure
- Work preference questionnaire
- Organisational mapping questionnaire
- Organisational beliefs measure
- Personal beliefs measure
- Creativity audit
- Peg board measure

(b) overview of participant observation

Style Q-sort

CIBA-GEIGY/ASTON UNIVERSITY PROJECT

'Q'-SORT QUESTIONNAIRE

MARCH, 1976.

NAME:-_____

Dear,

I would be grateful for your assistance in completing this short questionnaire which I am using to collect data for my research studies on the communication of innovation.

On the following pages are a series of statements, each of which describes a quality or character trait attributable to a research and development scientist. Next to each statement, on the right, is a box. Please place a number in that box, corresponding to the relevance you feel that the statement has. For example, if the statement were:-

"Reacts quickly to research problems; immediately generates a great number of ideas".

and you thought this highly relevant, you would place a "5" in the box. Or, if you found it relatively unimportant, a "2". The available categories are:-

1	Irrelevant
2	Relatively unimportant
3	Indifferent
4	Relatively important
5	Highly relevant

Please try and answer quickly and do not spend too much time on any one statement. Remember, too, that there are NO RIGHT OR WRONG ANSWERS.

When you have completed the questionnaire, I would be grateful if you would return it to me. Thank you.

JOHN BESSANT

Please put number in each box:-

1	2	3	4	5
IRRELEVANT	RELATIVELY UNIMPORTANT	INDIFFERENT	RELATIVELY IMPORTANT	HIGHLY RELEVANT

(1) Reacts quickly to research problems; immediately generates a great number of ideas. ☐

(2) Is somewhat deficient in his command of basic sources and technical literature in the field. ☐

(3) Pursues details and ramifications of research problems with great thoroughness. ☐

(4) His research interests lie within a narrow range. ☐

(5) Has exceptional facility in mathematical analysis. ☐

(6) Easily discouraged; needs help and encouragement to do his best work. ☐

(7) Is keenly interested in methodological aspects of research. ☐

(8) Prefers to work on problems which lend themselves to elegant and exact solutions. ☐

(9) Tends to slight the contributions of others; takes undue credit for himself. ☐

(10) Likes to play his hunches in research; is guided by his subjective impressions. ☐

(11) Is neat and orderly in his habits and manner of work. ☐

(12) Dislikes and avoids administrative details connected with research projects. ☐

(13) Is good at developing short-cuts and approximation techniques. ☐

(14) Frequently makes errors; his work needs to be checked for accuracy. ☐

(15) Prefers to work alone; is not a "team" research man ☐

(16) Is erratic in his research output; varies from work of excellent quality to work of marginal or even inferior worth. ☐

(17) Indifferent to the practical implications of his own research. ☐

(18) Seldom comes up with a really new idea or suggestion. ☐

(19) Has exceptionally high standards of research performance for himself as well as for others. ☐

(20) Has a special talent for solving instrumentation problems. ☐

(21) Is thorough and patient in his approach to research issues; does not get upset if progress is slow. ☐

(22) Is a driving, infatigable research man; cannot stop working on a problem until it is solved. ☐

(23) Is relatively uninformed on most subjects other than his research speciality. ☐

(24) Good at evaluating research; able to diagnose strong and weak points in a program quickly and accurately. ☐

(25) Is fiercely competitive; wants to be the best man in every research task that he undertakes. ☐

(26) Seeks out the help and advice of other people when he hits a trouble spot in his own research. ☐

(27) Makes a serious effort to read current publications and to "keep up" on the literature in his field. ☐

(28) Is creative in anything he tries, whether in science or not.

(29) Has an orderly, well-organised approach to research, plans his projects and activities with great care and precision.

(30) Gives freely of his own time and ideas to other research endeavours without asking for special credit or recognition.

(31) Likes to talk out his research ideas and get other people's reactions.

(32) Many of his ideas turn out to be impractical.

(33) He is aware of his own professional limitations; does not attempt what he cannot do.

(34) Has a quick tempo of thought and speech.

(35) Prefers to think in analytical and mathematical ways, rather than in terms of physical and structural models.

(36) Is never too busy to "talk shop" with other researchers.

(37) Has an exceptionally good memory.

(38) Has a knack for improvising quick solutions in research trouble spots.

(39) Is a research perfectionist; devotes endless attention to matters of design, apparatus, procedure etc.

(40) Plays his cards "close to the vest"; prefers not to tell anyone about his research plans until his work is finished.

(41) Is a creative and inventive researcher.

(42) Is intolerant of metaphysical issues.

(43) Is a talented "re-write" man; can take other people's ideas and hunches and fashion them into practical research designs and programs. ☐

(44) Has strong research biases; is vehement in his disapproval of certain methods and procedures. ☐

(45) Primarily an "idea man"; prefers to turn his hunches and hypotheses over to someone else for systematic experimentation and analysis. ☐

(46) Somewhat given to bluffing; claims to know more than he does. ☐

(47) Stimulating to other people; seems to catalyse others into more original and productive endeavour than they would otherwise achieve. ☐

(48) Tends to be sarcastic and disparaging in describing the work of other researchers. ☐

(49) He is intellectually gifted. ☐

(50) Has a lively sense of intellectual curiosity and inquiringness, a desire to know and to understand. ☐

(51) Is flexible and adaptable in his thinking; able to shift and to restructure easily. ☐

(52) Takes an esthetic view; is sensitive to matters of form and elegance in research problems. ☐

(53) Has a "sense of destiny" with respect to his own research career, an inner conviction of the worth and validity of his own efforts. ☐

(54) Enjoys philosophical speculation. ☐

(55) Lacks confidence, is afraid to strike out in new direction. ☐

(56) Subordinates everything to his research and scientific goals; puts scientific values above all others. ☐

Thank you again for your co-operation.

ASTON UNIVERSITY PROJECT

Work Preference Questionnaire

Once again, I would be grateful for your assistance in completing this short questionnaire, the results of which I hope to use in my research.

The purpose of this questionnaire is to look at some of the views that you have towards your IDEAL ORGANISATION and IDEAL BOSS. Please do not describe your current job situation in this questionnaire: think of the type of organisation and boss you would ideally prefer for your personal satisfaction regardless of whether or not they would be the best choice for you at your particular stage or career.

You will find the questionnaire is rather an unusual format. On the following pages you are given pairs of descriptions. The first set of these describes different kinds of organisations, and the second set deals with differing types of boss. Please read each pair of statements and then mark, with a cross, the one statement in the pair which you find closest to your own preference. By marking one statement this does not mean that you have no preference at all for the other statement. It just means that, on balance, one is slightly more orientated towards your way of thinking than is the other.

The choices may be sometimes rather tricky - like choosing between the lesser of the two 'evils' or the better of the two 'goods'. Nevertheless you will find that a choice is possible - one will just tip the balance for you.

Read each statement carefully and always make one choice from each pair of descriptions. Please do not leave out any questions.

Would your ideal organisation be one...

1. Where a person's promotion is unpredictable and depends largely on his own good performance.	or	Where a person can see exactly how his career will progress after certain periods of time.
2. That regards special benefits, such as attractive bonuses, free pension schemes and a company car, as the prime incentive to remain in the job.	or	That concentrates on tempting new employees with interesting work, although it is not able to pay as much as other organisations providing less interesting work.
3. Where it is emphasised that the 'job comes first', therefore afterwork pleasures should take secondary importance.	or	Where it is very difficult to carry on work over a weekend period should someone so desire.
4. Where the few changes in tasks that occur allow people to perform one type of work with considerable care and proficiency.	or	Where there is constant pressure to complete a task well in a short period of time and to then become involved with another task.
5. Where there is a general attitude that, even if the working conditions are very poor, much can be compensated by interesting work.	or	Where little that is favourable can be said about the work itself but where the attitude of management towards its employees' welfare is first-class.
6. That gives people jobs that can very likely be done well.	or	That gives people work which is not so difficult that they would have to rely on luck to do a good job nor so easy that they are bound to succeed.
7. Where it is expected that leisure time will be sacrificed if work pressure is great.	or	Where it is felt that working late is undesirable because eventually strain will be experienced in normal working hours.
8. That believes that if a person concentrates primarily on working in a warm, close fashion with his co-workers, good work must follow.	or	That regards the successful completion of an employee's assignment as more important than the feelings of that person's co-workers.
9. That expects individuals to help the organisation by fulfilling their own personal goals.	or	That expects its employees to strongly identify with the organisation rather than think of themselves as individuals apart.
10. Where good working companions and generous holidays are provided to make up for the tedious nature of the work.	or	Where there is more concern with employees' satisfaction with the actual work that they do than with their general conditions of work.
11. Where each employee is solely responsible for most of the work that he performs.	or	Where several people are always responsible for, and take the credit for, a particular piece of work.

Would your ideal boss be someone...

12.	Who gives his employees work that they feel sure of doing well without too much effort.	or	Who gives people work requiring quite a lot of struggling to master.
13.	Who insists on finding out how worthwhile his employees see their work but neglects looking into the enjoyment that they get from their work.	or	Who regards the pleasure that his employees get from their work as more important than the actual worthwhileness of the work.
14.	Who emphasises the importance of the work group's responsibility for its decisions rather than particular individuals in the group taking the responsibility.	or	Who relies on a particularly efficient individual in a work group to control the group's activities.
15.	Who expects to be consulted only for very exceptional work problems.	or	Who encourages employees to follow set procedures in their work.
16.	Who attempts to provide attractive work for his employees even if it is not of great value to them.	or	Who would not give people work that they could view as of little value even though it may be highly attractive to them.
17.	Who gives his employees general guidelines on which to base their own decisions about how to proceed with their work.	or	Who gives clear, very comprehensive instructions on how employees should carry out their work.
18.	Who finds that for group morale it is better to try to preserve good co-worker relationships that may be spoiled by letting people keep working at a task to their own satisfaction.	or	Who feels that a certain degree of bad feeling amongst employees is worth tolerating if they are very much involved with their work.
19.	Who looks for future employees who will be able to work independently of others.	or	Who looks for future employees who will primarily be good at getting on well with other employees.
20.	Who would rather employees consulted him with work difficulties than struggle with them themselves.	or	Who will not interfere with work for which employees have responsibility.
21.	Who expects an individual's work rate to remain relatively uninfluenced by his colleagues.	or	Who relies on the group as a whole to produce a given amount of work, expecting the group to influence an individual's quantity of work done.

22.	Who views good employee relations as being most important and incompatible with competitiveness.	or	Who insists on individuals trying to achieve a better performance rating than their co-workers.
23.	Who gives employees work where they need to write fairly detailed arguments about problem solutions.	or	Who gives employees work that involves very little written reporting or problem discussions.
24.	Who feels that working late should be avoided.	or	Who encourages working late in order to meet a deadline.

When you have completed the questionnaire, I would be grateful if you would return it to me.

Thank you again for your co-operation.

J. BESSANT

Organizational mapping questionnaire

CIBA-GEIGY PLASTICS AND ADDITIVES COMPANY, PIGMENTS DIVISION/ASTON UNIVERSITY

JOINT PROJECT

Once again, I would be very grateful for your cooperation in completing this questionnaire which is designed to test attitudes and opinions on a wide variety of organisational factors. In this way I am hoping to identify relevant problem areas and also to examine any areas where the need for change is strongly felt: there is also a section designed to reflect how far and in what directions change has already taken place.

On the following pages are a series of broad headings and below them a list of relevant statements. I would be grateful if you would record your feeling about each individual statement by placing a number, corresponding to the required category, next to the statement.

The available categories are:-

(1) - strongly agree
(2) - agree
(3) - indifferent
(4) - disagree
(5) - strongly disagree

Thus, if you felt that the statement, in section (1), that "the objectives have been realistically planned" was one which you strongly agreed with, you would place a (1) next to it, on the right of the page. Alternatively if you disagreed with it, you would place a (4) and so on.

Each heading is described in two contexts: from within the department, and from within the organisation of Pigments Division as a whole.

If you have any difficulties or queries please do not hesitate to consult me. I should be grateful if you would return the finished questionnaire to me.

Thank you for your cooperation.

J. BESSANT

SECTION (1) Objectives

In the context of this department, how far do you feel that:-

(a) the objectives have been realistically planned?

(b) the objectives have been effectively communicated?

(c) the objectives have been clearly understood?

(d) the objectives have been successfully achieved?

(e) the objectives have been flexibly defined so as to be sensitive to changes outside the department?

(f) the objectives have been planned to make effective use of departmental resources (e.g. people, equipment, etc.)?

(g) there is a high level of involvement in the development of a departmental strategy to meet these objectives?

(h) there is a clear statement of formal R. & D. policy?

(i) the major obstacles to the fulfilment of these objectives arise from non-technological factors?

(j) the major obstacles to the fulfilment of these objectives arise from outside the department?

In the context of the Pigments Division organisation, how far do you feel that:-

(k) the objectives have been realistically planned?

(l) the objectives have been effectively communicated?

(m) the objectives have been clearly understood?

(n) the objectives have been successfully achieved?

(o) the objectives have been flexibly defined so as to be sensitive to changes within the organisation?

(p) the objectives have been flexibly defined so as to be sensitive to changes outside the organisation?

(q) the objectives are too strongly influenced by Basle?

(r) there is a clear statement of formal R. & D. policy?

(s) there is a clear understanding of the role of R. & D. in the organisation of Pigments Division?

SECTION (2) Structural Factors

In the context of this department, how far do you feel that:-

(a) the existing structure makes effective use of available resources (e.g. people, equipment, etc.)?

(b) the existing structure permits the use of individual initiative?

(c) the existing structure allows for greater delegation of responsibility?

(d) the existing structure permits each member of the department to make a significant contribution to, and to feel involved in, the life and work of the department as a whole?

(e) the existing structure is well adapted to the function the department has to perform?

In the context of the Pigments Division organisation, how far do you feel that:-

(f) the existing structure permits each individual to feel involved in and able to contribute to the life and work of the organisation?

(g) the existing structure allows for delegation of responsibility?

(h) the existing structure is flexibly defined to respond to changes in the outside world?

(i) the existing structure can quickly adapt to changes in the world outside?

(j) the existing structure is too far dominated by Basle?

(k) the existing structure is too rigidly defined to permit adequate contact between groups and departments?

(l) there is a gap between different levels in the management hierarchy?

(m) there is a distortion of perception across this gap?

SECTION (3) Communication

In the context of this department, how far do you feel that:-

(a) information is effectively communicated?

(b) information is selectively 'filtered' before being communicated?

(c) information is communicated in a timely fashion, so that a sense of involvement and awareness is generated?

(d) information is more completely and openly communicated, i.e. that 'the whole story' gets passed on, by the informal network than by the formal one?

(e) information is more effectively communicated, and in a more rapid fashion by the informal network than by the formal?

(f) the informal communication network is better adapted to keeping people informed and thus fostering a feeling of involvement and awareness?

(g) the informal communication network represents a distorting factor which contributes little to and may in fact inhibit the passage of correct information?

(h) the informal communication network reaches a much wider 'audience' with a much greater variety of information than does the formal?

In the context of the Pigments Division organisation, how far do you feel that:-

(i) information is effectively communicated?

(j) information is passed on a selective 'need to know' basis rather than on a completely open 'telling the whole story' basis?

(k) information is communicated in a timely fashion such that a feeling of awareness and involvement is generated?

(l) information is more effectively communicated, and in a more rapid fashion by informal channels rather than by formal ones?

(m) the informal communication network represents a distorting factor which contributes little to, and may in fact inhibit, the passage of correct information?

(n) the informal communication network reaches a much wider 'audience' with a much greater variety of information than does the formal?

SECTION (4) Job-related factors

In the context of this department, how far do you feel that:-

(a) jobs are accurately defined?

(b) jobs permit a high degree of self-fulfilment?

(c) jobs offer a realistic opportunity for career development?

(d) the assessment procedures in use are effective indicators of performance?

(e) existing job descriptions offer the opportunity to contribute to the department as a whole?

(f) the assessment procedures are carried out in a uniform fashion?

(g) the assessment procedures permit an objective analysis of performance?

(h) promotions represent a meaningful change in job characteristics rather than an automatic 'step up the ladder'?

SECTION (5) Group-related factors

In the context of this department, how far do you feel that:-

(a) there is good cooperation between groups?

(b) there is good cooperation amongst individuals within groups?

(c) there is a belief that conflicts and disputes can only be resolved in a win/lose fashion rather than by a compromise acceptable to both sides?

(d) there is good mutual understanding between groups and a clear appreciation of the problems and difficulties involved in other areas?

(e) there is a clear definition of the task(s) which the group has to fulfil?

(f) there is a clear definition of the role the group has to play in the department?

(g) the clear understanding of role and task of the group leads to a sense of involvement, awareness and cooperation?

(h) that informal relationships help to strengthen a group from within?

(i) that informal relationships help to avoid confrontation situations between groups?

(j) that informal relationships help to foster a greater self-awareness and improve interaction with others both within and between groups?

In the context of the Pigments Division organisation, how far do you feel that:-

(k) there is good cooperation between groups?

(l) there is a belief that conflicts and disputes can only be resolved in a win/lose fashion rather than by a compromise acceptable to both sides?

(m) there is good mutual understanding between groups and a clear appreciation of the problems and difficulties involved in other areas?

(n) that informal relationships help to foster a greater self-awareness and improve interaction with others both within and between groups?

SECTION (E) Innovation

In the context of the Pigments Division organisation, how far do you feel that:-

(a) attitudes towards innovation are too conservative?

(b) emphasis is placed on systematic work within procedure rather than on speculative, more radical work?

(c) the overall policy could be described as safe and sure?

(d) major departure from this policy would only result in major problems?

(e) the major barriers to innovation are not in the production of good ideas but in the process of carrying these into practice?

(f) these problems are not so much a function of the system itself as the personalities and behavioural factors involved?

(g) that the 'streamlining' of Meeting III has led to a 'gap' between functional departments in the innovative process and the R. & D. policy interpretation as performed by Meeting III.

(h) that the setting up of the T.C.G. has helped towards closing this gap by providing a link between functional departments and Meeting III?

SECTION (7) Change

(In this section, please indicate your opinion of the change in terms of the following categories:-

(1) greatly improved
(2) improved
(3) no change
(4) deteriorated
(5) greatly deteriorated.

Please put the relevant figure on the right of the page as before).

In the context of this department, during the past 12 months, how far do you feel that there has been a noticeable change in:-

(1) definition of objectives?
planning " " ?
communication " ?
understanding " ?
achievement " " ?
flexibility in setting of objectives?

(2) the existing structure?
the use of resources within that structure?
the " " individual initiative within that structure?
the involvement of individuals in that structure?
the adaptability of that structure to the tasks of the dept.?
delegation of responsibility within that structure?

(3) communication efficiency?
" openness ?
" speed ?
closer links between formal and informal networks?

(4) job definition ?
self-fulfilment?
career development opportunities?
assessment procedures?

(5) cooperation between groups?
" " individuals?
attitudes to interfacial problems?
mutual understanding between groups?
task definition for groups?
role definition " " ?

In the context of the Pigments Division organisation, how far do you feel that there has been a noticeable change in:-

(1) definition of objectives?
planning " " ?
communication " ?
achievement " " ?
flexibility " " ?
understanding " ?
influence on objectives by Basle?
definition of R. & D. role?

(2) the existing structure?
the use of resources within that structure?
the delegation of responsibility within that structure?
flexibility of structure?
adaptability " " ?
influence on structure by Basle?
contact between groups and departments?
distance between levels in the hierarchy?
perceptions across interfaces?

(3) communication efficiency?
" openness ?
" speed ?
closer links between formal and informal networks?

(5) cooperation between groups and departments?
attitudes to interfacial problems?
mutual understanding between groups?
task definition for groups?
role " " " ?

(6) attitudes towards innovations?
overall policy for innovation?
emphasis on more radical innovation?

Thank you again for your cooperation.

Organizational beliefs questionnaire

CIBA-GEIGY PLASTICS AND ADDITIVES COMPANY, PIGMENTS DIVISION/ASTON UNIVERSITY

JOINT PROJECT

The following questionnaire is concerned with how people feel about the division - the atmosphere, the way things are done, etc. Information of this kind is valuable since it places a study of innovation in the context of a real organisation involving people with varying attitudes, feelings etc.

The format is simple: on the following pages you will find a list of statements with a set of boxes on the right-hand side. The boxes are headed with the following options:

(1) Agree strongly

(2) Agree

(3) Indifferent

(4) Disagree

(5) Disagree strongly

(6) Don't know

For each statement, would you please mark the box which most closely represents how you feel about it. There are no right or wrong answers but the preferred response is the one which comes first into your head rather than one arrived at after long deliberation.

When you have finished, I would be grateful if you would return the questionnaire to me.

Many thanks for your co-operation.

J. BESSANT

	Agree strongly	Agree	Indifferent	Disagree	Disagree strongly	Don't know
1. Formal rules and regulations have a very important place here?						
2. People here tend to hide their deeper feelings from one another?						
3. This company has failed to keep pace with a changing world?						
4. Senior management are out of touch with what's really happening?						
5. This company treats some people as just a pair of hands?						
6. Management style in this company is out of step with the demands of the present day?						
7. There's not enough pressure put on people to perform well?						
8. This company does not care about the well-being of its employees?						
9. This place has a reputation for being indifferent to the needs of the wider community?						
10. This company places too much emphasis on technical skills and not enough on 'people'? skills?						
11. The company is always trying to take advantage of us?						
12. There is a lot of bootlicking here?						
13. When people leave this company, they become much more successful?						

	Agree strongly	Agree	Indifferent	Disagree	Disagree strongly	Don't know
14. In this company, decisions are made by groups too far removed from what's really happening?						
15. Too many of our managers are failures?						
16. Managers in this company often lack 'people' skills?						
17. High-level co-ordination is often irrelevant at the technical level?						
18. The planning process is too remote?						
19. In this company issues never get raised or confronted openly?						
20. People tend to stick to old-established rules and procedures rather than try and introduce new ways of doing things?						
21. People tend not to see any connection between company performance and their own responsibilities?						
22. This company is too conservative?						
23. Senior management have too narrow an outlook?						
24. People who get pushed around here are expected to fight back?						
25. Senior management are too isolated?						
26. Senior personnel are frequently jealous of their authority?						

	Agree strongly	Agree	Indifferent	Disagree	Disagree strongly	Don't know
27. Senior management don't let people know what they're doing?						
28. People give lip service to training and development without doing anything about it?						
29. Planning groups operate in a world of their own?						
30. This company has grown too big for its own well-being?						
31. Control of this company rests in the hands of too few people at too high a level?						
32. Things are getting worse for this company?						
33. People actively seek out the ideas and opinions of others?						
34. This company lacks professional managers?						
35. Senior personnel will go out of their way to help you with your work?						
36. People here follow the maxim 'business before pleasure'?						
37. To succeed in this company you need to prove yourself in pigments technology - nothing else matters?						
38. Formal rules and regulations have a very important place here?						
39. Few people here are stimulated by intellectual activities or problems?						
40. People aren't generally interested in the company's problems?						

		Agree strongly	Agree	Indifferent	Disagree	Disagree strongly	Don't know
41.	People are satisfied with the routine and mediocre?						
42.	It is fairly easy to keep up here without working too hard?						
43.	People here are encouraged to take a long-term view?						
44.	People think that the company owes them a living?						
45.	People here don't know anything about the rest of the division?						
46.	New ideas are always being tried out here?						
47.	Unusual or exciting plans are encouraged here?						
48.	There are no favourites in this place - everyone gets treated alike?						
49.	This company suffers from unresolved conflicts at high level?						
50.	There is a lot of group spirit around here?						
51.	There always seem to be a lot of little quarrels going on here?						
52.	Careful reasoning and clear logic are highly valued here?						
53.	People ask permission before deviating from common policies or practices?						

	Agree strongly	Agree	Indifferent	Disagree	Disagree strongly	Don't know
54. There are few opportunities for informal conversation with senior personnel?						
55. Criticism is taken as a personal affront in this organisation?						
56. Managers and supervisors tend to overlook their training and development responsibility?						
57. Groups and departments in this company don't really trust each other?						
58. People enjoy working for this company?						
59. People are generally good listeners?						
60. People avoid direct clashes with senior personnel at all costs?						
61. Managers tend to de-emphasise training and development in favour of more pressing demands?						
62. Work is well organised and progresses systematically from week to week?						
63. A discussion about the latest scientific developments would not be uncommon here?						
64. The work atmosphere emphasises efficiency and usefulness?						
65. Most activities present a real personal challenge?						
66. Most people here seem to be especially considerate of others?						

		Agree strongly	Agree	Indifferent	Disagree	Disagree strongly	Can't know
67.	People here feel they must really work hard because of the important nature of their work?						
68.	People get recognition for new ideas?						
69.	There is so much to do here that people are always busy?						
70.	Managers and supervisors really care about the people they supervise?						
71.	People here are generally efficient and successful in practical affairs?						
72.	People go out of their way to develop effective working relationships with others?						
73.	The flow of information downwards is smooth and efficient?						
74.	The ability to plan ahead is highly valued here?						
75.	People here speak out openly?						
76.	People feel that there's no point in trying harder - nobody else does?						
77.	Everyone here is safety conscious, anxious to avoid accidents and put right the conditions which produce them.						
78.	Social events get a lot of enthusiasm and support?						

Thank you once again for completing the questionnaire.

Creativity audit.

Manchester Business School
UNIVERSITY OF MANCHESTER

(b) Participant Observation - an overview

In keeping with demands imposed on a research programme which is closely-involved in a real rather than an experimental situation, selection of a highly flexible approach has been made. An appreciation of the close interrelationship between theory and method is required. This can be gained by adoptin the so-called interactionist viewpoint, i.e. one which views research methods not as atheoretical tools but rather as mean of acting on the environment and making it meaningful.

In this connection, Denzin (1970) suggests a series of principles against which methods and sociological activity ca be evaluated: these include:-

'(a) the investigator must take the perspective or 'role of the acting other' and view the world from his subject's point of view - but in so doing he must maintain the distinction between everyday and scientific conceptions of reality.

(b) ...research methods must be capable of reflecting process or change as well as static behavioural forms...

(c) ...the investigator must link his subject's symbols and definitions with the social relationships and groups that provide those definitions.....'.

This suggests a requirement for a research approach which:

(i) permits an intimate and long-term contact with the subjects.

(ii) is flexible enough to develop and test hypotheses within the context of the subject culture and its characteristics (e.g. language).

(iii) permits the use of formal sociological techniques whilst also suggesting and developing informal ad hoc sensors.

(iv) will have an outcome of value to the investigator in terms of greater understanding and awareness.

It is suggested that participant observation fits this general specification and its adoption as the major methodological approach was made on this basis.

Much of the seminal work on a variety of social organisations has been carried out by the process of observation by investigators actually connected in some way with these cultures. The most familiar example of this will be the anthropologist's use of fieldwork - living amongst his subjects for a sustained period of time, collecting data and interpreting experience in an attempt to arrive at a better understanding of the culture.

This debate is one strand of a larger dialogue: Hinkle and Hinkle (1954) talk of the fundamental epistemological question for example, of subjective and objective interpretation.

Accepting that this debate has no easy answers, we can assume participant observation to have a place as a methodology and concentrate on the process itself. The principal point of difference with other methodologies is the emphasis on the dynamics of the wider context of the organisation under study. These suggest a multiple rather than a specific approach, for reasons such as:

(i) the organisation is manifest in many situations simultaneously

(ii) there is a historical perspective to the organisation

(iii) many organisational features and determinants are only imperfectly inferable by direct observation.

Zelditch (1962) describes three types of information which may be acquired: incidents and histories, distributions and frequencies and 'generally known rules and statuses'. He identifies three classes of information gathering: observation, interviewing and sampling. It is then possible to see which information can be best gathered by which combination of methods - and thus, how firm an evidential basis to any given piece of information can be supplied.

Such an approach is likely to commend itself to many subjects and investigators for reasons of simplicity and applicability. However its general nature has meant a lack of detailed and codified study and this represents a limitation. At best it can be a complex learning process in which situational and personal interactions are the key experiences.

McCall and Simmons (1969) suggest several reasons for the lack of codification:

(a) participant observation is not a single method but rather a characteristic style of research which makes use of a number of methods and techniques including observation, interviewing, document and archive analysis, survey methods and individual impressionism.

(b) structure is deliberately loose so as to maximise discovery and description rather than to test theories systematically.

(c) the rejection of a priori concepts allows the formulation of new concepts within the subject context. This raises a problem of validity: whilst totally consistent within the system under study the interrelationship with an external body of knowledge is complex. Observer bias and the whole issue of 'subjectivity' in research become important considerations.

Dean, Eichhorn and Dean (1967) suggest a list of advantages and disadvantages to using unstructured methods - these can be summarised as:-

Advantages

(a) observation and interviewing are non-standardised and thus highly responsive.

(b) they make effective use of the relationships the researcher establishes with informants in the field.

(c) lack of a prior judgement on issues means that the problem can be reformulated at several stages.

(d) the closer contact with the field situation means that the researcher is better able to avoid misleading or meaningless questions.

(e) the impressions of a field worker are often more reliable for classifying respondents.

(f) by using unstructured methods the researcher can infiltrate a situation at whatever pace is necessary.

(g) the field worker can constantly modify his categories to find the most suitable analysis of the problem under study.

(h) the field worker can impute motives more accurately.

(i) the field worker can generally get at 'depth' material.

(j) the field worker can store and later integrate large volumes of semi-relevant data which may later prove of much greater value.

(k) the field worker can make effective use of informant's skill and insights.

(l) the field worker is in a better position than the survey researcher in delicate situations where covert research is essential.

(m) difficult-to-quantify variables are probably less distorted by unstructured observation than by an abortive attempt to operationalise them for quantification by a survey.

Disadvantages

(a) because of the non-standard way in which the data is collected, it is invalid or unusable in statistical treatment.

(b) there is in the researcher's use of the relationships he establishes in the field, a high likelihood of bias.

Although the advantages seem to far outweigh the disadvantages, it will also be seen that the latter are fundamental to the whole research act: the problem, once again, becomes the relative value of subjective and objective data. A possible reconciliation of these may come from considering even the more sophisticated elements of social organisation as being amenable to a very basic anthropological study in which the notion of 'hard', objective data does not emerge until at least a bare understanding of the culture has been acquired.

In confronting the research situation for the first time, the researcher must decide what his participation in the organisation will be. Junker (1952) suggests that there are four clearly defined roles ranging from complete participant to complete observer with the middle roles of participant-as-observer and observer-as-participant. The choice and the factors influencing it have been discussed by Gold (1954) and he makes clear the importance of the role in the research act. 'Every field work role is at once a social interaction device for securing information for scientific purposes and a set of behaviours in which an observer's self is involved. While playing a field work role.....the field observer often attempts to master hitherto strange or only generally understood universes of discourse relating to many attitudes and behaviours.....success in both role-taking and role playing requires success in blending the demands of self-expression and self-integrity with the demands of the role'.

In the case of complete participant, the true identity and purpose of the researcher is not revealed to those whom he observes. The intention is to frequently interact in as many situations as possible including those of a social and informal nature. The basic principle here is role-pretence, and as such bears the additional demands, traditionally associated with the acting profession of 'becoming the part'. As Gold has it 'instead of being himself in the pretended role, all he can be is a 'not-self', in the sense of perceiving that his actions are meaningful in a contrived role'. The two problems associated with this role can be summed up as:-

(a) the observer may become too self-conscious about revealing his true self and handicapped when attempting to perform convincingly in the pretended role.

(b) the observer may incorporate the role into his self-conceptions and achieve self-expression in the role, but find he has violated his observer role to the extent that his findings are invalidated.

A third unspoken problem exists in repsect of the delicate balance of a research situation set up in this way: the lack of openness means that at any juncture the wrong construction could be placed upon the research activity and the emotional accusation of 'spying' or similar be levelled, thus destroying relationships which may have taken several months to build up. Thus, except for short periods and when using an observer well able to cope with the strain of such activity, the complete participant role is not a very effective approach.

By contrast, there is a strong awareness of the field relationship on both sides in the case of the participant-as-observer. Initially there may well be considerable suspicion and anxiety aroused, since the relationship will have been openly defined as a study situation: however, in time this will diminish to be replaced by a growing trust and confidence in the researcher. The major difficulties attached to this role are in promoting intimacy in the relationship without allowing it to introduce a bias due to friendship etc. Simmel (1956) quoted by Gold, makes a useful distinction between intimate content and intimate form. 'In other words, intimacy is not based on the content of the relationship....Inversely, certain external situations or moods may move us to make very personal statements and confessions, usuallly reserved for our closest friends only, to relatively strange people e.g. doctors. But in such cases we nevertheless feel that this 'intimate' content does not yet make the relation an intimate one. For in its basic significance, the whole relation to these people is based only in its general unindividual ingredients. That 'intimate' content, although we have perhaps never revealed it before and thus limit it entirely to this particular relationship, does nevertheless not become the basis of its form, and thus leaves it outside the sphere of intimacy'.

The demands of pretence in observer role are still quite considerable, particularly in the early phases but it is possible , without trespassing the bounds of intimacy indicated above, to receive a measure of support from the field relationship. This appears to depend on the openness of the approach and on the growing trust and acceptance of the study

/subjects.

In the case of observer-as-participant, the involvement is decreased and the contact which does take place is generally of a more formal nature. Inevitably, this introduces a sense of 'distance' in the interaction which could lead to misunderstandings on both sides: this effect is compounded by the lack of background or of relationship and tends to lead to a minimally productive interaction which may be frustrating rather than of positive value. However, when the situation demands a more formal approach, such a technique may be viewed as the correct role to play in a non-involved study - e.g. meeting and conference observation.

The final role available is that of complete observer and in this there is a minimum of social interaction involved. Since this effectively eliminates the subject's views from the study, this approach is rarely used unless the situation cannot be handled in an interactive fashion. The potential for misunderstanding the observed situation is high since there is no opportunity for corrective feedback: nevertheless, there is no intimacy or role-adoption problem to contend with. Above all, the dominant principle in the above four roles remains the same as that outlined at the beginning - that the approach will necessarily reflect and involve the researcher as much as the research subject. Thus the adoption of roles must bear a strong relationship to the self - and a better understanding of both will be the consequence of participating in an interactive approach of this kind.

As regards the phases of participant observation or the process of forming and developing relationships, this has already been covered in the methodology chapter.

To discuss the major philosophical and methodological issues surrounding this approach is beyond the scope of this account. What has been presented is an expansion of the subject to cover role and process considerations: further examination must take place elsewhere.

Appendix 2 : Results

Q-sort measure
Work preference questionnaire
Organisational mapping questionnaire
Organisational beliefs measure
Personal beliefs measure
Creativity audit.

Q-sort Measure

Question Number	Mean	Standard deviation	(Sample Size = 14)
1	4.14	0.77	
2	4.07	1.26	
3	4.14	0.97	
4	3.21	1.88	
5	2.57	1.22	
6	4.14	0.66	
7	3.35	1.00	
8	3.42	1.21	
9	3.92	1.07	
10	3.64	0.74	
11	3.50	1.16	
12	3.71	0.91	
13	4.14	0.86	
14	4.21	1.88	
15	3.21	1.25	
16	3.78	0.89	
17	3.92	1.20	
18	3.92	1.20	
19	4.07	0.73	
20	3.35	0.74	
21	4.07	0.91	
22	3.71	0.72	
23	3.35	1.44	
24	4.42	0.85	
25	3.64	0.92	
26	4.57	0.51	
27	4.21	0.69	
28	3.71	1.13	
29	4.07	0.73	
30	3.85	1.09	

Q-sort Measure

Question Number	Mean	Standard deviation	(Sample Size = 14)
31	4.35	0.74	
32	3.28	1.13	
33	4.07	0.61	
34	3.42	0.93	
35	2.85	0.77	
36	3.35	1.08	
37	3.21	0.97	
38	4.14	0.86	
39	2.64	1.15	
40	3.64	1.15	
41	4.57	0.75	
42	2.85	1.35	
43	4.14	0.77	
44	3.57	1.15	
45	3.85	0.94	
46	3.64	1.64	
47	4.71	0.46	
48	3.50	1.16	
49	3.50	1.22	
50	4.57	0.64	
51	4.78	0.42	
52	3.28	1.26	
53	3.28	1.26	
54	2.85	1.02	
55	3.76	1.31	
56	3.42	1.34	

Work Preference Questionnaire

Question Number	Production		Applications		Research		Process Development		Total Organisation		
1	7	3	7	3	10	3	11	5	35	14	
2	6	4	8	2	4	9	8	8	26	23	
3	4	6	4	6	8	5	7	9	23	26	
4	4	6	2	8	5	8	2	14	13	36	
5	4	6	6	4	11	2	14	2	35	14	
6	7	3	3	7	2	11	4	12	16	35	
7	5	5	5	5	6	7	6	10	22	27	
8	8	2	7	3	10	3	9	7	34	15	
9	5	5	8	2	10	3	12	4	35	14	
10	2	8	5	5	1	12	1	15	9	40	
11	7	3	6	4	12	1	15	1	40	9	
12	2	8	4	6	2	11	2	14	9	40	
13	8	2	8	2	11	2	16	0	43	6	
14	6	4	6	4	4	9	6	10	22	27	
15	8	2	8	2	12	1	16	0	44	5	
16	3	7	5	5	1	12	0	16	7	42	
17	10	0	8	2	13	0	16	0	47	2	
18	7	3	6	4	5	8	6	8	24	25	
19	2	8	6	4	4	9	8	8	19	30	
20	10	0	10	0	13	0	14	2	47	2	
21	21	6	2	8	4	9	8	8	18	31	
22	4	6	5	5	10	3	9	7	28	21	
23	8	2	6	4	11	2	15	1	40	9	
24	5	5	5	5	9	4	12	4	32	17	

Question Number	Production			Process Development			Applications			Research			Total Organisation		
	Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation
Section (1)															
1	9	2.66	0.86	16	2.12	0.80	11	2.63	1.20	12	2.91	0.99	48	2.54	0.98
2	9	2.55	0.88	16	2.87	1.40	11	2.45	0.93	12	2.66	0.88	48	2.66	1.07
3	9	2.33	0.50	16	2.62	1.08	11	2.45	1.21	12	2.66	0.88	48	2.54	0.96
4	9	2.33	0.70	16	2.50	0.73	11	2.90	1.13	12	2.83	0.83	48	2.64	0.86
5	9	2.66	1.22	16	3.18	0.83	11	2.45	0.93	12	3.91	1.08	48	3.10	1.11
6	9	2.44	0.88	16	2.56	1.20	11	2.54	1.12	12	3.08	0.99	48	2.66	1.07
7	9	2.66	1.11	16	3.37	1.08	11	2.81	1.32	12	3.25	0.96	48	3.08	1.12
8	9	4.00	0.86	16	3.12	0.94	11	2.27	1.10	12	3.08	1.24	48	3.14	1.16
9	9	2.22	0.83	16	2.87	1.20	11	2.36	1.02	12	1.91	1.08	48	2.39	1.10
10	9	2.44	1.23	16	2.81	0.91	11	2.54	1.12	12	2.25	1.13	48	2.54	1.07
11	9	3.33	0.70	16	2.75	0.68	11	3.09	1.13	12	3.33	0.98	48	3.08	0.89
12	9	3.00	1.00	16	3.37	1.20	11	3.45	1.03	12	3.41	1.08	48	3.33	1.07
13	9	3.22	0.66	16	3.31	0.94	11	3.36	0.92	12	3.50	1.00	48	3.35	0.88
14	9	3.00	0.70	16	2.81	0.75	11	3.18	0.75	12	2.91	0.90	48	2.95	0.77
15	9	2.88	0.78	16	2.81	0.75	11	3.18	0.98	12	3.50	1.00	48	3.08	0.89
16		3.11	1.26	16	2.81	0.98	11	3.27	1.00	12	3.50	1.08	48	3.14	1.07
17	9	2.11	0.60	16	3.06	1.12	11	2.36	1.02	12	2.5	1.16	48	2.58	1.06
18	9	3.88	0.78	16	3.18	0.91	11	2.72	1.00	12	3.66	1.07	48	3.33	1.01
											3.91	1.24	48	3.35	1.12

Organisational Mapping Questionnaire

Question Number		Production			Process Development			Applications			Research			Total Organisation		
		Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation
Section (2)	1	9	2.77	1.20	17	2.82	0.95	11	3.09	1.37	12	3.58	1.08	49	3.06	1.14
	2	9	1.88	0.92	17	3.00	1.17	11	3.00	1.26	12	2.75	0.86	49	2.73	1.13
	3	9	2.55	0.88	17	3.35	1.32	11	2.90	1.30	12	3.08	0.79	49	3.04	1.13
	4	9	2.44	1.13	17	3.35	1.27	11	2.63	1.36	12	3.50	1.08	49	3.06	1.26
	5	9	2.33	0.86	17	3.00	0.86	11	2.63	1.20	12	3.50	1.24	49	2.91	1.09
	6	9	3.22	0.83	17	3.64	0.99	11	3.36	1.02	12	4.08	0.51	49	3.61	0.90
	7	9	3.00	1.00	17	3.05	0.89	11	3.00	0.77	12	3.33	0.77	49	3.10	0.84
	8	9	2.77	0.66	17	3.29	0.84	11	3.18	0.75	12	3.58	1.08	49	3.24	0.87
	9	9	2.88	0.78	17	3.35	0.78	11	3.36	0.92	12	3.66	1.15	49	3.34	0.92
	10	9	2.11	0.60	17	3.00	0.93	11	2.72	1.00	12	2.75	1.28	49	2.71	1.02
	11	9	2.22	0.83	17	2.52	1.00	11	2.36	1.20	12	1.91	0.90	49	2.28	1.00
	12	9	1.88	0.33	17	2.17	0.95	11	2.00	0.89	12	2.16	1.19	49	2.08	0.90
	13	9	1.88	0.60	17	2.00	0.79	11	2.18	0.60	12	2.00	1.04	49	2.02	0.77
Section (3)	1	9	2.66	1.41	17	3.35	1.41	10	3.00	1.41	12	2.58	0.99	48	2.95	1.32
	2	9	2.44	1.01	17	2.64	1.16	10	2.20	0.91	12	2.33	1.07	48	2.43	1.04
	3	9	2.77	1.56	17	3.29	1.21	10	3.00	1.15	12	3.50	0.90	48	3.18	1.19
	4	9	2.33	1.00	17	2.82	1.13	10	2.30	0.94	12	3.08	0.79	48	2.68	1.01

Question Number		Production			Process Development			Applications			Research			Total Organisation		
		Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation
Section (3)	5	9	2.22	0.97	17	2.70	1.04	10	2.60	1.17	12	3.00	0.73	48	2.66	0.99
	6	9	3.00	1.00	17	2.76	1.20	10	3.00	1.05	12	3.33	0.98	48	3.00	1.07
	7	9	2.55	1.33	17	3.17	1.18	10	2.60	0.96	12	2.25	0.86	48	2.70	1.12
	8	9	2.11	0.78	17	2.17	0.80	10	2.60	0.96	12	2.41	0.99	48	2.31	0.87
	9	9	3.11	1.05	17	3.41	1.06	10	3.10	1.10	12	3.58	1.08	48	3.33	1.05
	10	9	1.77	0.44	17	2.64	1.27	10	2.40	1.07	12	1.83	1.19	48	2.22	1.13
	11	9	3.55	0.88	17	3.47	1.12	10	3.30	1.05	12	3.66	0.77	48	3.50	0.96
	12	9	2.22	0.66	17	2.76	0.90	10	3.00	1.05	12	2.66	0.88	48	2.68	0.90
	13	9	2.33	1.00	17	2.76	1.20	10	2.50	0.97	12	2.58	0.99	48	2.58	1.04
	14	9	2.22	0.83	17	2.52	0.79	10	2.70	0.94	12	2.66	0.88	48	2.54	0.84
Section (4)	1	9	3.44	1.23	17	3.47	1.17	11	3.09	1.30	12	3.00	1.34	49	3.26	1.23
	2	9	2.77	1.20	17	2.82	1.23	11	2.90	0.94	12	3.50	0.90	49	3.00	1.09
	3	9	3.88	1.16	17	3.11	1.21	11	3.36	0.67	12	3.25	0.96	49	3.34	1.05
	4	9	3.55	1.33	17	3.35	1.22	11	3.18	1.07	12	3.16	1.02	49	3.30	1.14
	5	9	3.55	0.88	17	3.35	1.05	11	2.90	0.94	12	3.08	0.90	49	3.22	0.96
	6	9	3.33	1.22	17	3.29	1.21	11	3.27	1.19	12	3.50	1.24	49	3.34	1.18
	7	9	3.00	0.86	17	3.00	1.11	11	2.90	1.13	12	3.08	0.90	49	3.00	1.00
	8	9	2.66	1.00	17	3.17	1.07	11	3.18	1.25	12	3.50	1.16	49	3.16	1.12

Question Number		Production			Process Development			Applications			Research			Total Organisation		
		Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation
Section (5)	1	9	2.22	0.83	16	3.12	0.80	11	2.63	0.80	12	2.41	0.79	48	2.66	0.85
	2	9	1.66	0.50	16	2.00	0.63	11	2.36	0.50	12	1.91	0.28	48	2.00	0.54
	3	9	3.33	1.32	16	3.12	0.71	11	3.27	0.90	12	3.33	1.23	48	3.25	1.00
	4	9	3.22	1.30	16	3.68	0.94	11	3.18	0.98	12	2.83	1.02	48	3.27	1.06
	5	9	2.22	0.66	16	2.50	0.89	11	2.54	0.82	12	2.08	0.51	48	2.35	0.75
	6	9	2.33	0.86	16	2.93	0.92	11	2.00	0.44	12	2.25	0.75	48	2.43	0.84
	7	9	2.33	0.86	16	2.43	0.62	11	2.36	0.50	12	2.75	0.86	48	2.47	0.71
	8	9	1.77	0.44	16	1.87	1.02	11	2.00	0.00	12	1.83	0.57	48	1.87	0.67
	9	9	1.77	0.44	16	1.62	0.80	11	2.09	0.30	12	1.75	0.45	48	1.79	0.58
	10	9	1.88	0.60	16	1.81	0.54	11	2.09	0.30	12	1.75	0.45	48	1.87	0.48
	11	9	3.44	1.01	16	3.50	1.21	11	3.27	1.00	12	4.16	0.57	48	3.60	1.02
	12	9	2.77	1.09	16	2.31	0.79	11	2.36	0.80	12	2.08	0.79	48	2.35	0.86
	13	9	4.00	0.00	16	3.68	1.01	11	3.54	0.68	12	4.50	0.67	48	3.91	0.82
	14	9	1.88	0.60	16	1.87	0.50	11	2.18	0.60	12	2.08	0.99	48	2.00	0.68

Organisational Mapping Questionnaire

Question Number		Production			Process Development			Applications			Research			Total Organisation		
		Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation
Section (6)	1	9	2.66	1.00	16	2.75	1.06	11	2.18	0.75	12	1.66	0.49	48	2.33	0.95
	2	9	2.11	0.60	16	2.50	0.96	11	2.45	0.82	12	1.66	0.49	48	2.20	0.82
	3	9	2.22	0.83	16	2.56	1.03	11	2.36	1.02	12	2.08	1.24	48	2.33	1.03
	4	9	3.00	1.11	16	3.12	0.88	11	3.54	0.68	12	3.83	0.83	48	3.37	0.91
	5	9	1.77	0.44	16	2.37	0.95	11	1.81	0.60	12	1.50	0.52	48	1.91	0.76
	6	9	2.55	1.13	16	2.43	0.81	11	2.72	0.90	12	2.58	1.37	48	2.56	1.02
	7	9	2.55	0.52	16	2.81	0.74	11	2.63	0.92	12	2.58	0.51	48	2.66	0.69
	8	9	3.11	0.60	16	3.12	0.61	11	3.09	0.70	12	3.41	0.66	48	3.18	0.64

Organisational Beliefs Questionnaire

Question Number	Production			Process Development			Applications			Research			Organisation		
	Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation
1	19	2.36	1.11	19	2.47	0.96	11	3.00	0.89	16	2.00	0.89	65	2.41	1.01
2	19	2.84	1.06	19	3.42	1.12	11	2.90	1.13	16	3.25	0.93	65	3.12	1.06
3	19	3.31	1.05	19	2.94	0.84	11	2.63	1.02	16	2.50	1.09	65	2.89	1.03
4	19	2.78	1.31	19	3.84	0.60	11	2.27	0.78	16	3.87	0.95	65	3.27	1.15
5	19	2.52	1.21	19	2.00	0.57	11	2.54	1.03	16	3.00	1.09	65	2.49	1.04
6	19	2.94	1.02	19	3.26	1.04	11	3.00	1.00	16	3.37	0.95	65	3.15	1.00
7	19	2.21	1.33	19	2.26	0.73	11	2.81	0.98	16	2.56	1.09	65	2.44	1.06
8	19	4.05	1.22	19	3.00	0.94	11	2.81	1.07	16	2.75	1.23	65	3.21	1.23
9	19	3.52	1.07	19	3.15	0.89	11	3.27	0.78	16	3.06	1.06	65	3.26	0.97
10	19	2.36	1.06	19	2.00	0.74	11	2.72	1.10	16	2.18	0.83	65	2.27	0.94
11	19	3.68	1.00	19	3.47	1.02	11	3.27	0.78	16	2.93	0.99	65	3.36	0.99
12	19	3.21	1.18	19	3.26	0.87	11	3.09	0.83	16	2.87	1.08	65	3.12	1.00
13	19	2.84	0.95	19	3.36	1.06	11	1.90	0.83	16	2.75	0.93	65	2.81	1.05
14	19	2.31	1.00	19	2.68	0.82	11	2.27	0.64	16	2.31	0.70	65	2.41	0.82
15	19	3.47	0.77	19	2.73	1.32	11	2.63	1.02	16	3.06	0.85	65	3.01	1.05
16	19	2.78	1.03	19	2.94	0.97	11	2.00	0.44	16	3.06	1.06	65	2.76	0.99
17	19	3.05	1.07	19	2.15	0.76	11	3.45	1.12	16	2.62	1.20	65	2.75	1.11

Organisational Beliefs Questionnaire

Question Number	Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation
18	19	2.57	0.69	19	2.26	0.87	11	2.36	0.67	16	2.12	0.95	65	2.33	0.81
19	19	3.05	0.97	19	2.57	0.83	11	2.90	0.83	16	2.06	0.92	65	2.64	0.94
20	19	2.47	1.12	19	2.73	0.99	11	2.90	0.94	16	2.62	0.80	65	2.66	0.97
21	19	2.47	1.02	19	2.26	1.04	11	2.72	1.00	16	2.68	1.01	65	2.50	1.01
22	19	3.05	0.91	19	3.10	0.93	11	2.54	0.68	16	3.50	0.96	65	3.09	0.93
23	19	2.89	0.87	19	2.89	0.99	11	3.00	0.77	16	2.93	1.18	65	2.92	0.95
24	19	3.31	0.88	19	4.05	0.84	11	3.63	1.02	16	3.25	1.23	65	3.56	1.03
25	19	2.26	0.87	19	2.52	0.96	11	2.36	0.80	16	2.25	0.68	65	2.35	0.83
26	19	2.57	0.83	19	3.00	1.10	11	2.45	0.52	16	2.50	1.26	65	2.66	1.00
27	19	2.42	1.01	19	2.36	0.83	11	2.45	0.68	16	2.12	0.71	65	2.33	0.83
28	19	2.31	0.88	19	3.31	0.94	11	2.81	1.07	16	3.50	0.73	65	2.98	1.00
29	19	2.26	0.87	19	2.36	1.06	11	2.81	0.87	16	2.37	1.08	65	2.41	0.98
30	19	3.68	0.94	19	2.78	0.91	11	3.45	0.82	16	3.00	0.73	65	3.21	0.92
31	19	3.05	1.12	19	3.10	0.87	11	3.27	1.00	16	3.00	0.96	65	3.09	0.97
32	19	3.36	1.11	19	2.78	0.97	11	1.63	0.67	16	3.12	0.80	65	2.84	1.09
33	19	2.63	1.25	19	2.73	0.99	11	3.00	0.77	16	2.37	1.14	65	2.66	1.07
34	19	2.89	0.93	19	2.68	1.24	11	2.63	0.80	16	2.87	0.88	65	2.78	0.99

Organisational Beliefs Questionnaire

Question Number	Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation
35	19	3.36	1.16	19	3.36	0.89	11	3.18	0.98	16	3.36	0.81	65	3.38	0.96
36	19	2.78	0.85	19	2.73	0.87	11	3.54	0.82	16	2.43	0.72	65	2.81	0.88
37	19	3.42	1.21	19	3.21	1.08	11	4.09	0.70	16	2.37	1.02	65	3.21	1.17
38	19	2.73	0.93	19	2.15	0.95	11	3.27	0.78	16	2.12	0.95	65	2.50	1.00
39	19	3.15	0.83	19	2.89	0.99	11	3.09	0.94	16	3.31	0.94	65	3.10	0.92
40	19	2.89	1.04	19	3.21	0.85	11	3.54	1.12	16	3.00	0.96	65	3.12	0.99
41	18	3.16	1.04	19	3.15	0.83	11	4.36	0.50	16	3.12	1.02	64	3.35	0.99
42	18	2.94	1.30	19	3.68	1.10	11	2.63	0.80	16	3.75	1.06	64	3.31	1.18
43	18	3.44	0.98	19	2.84	1.01	11	3.27	1.00	16	2.93	1.06	64	3.10	1.02
44	18	2.83	1.04	19	2.94	0.84	11	3.18	0.87	16	3.31	0.87	64	3.04	0.91
45	18	1.94	1.05	19	2.94	1.12	11	3.36	0.80	16	2.68	0.94	64	2.67	1.11
46	18	2.77	1.00	19	2.26	0.80	11	3.54	0.68	16	2.50	0.96	64	2.68	0.97
47	18	3.16	1.04	19	2.94	0.91	11	3.81	0.60	16	2.93	0.99	64	3.15	0.96
48	18	2.88	1.13	19	2.36	0.89	11	4.09	0.94	16	2.50	1.15	64	2.84	1.18
49	18	2.61	0.50	19	1.68	0.58	11	2.81	0.87	16	1.43	0.51	64	2.07	0.82
50	18	2.55	1.14	19	2.73	0.99	11	3.18	0.60	16	2.06	0.92	64	2.59	1.01
51	18	2.66	0.90	19	3.21	0.85	11	2.90	0.94	16	2.75	1.00	64	2.89	0.92

Organisational Beliefs Questionnaire

Question Number																	
52	18	2.44	0.70	19	2.68	1.05	11	2.81	0.75	16	2.93	1.12	64	2.70	0.93		
53	18	2.77	1.00	19	2.89	0.99	11	2.72	1.10	16	3.56	0.81	64	2.98	0.96		
54	19	2.47	1.02	19	2.63	1.21	11	2.36	0.67	16	3.06	0.92	65	2.70	1.07		
55	19	2.73	0.93	19	3.00	0.88	11	2.36	1.20	16	2.75	1.06	65	2.75	0.91		
56	19	2.84	1.01	19	3.21	1.13	11	2.09	0.94	16	3.31	1.19	65	2.98	1.15		
57	19	2.52	0.96	19	3.05	1.07	11	2.81	0.75	16	2.62	1.02	65	2.63	1.03		
58	19	2.78	0.78	19	3.15	0.95	11	3.09	0.70	16	3.12	0.95	65	2.98	0.87		
59	19	2.89	0.87	19	2.73	0.87	11	2.81	0.98	16	2.93	1.18	65	2.89	0.92		
60	19	2.94	1.02	19	2.52	0.96	11	2.36	1.02	16	2.87	1.08	65	2.78	1.00		
61	19	2.52	1.12	19	3.15	1.16	11	3.09	0.94	16	3.62	0.88	65	2.95	1.15		
62	19	2.94	1.02	19	3.52	1.02	11	3.36	1.02	16	3.68	1.07	65	3.30	1.05		
63	19	2.52	1.12	19	3.15	0.89	11	3.36	0.50	16	2.93	1.23	65	3.23	1.08		
64	19	2.89	1.04	19	3.10	0.99	11	3.54	0.82	16	2.43	1.31	65	2.92	1.03		
65	19	3.47	1.17	19	3.15	1.06	11	3.18	0.75	16	2.31	1.01	65	3.00	1.08		
66	19	2.89	0.93	19	2.47	1.12	11	3.72	0.78	16	2.43	0.89	65	2.73	1.00		
67	19	3.10	1.10	19	2.57	1.01	11	3.63	0.92	16	2.68	1.07	65	2.95	1.03		
68	19	3.00	1.00	19	2.57	0.90	11	3.36	0.80	16	2.56	0.89	65	2.83	0.96		

Organisational Beliefs Questionnaire

Question Number	Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation	Sample Size	Mean	Standard deviation
69	19	3.10	0.93	19	3.10	1.19	11	3.36	1.12	16	3.06	1.06	65	3.13	1.13
70	19	2.84	0.89	19	3.00	1.05	11	2.27	0.46	16	2.06	0.77	65	2.76	1.05
71	19	3.10	1.32	19	2.36	0.83	11	3.27	0.78	16	2.56	1.03	65	2.41	0.78
72	19	2.78	0.97	19	3.52	0.61	11	3.81	0.87	16	3.62	0.71	65	3.32	0.79
73	19	2.42	0.69	19	3.89	0.65	11	2.63	0.92	16	3.68	0.79	65	3.83	0.82
74	19	2.89	0.87	17	2.76	0.97	11	2.63	0.92	16	2.93	0.88	65	2.69	0.89
75	19	3.89	0.99	17	2.58	0.87	11	3.81	0.60	16	2.80	0.67	65	3.66	0.90
76	19	2.47	0.84	17	3.29	0.91	11	3.09	0.94	16	2.53	1.35	65	2.95	1.15
77	19	3.26	0.93	17	2.52	1.00	11	2.72	1.19	16	1.93	0.70	65	2.41	1.00

Personal Beliefs Measure

Question Number	Agree	Don't Know	Disagree
1	10	3	21
2	5	0	29
3	3	2	29
4	34	0	0
5	34	0	0
6	8	2	24
7	9	2	23
8	28	3	3
9	23	3	8
10	33	0	1
11	11	3	20
12	34	0	0
13	14	1	19
14	20	7	7
15	34	0	0
16	34	0	0
17	31	1	0
18	9	6	19
19	20	4	10
20	34	0	0
21	15	6	13
22	14	2	18
23	34	0	0
24	12	2	20
25	25	3	6
26	19	2	13
27	17	3	14
28	18	0	16
29	14	3	17
30	16	3	15
31	8	1	25
32	25	4	5
33	4	3	27
34	7	2	25

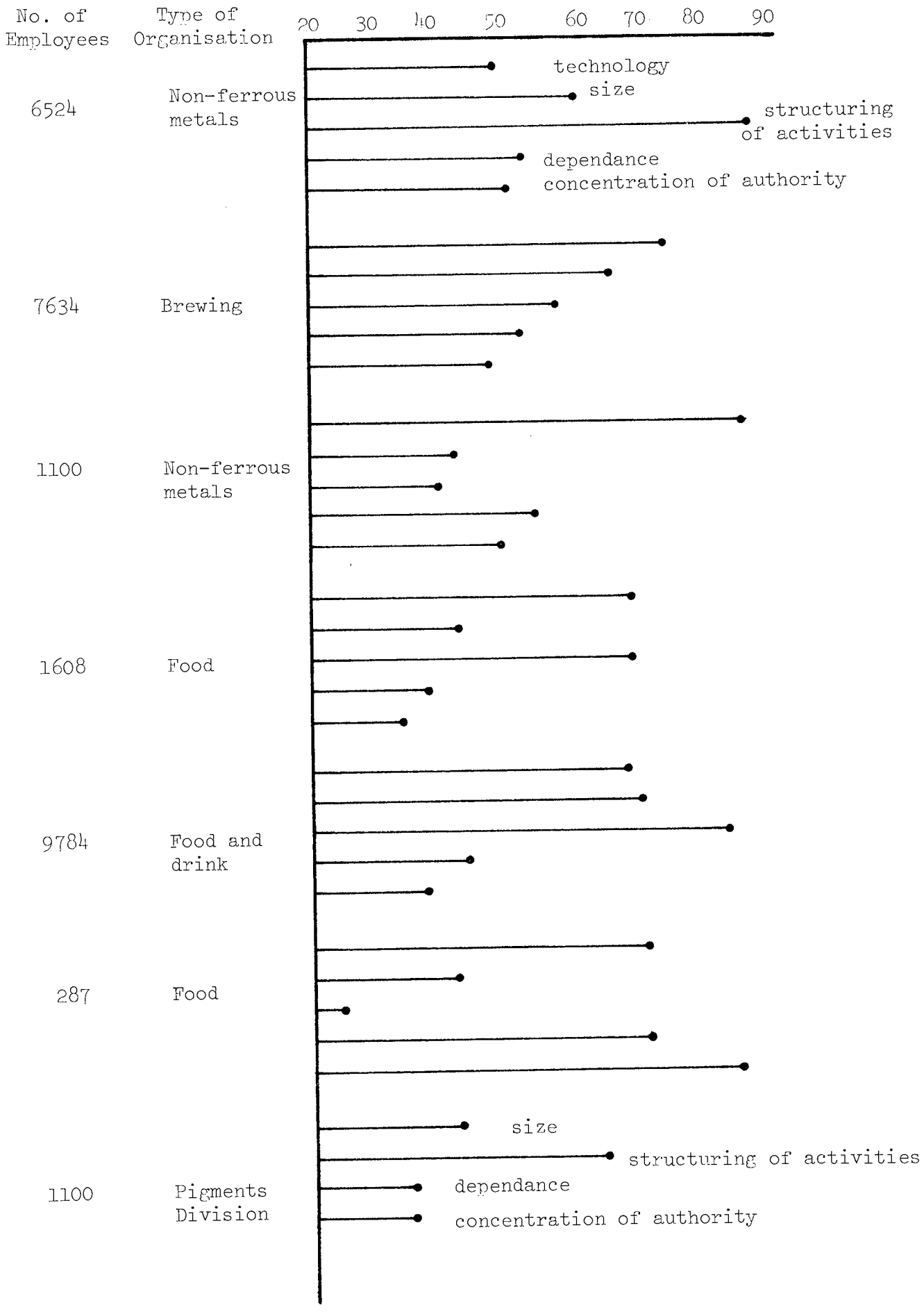
Creativity Audit

	Question Number	Mean	Standard Deviation	Sample Size	Variance
Section (1)	1	1.612	1.077	49	1.159
	2	1.184	1.112	49	1.236
	3	1.367	1.093	49	1.196
	4	1.939	0.922	49	0.85
	5	1.347	1.091	49	1.190
	6	2.02	1.315	49	1.729
Section (2)	1	2.653	1.653	49	2.731
	2	2.755	0.879	49	0.772
	3	2.755	1.493	49	2.230
	4	1.408	1.098	49	1.205
	5	2.367	0.994	49	0.987
	6	2.796	1.241	49	1.541
	7	2.571	0.707	49	0.500
	8	2.347	1.362	49	1.856
	9	2.143	1.291	49	1.667
	10	2.102	1.177	49	1.385
	11	2.837	0.773	49	0.598
	12	2.265	1.455	49	2.116
	13	2.327	1.029	49	1.058
Section (3)	1	2.327	0.944	49	0.891
	2	1.694	1.140	49	1.300
	3	2.551	0.959	49	0.919
	4	2.184	1.380	49	1.903
	5	2.816	0.755	49	0.570
	6	2.571	0.979	49	0.958
	7	1.612	1.511	49	2.284
	8	2.000	1.354	49	1.833
	9	2.367	0.809	49	0.654
	10	2.020	1.392	49	1.937

Creativity Audit

	Question Number	Mean	Standard Deviation	Sample Size	Variance
Section (3)	11	2.204	0.979	49	0.957
	12	1.388	0.975	49	0.951
	13	2.469	0.710	49	0.504
	14	2.224	0.963	49	0.928
	15	1.857	1.021	49	1.042
	16	2.592	0.734	49	0.538
	17	0.959	1.020	49	1.040
	18	1.898	1.065	49	1.135
	19	1.918	1.057	49	1.118
	20	2.286	1.369	49	1.875

Aston Index for Process Manufacturing Organisations



Appendix 4 : List of Documents not included either in thesis or appendices but available for consultation.

- minutes of monthly meetings with supervisors and invited others from January 1976 until December 1977.

- results of individual factors study carried out in Process Development. These are not included principally because, in addition to being a relatively difficult and time-consuming measure, the results were highly specific to individuals and gave little insight of a general nature.

- results of pegboard and other Production/Process Development informal assessments. The nature of these measures was to generate extra information about the interface: this has been used in the general discussion in the study.

- library circulation survey.

- quarterly reports. These have been extensively quoted during the thesis but are not reproduced in full.

- measures of observation contact

- normative maps