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A CYBERNETIC METHODOLOGY TO STUDY AND DESIGN HUMAN ACTIVITIES

RAUL ESPEJO

Doctor of Philosophy

THE UNIVERSITY OF ASTON IN BIRMINGHAM

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SUMMARY

This thesis offers a methodology to study and design effective communication mechanisms in human activities. The methodology is focused in the management of complexity. It is argued that complexity is not something objective that can be worked out analytically, but something subjective that depends on the viewpoint. Also it is argued that while certain social contexts may inhibit, others may enhance the viewpoint's capabilities to deal with complexity. Certain organisation structures are more likely than others to allow individuals to release their potentials. Thus the relevance of studying and designing effective organisations.

The first part of the thesis offers a 'cybernetic methodology' for problem solving in human activities, the second offers a 'method' to study and design effective organisations.

The cybernetic methodology discussed in this work is rooted in second order cybernetics, or the cybernetics of the observing systems (Von Foester 1979, Maturana and Varela 1980). Its main tenet is that the known properties of the real world reside in the individual and not in the world itself. This view, which puts emphasis in a, by nature, one sided and unilateral appreciation of reality, triggers the need for dialogue and conversations to construct it.

The 'method' to study and design organisations is based on Beer's Viable System Model (Beer 1979, 1981, 1985). This model allows to assess how successful is an organisation in coping with its environmental complexity, and, moreover, permits to establish how to make more effective the responses to this complexity. These features of the model are of great significance in a world where complexity is perceived to be growing at an unthinkable pace. But, "seeing" these features of the model assumes an effective appreciation of organisational complexity; hence the need for the methodological discussions offered by the first part of the thesis.

**Key Words:** Complexity, Law of Requisite Variety, Design, Methodology, Organisation Structure.

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Expanding transformation, in general, includes the  
 co-ordinate participation of several, at the same time,  
 thus expressing the unavoidable need for multiple  
 mechanisms to support their interlink.

The scope of "external" transformation is often  
 influenced by the interests of a line in particular, and  
 not by the most likely to be affected by a line. This  
 latter participation, especially in choice to some extent  
 difficult to implement, it requires to develop effective  
 mechanisms for participation.

# A Cybernetic Methodology to Study and Design Human Activities

## 1. Introduction to This Work

### 1.1 General Themes

This work is about problem solving in human activities.

In this work human activities are defined as human produced **changes or transformations** in the real world. Coping with their complexity is an unavoidable task for those concerned. The challenge is to bring about adequate responses to the problems that emerge while these transformations are being produced. In any case different realities arise as a result of focusing in different transformations and producing different responses.

Producing transformations, in general, entails the co-ordinated participation of several, if not many, people, thus suggesting the unavoidable need for communications mechanisms to support their interactions.

The choice of "desirable" transformations is often over influenced by the interests of a few in positions of power and not by the most likely to be affected by them. This latter, participative, approach to choice is much more difficult to implement; it requires to develop effective mechanisms for participation.

Producing transformations is often the outcome of happenstance and not of processes with an adequate understanding of the social costs underlying them. These costs, whether in the form of injustices or inequities, are then experienced by the people themselves, in their unavoidable, on going, interactions with each other. Unharnessed self regulation and self organisation may well lead to relations of oppression and exploitation as well as to intractable conflicts.

It is not good enough to chose transformations, however appealing they might be to particular groups or individuals, without an understanding of how they may affect those individuals entailed by them. That human activities will always have undesirable costs is a fact; it is impossible to take full account of all their implications; problems of one kind or another will always exist, however, the more the problem solving capacity is left in the hands of a few, and not in the hands of all those affected by the situation, the more likely is that individuals will perceive undesirable costs whether in the form of injustices or inequities.

This work is about organisational design

While it seems unavoidable that some kind of undesirable costs will always be present in human activities, the problem is to find out how to minimise them. The design of effective organisations is one such option, but this design

depends on a good appreciation of the complexity entailed by the corresponding real world transformations. This appreciation is at the core of designing the interplay between global -organisational- transformations and specific -individual- activities.

The work of Stafford Beer in management cybernetics (e.g. Beer 1975, 1979) permits to think in original ways about organisational design, in particular about the interplay between the global organisation and the particular individual. Though his contribution is huge, naturally, many aspects of his work need further development.

This works offers insights about the management of complexity

The complexity of human activities seems to be in the history of the individuals involved rather than in the variety of their possible logical relationships. Complexity stems from the multiple meanings that the same activities may have for different people. These meanings are rooted in their histories. The aggregation of these individual histories defines the cultural context for change.

Therefore, whether a transformation takes place or not will depend on the ability of those responsible for it to manage the complexity of the cultural context.

This work explores two themes

Thus, a first theme of this thesis is how to account for, and how to manage, this 'human based' complexity. Its discussion should permit us to appreciate that complexity is inherent to real world interpersonal interactions and not something objective that can be worked out analytically. However, it will be argue that it is possible to create larger or smaller 'social spaces' for this complexity to unfold. Indeed, this is a major cybernetic insight. Certain organisational forms let individuals release better their potentials than others. Hence the relevance of the second major theme of this thesis; the study and design of effective organisations.

Studying the first theme will permit us to have a "cybernetic methodology" for problem solving in human activities, studying the second will permit us to develop a method to study and design organisations.

The cybernetics methodology discussed in this work is rooted both in the framework provided by second order cybernetics (Maturana and Varela 1980, Von Foester 1979) and hermeneutics as applied by Checkland (1981) to the study of problem situations.

Second order cybernetics is the cybernetics of the observing systems and its main tenet is that the known properties of the real world reside in the individual and not in the world

itself. This view, which puts emphasis in a, by nature, one sided and unilateral appreciation of reality, triggers the need for dialogue and conversations to construct it.

Hermeneutics is concerned with the interpretation of texts in their historic context, and as such it provides a powerful paradigm to discuss the problems of change in human activities. The interpretation that people give to their experiences, and the distinctions they are able to see in a situation, are closely related their backgrounds. As a whole, these interpretations and distinctions, define the scope for change in a given situation.

Studying the second theme will permit to offer a method to design organisations. This method is based on Beer's Viable System Model (Beer 1979, 1981, 1985). This model is a most outstanding contribution of systems thinking to the understanding of organisations, yet its use has been so far limited to a very small number of people. Despite the fact that Beer's books are both excellent and widely read, it is apparent that they have not inspired, so far, numerous applications. This situation, I believe, is the outcome of some methodological weaknesses in Beer's work.

The VSM as a model permits firstly, an assessment of the structural strategies used by an organisation to cope with environmental complexity, and, secondly, the design of effective responses to cope with this complexity. These features of the model are of great significance in a world

where environmental changes may be outpacing the capacity of organisations to produce responses. However, to use the model it is necessary to develop an effective appreciation of complexity; this is the purpose of the first theme.

This work is a contribution to 'Social Accounting'

This thesis is a contribution towards overcoming some of the methodological problems encountered by those wanting to use Stafford Beer's Viable System Model.

Ashby's Law of Requisite Variety (1964) is central to the discussion of complexity. The development of the VSM rests in Ashby's law, yet in my view, Beer has not worked out in detail the mechanisms that he invokes while applying this law. This shortcoming may be responsible for some of the difficulties encountered by people in practical applications of the VSM.

The Law of Requisite Variety permits to work out the concept of residual variety. This concept is in my view one of the main contributions of this work; it permits to understand how to balance complexities in situations where the parts in interaction possess inherently different complexities. The great significance of Ashby's law is that it offers a heuristics to design this balance at a minimum cost; this design, following Beer's work, is called "variety engineering".



For instance, this is characteristically the case of managers. Since managers are accountable for tasks requiring an information processing capacity much larger than their own, they need to reduce their information requirements to a level consistent with their information processing capacity. For this purpose, on the one hand, they must design attenuators of task complexity, thus accepting that their appreciations will be mediated by other people in the organisation, and on the other, they must design the amplification of their inherently limited capacity for direct action. The methodology and methods discussed in this thesis should contribute to the understanding of how to design amplification and attenuation in managerial situations.

Outstandingly, I think that this work establishes the rudiments of a more equitable and juster **system** to account for the contributions of people to an organisation's performance. Indeed, the VSM offers the template to develop a new and much more powerful "double entry book keeping" system; one that has complexity, and not money, as its main currency. The meaning of this proposition, though unfortunately not its full operational implications, should become clearer as the reader gets deeper into this thesis.

## 1.2 Structure of the Thesis

The thesis has two parts. The first, which goes from chapters 2 to 6, is general in nature and intends to develop a methodology to cope with organisational problem situations; the outcome is a "cybernetic methodology". The second, which goes from chapters 7 to 10, is focused in a particular type of problem situation, namely the organisation of human activities, and its outcome is a concrete method to design effective organisations.

The detailed structure of the thesis is as follow:

Chapter 2 introduces the idea of methodology, and in particular it attempts to make two kinds of distinctions; the first is between "hard" and "soft" problem situations, the second is between "hard" and "soft" methodologies (Checkland 1981). It argues that organisational problems are defined, in general, more by the need that people have to achieve stable interpersonal interactions, than by their need to achieve particular goals. However, stability in interpersonal interactions is influenced both by the appreciations that people develop about a situation and the structures underlying the outcomes of their interactions. To take account of these appreciative and structural aspects a 'cybernetic methodology' is introduced.

Chapter 3 is of particular practical importance. This chapter discusses the idea of a system and offers the view

that systems are mental constructs and not "things" in the real world. We all agree that it is not possible to know the real world itself, hence we need to use the constructs (i.e. systems) of a "viewpoint" to know what the "real world" is; should be, or ought to be for that viewpoint. Since, these constructs are rooted in the histories of each viewpoint, it is unlikely that different viewpoints will naturally focus their interactions in the same "system"; hence the relevance of having a method "to name" systems. This chapter offers practical insight into the problem of naming systems and the problem of establishing who are the participants in any problem situation. In particular, one application of this idea of naming systems is establishing the identities of organisations.

The ideas of complexity and the management of complexity are discussed in chapter 4. Complexity is presented not as objective property of the world but as the outcome of the interaction of a viewpoint with the situation of concern. This view makes apparent that the measurement of complexity is not something that can be done by an analyst independent of those responsible for the situations of concern. After explaining the natural proliferation of complexity in human activities, it becomes clear that viewpoints reduce this complexity in form or another. Indeed, for instance, the capacity of a person to cope with complexity is limited by his capacity to absorb it (i.e. by his perceptual and cognitive capabilities). Variety engineering is offered as

an approach to reduce complexity at a minimum cost for the viewpoint.

In chapter 5 the emphasis is in models, and in particular, in the way people use them. The limited capacity that people have to deal with the real world complexity makes apparent that models can have a great value in focusing their response capacity. While a person may have the capabilities to consider models at multiple levels of resolution, may not have the capabilities to manage the entailed complexities at all those levels. An organisation is necessary to deal with complexity at different resolution levels.

In chapter 6 all the above views are related to one system of action; the cybernetic methodology. The key idea is that the mechanisms of control and communication underlying interpersonal interactions are responsible for both the appreciations that people develop about situations and their capacity for action, and therefore that by changing these mechanisms it is possible to enhance or to inhibit the capacity of individuals to cope with problems. This discussion shows that an effective organisation is the best possible context for individuals to exercise their creative autonomy. Hence, while the design of organisations may appear just as one aspect of a problem situation, its significance is much larger. The design of effective organisations is a precondition for effective problem solving; it lifts constraints affecting the capabilities of

problem owners at the same time that it enhances their problem solving space.

The second part of the thesis is focused in organisational design. In chapter 7 the Viable System Model is derived from first principles. It is unfolded logically from the assumption that managers have a limited information processing capacity. The model comes out from the discussion of two types of problems: firstly, those faced by policy makers in their efforts to define organisational transformations, and secondly, those faced by managers in the control of the entailed organisational activities. Both types of problems have in common the need to produce an effective balance between a low complexity side (i.e. the policy makers and managers) and a high complexity side (i.e. the environment and the organisation). The specific mechanisms emerging from this discussion are the building blocks of the VSM.

In chapter 8 the VSM is used to discuss the case of a small company in the electrical engineering sector; the company P.M. Manufactures offers a rich context to discuss the model and makes apparent its diagnostic power. Historically, the study of this company was done before developing the method explained in chapter 9. In fact the simplicity of the company made possible studying its control and communication mechanisms to a degree that is uncommon with larger organisations; the product was a rich case study that was instrumental in developing the method.

Chapter 9 is in my view at the core of this thesis. This chapter explains how to apply the cybernetic methodology as developed in the first part of the thesis, and the VSM as developed in chapter 7, to the study of organisations. The outcome is a method to diagnose organisational weaknesses and to design effective organisations.

The method has four interrelated activities. The first is the definition of the organisation's identity, and is based on the idea of naming systems. The second is the modelling of structural levels and is based on the ideas of complexity and the management of complexity. The last two activities are more clearly focused in the VSM itself; they permit to study both the distribution of discretion between structural levels in the organisation and the mechanisms for adaptation and control. These two activities together are intended to facilitate the detailed design of control and communication mechanisms in an organisation.

Finally, chapter 10 is an application of the method to the design of the organisation structure of a Management Centre in a University. This application permits to appreciate some of the problems related to the definition of an organisation's identity, the unfolding of its structural complexity and the design of control and adaptation mechanism. This chapter should also be of interest to organisational theorists since it offers a cybernetic study of the so called 'matrix' structures.

# A CYBERNETIC METHODOLOGY TO STUDY AND DESIGN HUMAN ACTIVITIES

## Summary

This first part of the book is a general introduction to the methodology of cybernetics, which is a science of the control of systems. It is a methodology that facilitates the study and design of human activities, particularly in the area of organizational problem solving.

## PART I

### THE CYBERNETIC METHODOLOGY

Extensively, which deals with the methodology of cybernetics, which is a science of the control of systems. It is a methodology that facilitates the study and design of human activities, particularly in the area of organizational problem solving. The methodology of cybernetics is a science of the control of systems. It is a methodology that facilitates the study and design of human activities, particularly in the area of organizational problem solving. The methodology of cybernetics is a science of the control of systems. It is a methodology that facilitates the study and design of human activities, particularly in the area of organizational problem solving.

## Part I: The Cybernetic Methodology

### Summary

This first part of the thesis develops a methodology to tackle problems in human activities. Its heart is in the management of complexity. The aim of the methodology is to facilitate the processes of thinking about, and responding to, organisational problem situations.

Human activities are created by the interactions of people. Naturally, since people have different intentions, purposes, expectations, preferences, values, beliefs ... they will always perceive imbalances in these interactions. Problem solving is the process of finding stability in these interactions, while accepting and making the most out of the natural differences between people. Stability cannot be related to specific causes, it is an emergent property of the multiple, and some times intractable, interactions in progress. Yet, its study is often facilitated by focusing in particular transformations. An insightful definition of these transformations may permit to pin down useful aspects of the interactions, for which it may be possible to discover improvements. Studying the communication channels in between, and among, the affected people is an aid in this discovery. The capacity of these channels, measured by the complexity that they can carry for a given purpose, compared



against the unconstrained capacity that is perceived as necessary to perform effectively the related "real world" transformations, is used to study the adequacy of these mechanisms. The engineering of "**amplifiers and attenuators**" of complexity is part of the problem solving exercise.

Problem solving is both the appreciation of feasible changes and the implementation of these changes. It is the discovery and production of those changes that are capable of bringing about, and maintaining, stability in the interactions of the people involved. The related processes entail abstract technical studies, the analysis of interactions, and the interactions themselves. All these are aspects of the methodology to be developed in the first part of the thesis.

In Chapter 2 the cybernetic methodology is introduced in the background of the so called hard and soft methodologies for problem solving. The concept of a system, and a method to name systems, are discussed in Chapter 3; the concepts of complexity and the management of complexity, essential to study the cybernetics of a situation, are discussed in Chapter 4; the meaning and relevance of models, as well as criteria for effective modelling, are debated in Chapter 5. Finally, in Chapter 6, the methodology is revised as a **system** of activities affecting the real world.

## **2. Problems and Problem Solving Methodologies**

### **2.1 Introduction**

This chapter highlights the nature of problem situations in human activities and offers a discussion of available methodologies to tackle them. As an alternative to the so called hard and soft methodologies, a methodology based upon cybernetic principles is offered.

The activities of the cybernetic methodology entail abstractions about the "real world" as well as processes in the real world itself. While naming systems and modelling are examples of the first type, creating the conditions for effective problem solving and managing the process of problem solving are examples of the latter. In this way problem solving is offered as an interplay between the fully fledged complexity of the real world and the much simplified, but useful, world of models and abstraction.

### **2.2 The Cybernetic Framework**

The concern with problem situations is a response to their pervasive nature. A hallmark of human activities is that they are perceived as problematic. People's interactions, whether explicitly or not, bring about transformations of

one kind or another in the real world. Whether these transformations are perceived as threats or opportunities they often trigger the need for some kind of problem solving. The constant flux of new ideas, the creativity of people, the fears of the unknown, and a wealth of other factors, are responsible for changes in people's expectations. As these expectations depart from their perceptions about actuality, people start to recognise problem situations, that is, opportunities and threats that require their creative capacity to deal with them.

This chapter discusses different approaches to deal with these kind of situations. The 'hard' and 'soft' methodologies are recognised as the two extremes in the spectrum of possible methodologies. While 'hard' methodologies are inadequate to handle situations where the participants do not see problems eye to eye, the latter are inadequate in situations where the contexts for debates are inflexible. Since it is all too common for people **both** not to see problems eye to eye and to operate in inflexible contexts, it is argued that neither methodological extreme might be enough to deal with problematic situations. Hence, the case is argued for a different methodology based on cybernetic principles.

The cybernetic framework will offer us both powerful insights about problems of control and communications in complex situations and methodological aids to support the work of problem solvers. Problem solving, as implied above,

is the discovery and production of feasible and desirable changes to achieve stability in interpersonal interactions. Stability is perceived by observers; there is no objective stability independent of particular observers. The complexity of the real world cannot be captured in full; whatever is known about a situation is what an individual knows about it. Methodologically, this focus highlights that in problem solving it is essential to establish the appropriate **viewpoints** and the nature of their communication mechanism. Cybernetics offers a powerful conceptual framework for this purpose (Espejo 1987).

### **2.3 The Problem Solver**

This thesis is particularly concerned with organisational problems, that is, with problems that emerge when people need/want to work together in a co-ordinated fashion. In these situations an individual's ability to solve well defined problems, may be desirable but not essential. Thus, a person "who knows" precisely how to deal with a particular problem, but fails to communicate with others, is likely to render this capability ineffective. In organisations it is essential an ability to participate in situations with several participants, where simply because there are several participants in interaction, no one can either have complete information about the situation or produce desirable changes on its own.

Most human activities are stability oriented rather than goal oriented. It is a fact that people are often ready to adjust or change their goals in order to achieve stability in their interactions. This view suggests that problem solving is seldom only about finding the means to achieve certain goals, but most frequently, it is about finding the means to achieve stability in interpersonal interactions.

Moreover, since organisational activities are highly interconnected, achieving stability in one situation may prove to be the trigger of instabilities elsewhere. Finding a workable balance between them is the delicate "art of problem solving". Ackoff coined the term "mess" (Ackoff 1978) to describe this kind of situation; a mess is nothing else but a web of problems. This point makes apparent that problem solving is an on going activity.

Therefore, effective problem solvers are those individuals who succeed in contributing to the discovery and production of feasible and desirable changes in the multiple situations they participate. Indeed, problem solving is seldom the outcome of an individual's unilateral actions, more likely, it is the outcome of his effective participation in the organisational discovery and production of desirable and feasible "solutions".

## 2.4 Problems and Problem Situations

The nature of problem situations in human activity systems has been discussed most cogently by Peter Checkland (1981). In his view the problematic nature of human activities relates to the fact that individuals, because of their different histories, develop different appreciations about them. Problems of this kind, most likely will not be solved by unilateral actions, however sound and good they may appear to their proponents. Effective problem solving is more likely to be outcome of appreciative processes, in which the participants gradually develop a richer understanding of each others viewpoints.

Thus, there is a great difference between a "multiple viewpoints" and a "single viewpoint" problem solving situation.

For **individual viewpoints** (i.e. for individuals that express either their personal views or the views of a group of people they represent) problems emerge when they perceive relevant situations out of control. These perceptions may be triggered by mismatches between their **preferred** outcomes for the situation and the outcomes they perceive at **present** or anticipate in the **future**. Whether these mismatches appear to be well defined or not is important, but not central, to this definition. The point is simply that whenever individuals anticipate, or just feel anxiety, about the

outcomes of a situation, they are perceiving a problem. This anxiety may relate to current situations or to anticipated future situations. Individuals may recognise that something is out of hand today or may anticipate that something might be out of hand tomorrow; in either case they are perceiving a problem.

Thus, individual viewpoints construe problems as perceptions, with different degrees of uncertainty, of mismatches between expectations and reality.

On the other hand, "multiple viewpoints" or soft problems are centred in the fact that different viewpoints perceive **different equally valid mismatches in the same situation.** Each viewpoint is essentially perceiving a different problem, though all of them are participating in the same situation.

Soft problem situations emerge from the natural diversity of viewpoints in human activities. Diversity stems from the complexity of human activities, where no individual can have the privilege of full knowledge about, or control, of a situation. By nature, because individuals have a limited information processing capacity, they can only recognise a slice of any situation (each sees the same situation with a different perspective). If these partial views of a situation are compounded by poor communications, then, most likely viewpoints will have difficulties in understanding each others' views, thus, possibly making the problem

situation even more intractable. Problems are often rooted in these two facts; that people have different appreciations of the same situation, and also, that they have inadequate communication mechanisms to relate to each other.

#### 2.4.1 Control Problems

From the perspective of an **individual** viewpoint the emphasis in problem solving is in **managing the complexity** of real world processes. The problem is finding the appropriate responses to counter the disturbances responsible for the perceived mismatches. Cybernetically, as it will be discussed in Chapter 4, the viewpoint is aiming to control the outcomes of a **black box**. This is the case even if the viewpoint is not aware of the black box. A mismatch may be perceived anywhere between the extremes of a well defined and a totally undefined mismatch.

Individual viewpoints have to deal with at least two fundamental dimensions of uncertainty. Firstly, the viewpoint may have some degree of uncertainty (from low to high) as to **what is the problem**, secondly it may have some degree of uncertainty (from low to high) as to **how to tackle the problem situation**. In global terms these two dimensions define four types of problems (Figure 2-1):

**Operational problems** are those where the viewpoint knows what the problem is and how to handle it. These are simple



problems that may lend themselves to mathematical modelling and computer applications. The real problem is not in the content itself, but perhaps in the fact that the capacity to handle all instances of the problem is unavailable, or that the participants may lack motivation to tackle it.

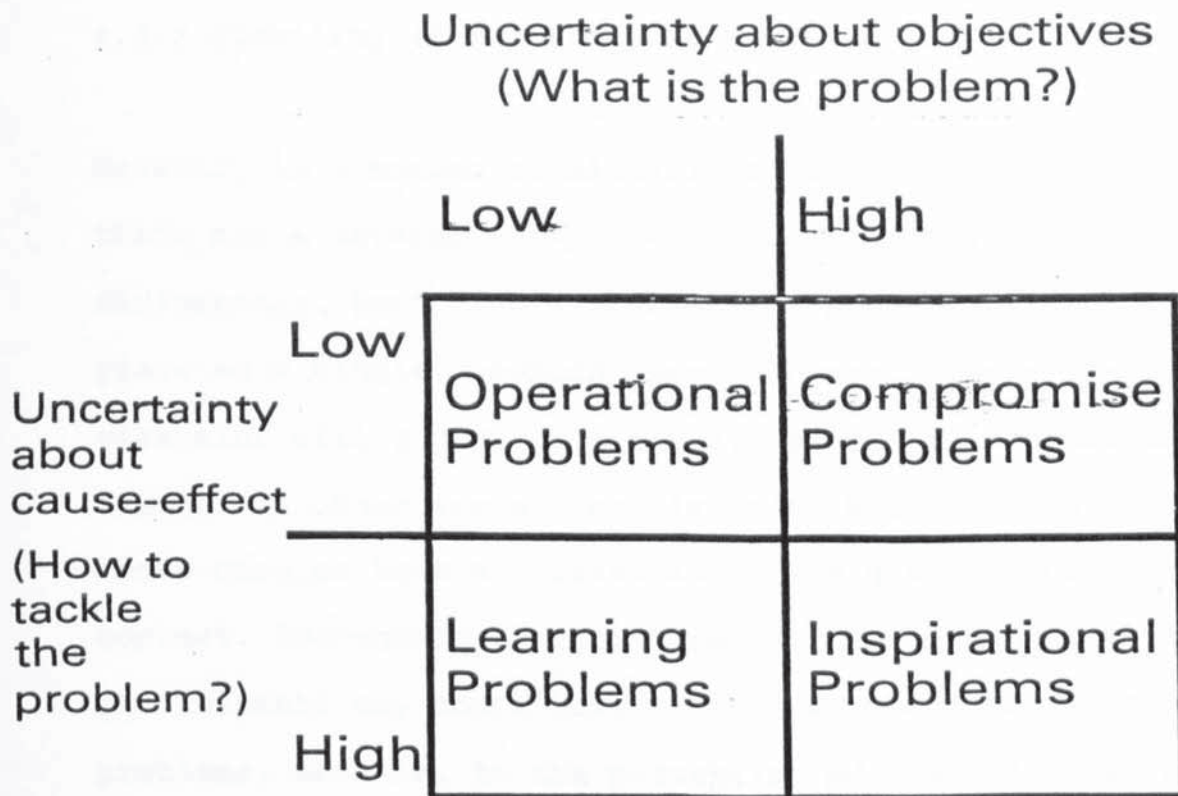
**Learning problems** are those where the viewpoint "knows" what the problem is but does not know how to tackle it. The solution is part of a learning process.

**Compromise or choice problems** are those where the viewpoint may know how to tackle the problem, but may be uncertain as to which option to take; the viewpoint is unclear about its preferences. Indeed, a person may be unclear as to which option, among those available, to take, or the participants (in the **one** viewpoint) may have different preferences.

In these three types of problems the viewpoint has a clear structure for the problem, even though, in the case of choice problems, it may be unsure about its preferences. These problems are common in human activities but they are comparatively simple to tackle, they all assume that the viewpoint knows, to a larger or lesser degree, what the problem is.

Figure 2-1: Types of Control Problems

## TYPES OF PROBLEMS



On the other hand **inspirational** problems are those where the viewpoint is not clear about what is that it wants to tackle, let alone how to tackle it. These problems depend on the creativity of the viewpoint. The viewpoint may only know that there is a feeling of uneasiness. These problems are particularly challenging. The viewpoint has no signposts and indeed, it requires of creativity to find out which are the "black boxes" of interest.

#### 2.4.2 Stability (Soft) Problems

However, in a number of situations the problem will be that there are a several viewpoints perceiving the same situation differently. Even if the problem was perceived in the first place as a single viewpoint problem, most likely the viewpoint will depend on other viewpoints **to produce** any change. In other words, the viewpoint will need to establish those changes that are feasible in the given situational context. Inadequate appreciation of the views held by other participants may contribute to the perception of **soft problems, that is, to the perception of instabilities in interpersonal interactions.**

Therefore, soft problems are those emerging in situations where there are multiple viewpoints, and where problem solving is focused in the **communications** between the viewpoints rather than in the control of the outcomes of a situation.

It is important to reinforce that any problem, regardless of whether it is perceived as well structured or not, is potentially a soft problem as soon as its solution implies the participation of other viewpoints. For instance, the implementation of a response to a well structured organisational problem, such as the implementation of a "stock control" system, may be of the soft kind if it requires the participation of people who do not share the problem owner's appreciation of the implementation process. Analysts often encounter this kind of problems; they are inherent to the production of change in the real world. However, as a better appreciation of the situation grows, -something that does not imply that all viewpoints should think alike, but they all see a common feasible change- the problem situation moves from **softer to harder** grounds. This latter type of problems, i.e. hard problems, are mainly of a technical kind.

## **2.5 About Methodology**

The problem is how do we improve our abilities to handle soft problems both, as problem owners, and as system analysts?. In one form or another all of us deal intuitively with soft problems and "solve" them more or less effectively. But, this is not good enough.

We need **an approach** to deal with them; this approach is broadly what we call a methodology. Thus, **a methodology** for organisational problem solving could be defined as a set of

interrelated activities aimed at facilitating and making more effective the **processes** of problem solving.

### **2.5.1 Traditional Approaches to Problem Solving**

Traditional approaches to problem solving, like some forms of Operational Research (Kidd 1985) and Applied Systems Analysis (Miser and Quade 1986) have centred their efforts in **single viewpoint** problems, where the control of some outcomes is paramount. These approaches are concerned with the definition of strategies and methods to achieve defined goals.

Operational research is defined by the UK Operational Research Society as:

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

Similarly, the definition of systems analysis, as offered by Miser and Quade (1985):

"Systems analysis is the multidisciplinary problem solving activity that has evolved to deal with the complex problems that arise in public and private enterprises and organisations",

puts the emphasis in the multidisciplinary aspects of complex problems rather than in the holistic nature of human problems in organisations.

In spite of the difference in names, both systems analysis and operational research focus their concerns basically in the same issue, that is, **in the use of scientific methods to support the processes of problem solving in human systems.**

These methods appear to be concentrated in handling the technical aspects of a situation, rather than its human aspects. They seem to be more concerned with explaining, simulating or controlling a situation, rather than with steering effective communication processes to achieve the commitment of the concerned people. It is because of their technical focus, that the great success that these approaches have had in technical fields (e.g. design of production systems, computer systems, space programme) has not been paralleled in the more unstructured situations, where interpersonal communications are not dominated by some widely accepted common goals.

An example of a hard methodology can be appreciated in Exhibit 2-1, which defines the basic activities of one of the very early methods for Operational Research (Churchman et al 1957). This methodology was followed by many others, all driven by the assumption that the problem participants were fully committed with the espoused situational objectives. These methodologies share the worldview that problem solving is about finding responses to achieve well defined goals or objectives. Indeed, this also seems to be the case for those methodologies that recognise risk and uncertainty as key to problem solving (i.e. for those methodologies dealing with compromise problems).

Unfortunately for those who put their hopes in them, these problem solving approaches are inadequate when the complexity of human activities is dominated by the need to maintain stability in interpersonal interactions. Among others, information analysts have felt this inadequacy; they refer to the so called "problems of implementation" (Lucas et al 1980, Boland and Hirschheim 1987), that is, the problems of transferring abstract designs into the real world. It is apparent that the uncertainty natural to real world situations is not well captured by most of these approaches. It is also apparent that too often the agreed "solutions" lack in flexibility once they are implemented.

## Exhibit 2-1: A Hard Methodology

### **“Hard” Methodology**

- Formulate the problem  
(choose objectives)
- Construct a mathematical model
- Derive a solution from the model
- Test the model and the solution  
derived from it
- Establish control over the  
solution
- Put solution to work

CHURCHMAN, ACKOFF, ARNOFF (1957)



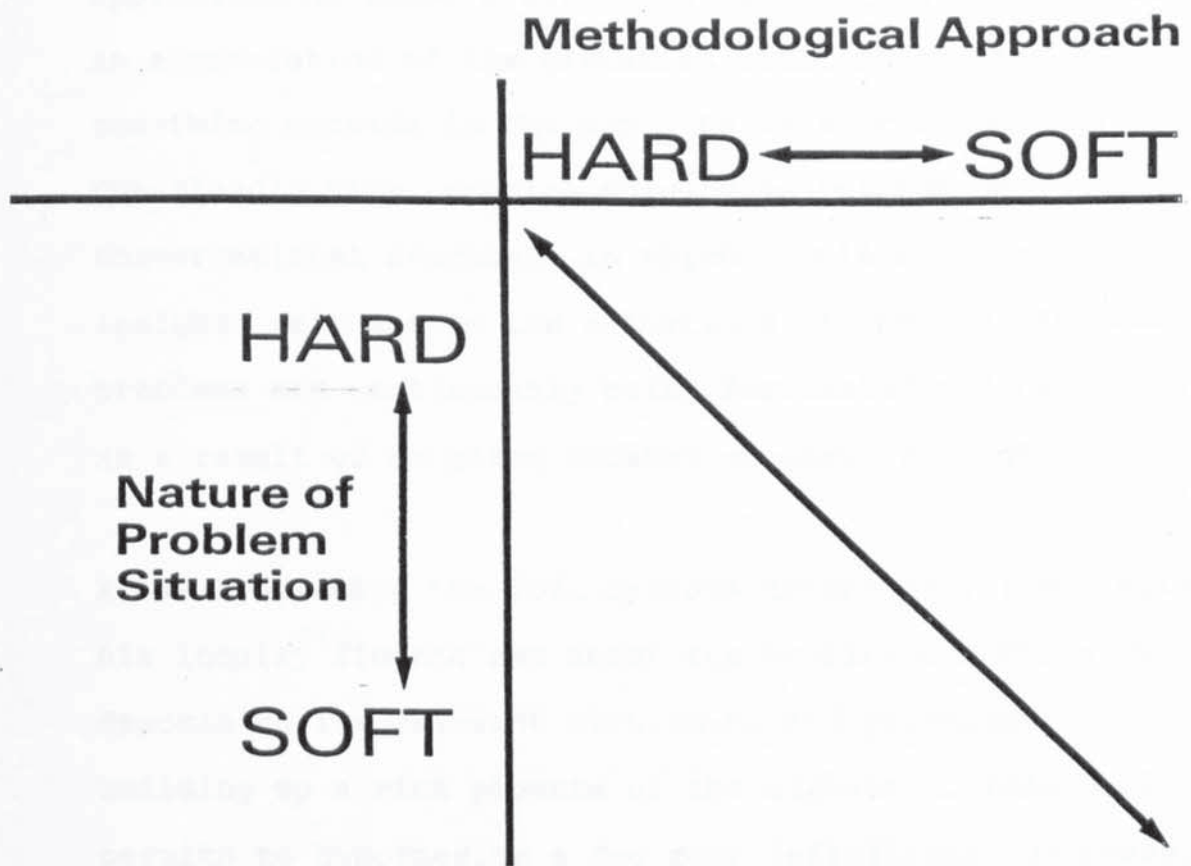
Of course, in spite of all the above distinctions, whether a situation is perceived as soft or hard, or softer or harder, depends on the context and the individuals concerned. Quite naturally, going to the extremes, the same problem will be perceived very differently if the context is either war or peace. The same situation may evolve from one extreme to the other, making appropriate the use of different methodologies. As suggested in Figure 2-2, for a harder problem it is necessary a harder methodology, one that assumes that the participants share objectives, and where the inquire is about the means to achieve these objectives (i.e. a control methodology). But, while soft problems do not lend themselves to precise techniques, individual viewpoints may use them to do independent analyses of the situation.

### **2.5.2 The Soft Systems and the Cybernetic Methodologies**

The recognition of the above situation has led to the development of new approaches like the so called "Soft Systems Methodology" (Checkland 1981), and several others, focused in the processes of problem solving, rather than in their specific technical content (Eden et al 1984, Kling 1987).

Of particular interest to this development is the work by Peter Checkland and his associates at Lancaster University (Checkland 1981, Wilson 1984). Influenced by Vickers'

Figure 2-2: Problems and Methodologies



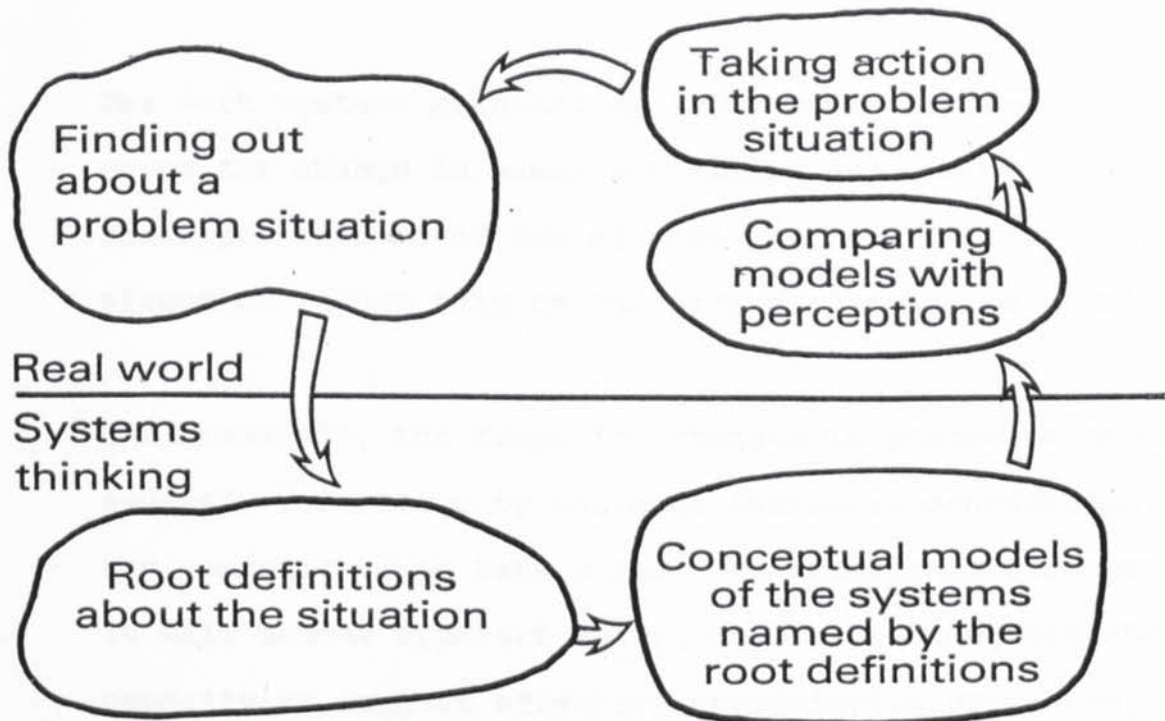
**appreciative systems** (Vickers 1965, 1972) Checkland has articulated the **Soft Systems Methodology** (Figure 2-3).

In Checkland's view **human activities** are not objective entities in the world. People are simultaneously creating and participating in real world activities, as such they are naturally embedded in problem situations. As a result of their personal histories people develop different appreciations **about** a situation rather than **of** a situation. An appreciation **of the situation** would imply that there is something outside in the world to be appreciated. In Checkland's view, problem solving is related to conversational processes in which people develop new insights relevant to the situations of concern. As such, problems are continuously being formulated and reformulated as a result of on going debates or conversations.

An analyst using the Soft Systems Methodology (SSM) starts his inquiry finding out about the problem situation by describing its relevant structures and processes i.e. by building up a **rich picture** of the situation. This knowledge permits to hypothesise a few **root definitions, or names**, relevant to the situation; these are concise, tightly constructed descriptions of human activity systems, which state the systems perceived as relevant to the situation by the analyst. What these systems do, that is their named transformations, is then structured in the form of **conceptual models**. The core of this methodology is comparing

Figure 2-3: The Soft Systems Methodology

## Soft Methodology



CHECKLAND, 1981

these models, which show the logical activities necessary to produce the named transformations, with the real world situation (as described in the first activity). This comparison takes place in the real world (i.e. in the world of the clients) and not in the abstract world of the analyst. From this comparison it should be possible, for the clients, to derive **systemically desirable and culturally feasible** changes, that is, the directions for taking action in the problem situation.

The Soft Systems Methodology (SSM) makes apparent that the scope for change in human activities depends upon changes in the appreciations of the clients involved in the problem situation rather than on the merits of technical options.

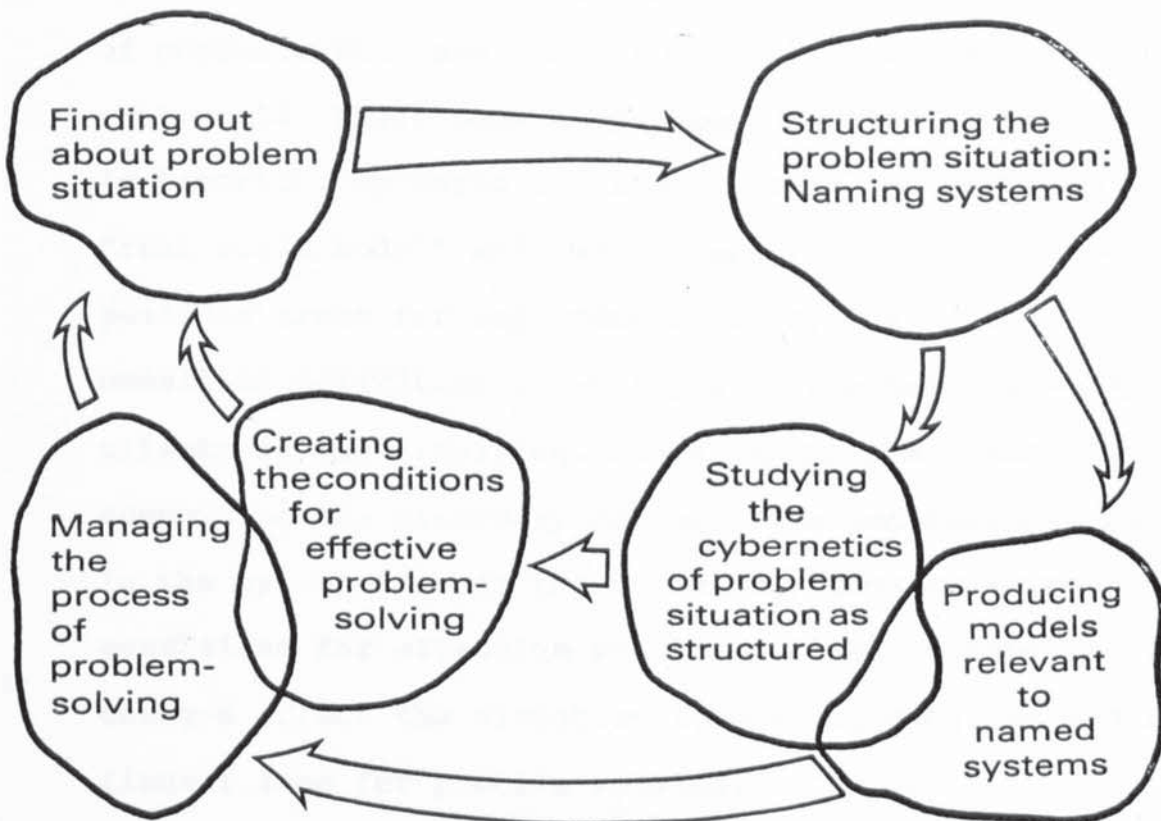
Unfortunately, the scope for changes in appreciation can be severely restricted by the organisational contexts in which the communications take place. Organisational structures, as it will become apparent later, may have inadequate channel capacity to support effective appreciative processes. If this is the case, however much the (client) viewpoints may communicate among themselves, they may leave out of their concerns other relevant viewpoints, or pay them inadequate attention. This fact, most likely, will reduce the effectiveness of their problem solving. Cybernetics, or "the science of communications and control in the animal and the machine" (Wiener 1960), offers a way to deal with these communication problems.

Hence, in this thesis an alternative methodology, the **cybernetic methodology**, is offered (figure 2-4). The emphasis of the cybernetic methodology is in the communication mechanisms between the participants in the problem situation. It is argued that inadequate mechanisms lead to inadequate appreciations about the situation, and that improvements in the situation depend upon structural changes. On the other hand the SSM, as suggested earlier, operates as if structural constraints did not exist.

The cybernetic methodology highlights the fact that the creation of **human activities** is strongly influenced by the communication mechanisms underlying the interactions of individuals. The cybernetic view is that these individuals are constrained to different degrees by the organisation structures in which they are embedded, and therefore, that by changes and modifications in these structures, it is possible for them to develop different appreciations of a problem situation. Moreover, while some structures may inhibit their appreciations or produce poor appreciations, others may liberate their views and make more likely richer appreciations of situations. Therefore, the cybernetic approach argues that effective problem solving implies the creation of as an effective **organisational** context as it is culturally feasible (for the creation of such an organisation must acknowledge the constraints dictated by the cultural environment)

## 2-4: The Cybernetic Methodology

### Cybernetic Methodology



The above approach implies studying the **cybernetics of the problem situation**, that is, studying the control and communication mechanisms underlying the situation. This study is done for the **organisation(s) named as relevant to the problem situation**. Therefore, at least one of the names produced by the "problem structuring" activity of the methodology (see Figure 2-4) is that of an organisational system. The outcomes of the cybernetic studies are models of communication and control mechanisms as perceived in the real world. These models are then compared with (cybernetic) criteria of effectiveness. Mismatches between a "real world model" and the "effective model" define possible areas for improvement. Thus, the outcome of the modelling activities is an input to the debates among clients in the situation. These inputs are aimed at supporting the discovery of desirable and feasible changes in the cybernetics of the situation, thus **creating the conditions for effective problem solving**. Naturally such changes affect the situation itself, closing the **cybernetic (inner) loop** for problem solving.

While the cybernetic improvements might not deal directly with the particular symptoms of the problem situation, they are intended to create the structural conditions for effective problem solving, i.e. for effective appreciation and action. Adequate regulatory mechanisms reduce the chances of dealing with self inflicted problems. It is in these conditions that the participants are more likely to



focus their problem solving capabilities in genuine differences in purposes, values and preferences, rather than in conflicts triggered by poor organisational communication processes.

Also, it is in these conditions that problem owners are more likely to get some benefit out of the models produced by analysts.

These models can be either **conceptual or descriptive** in purpose. The former establish the logical activities entailed by a system at an abstract level, the latter establish the real world activities as perceived by an analyst. The comparison of these two types of models should permit one to detect possible areas for improvement. This comparison, is not essentially different to Checkland's comparison of conceptual models and "rich pictures" of the situation. Except that in the cybernetic methodology intended and real world transformation may be used, in appropriate situations, to trigger the building up of conceptual and descriptive models for comparison purposes.

The last, and perhaps the most relevant of the activities in the **learning (outer) loop** of the methodology is **managing the process of problem solving**. It is at this stage that the management of the problem's complexity takes place. Debates should permit to establish what sort of improvements are desirable, and political negotiations should permit to establish their feasibility. Since producing "feasible

changes" will require most likely the contributions of other people, success in problem solving relates to success in implementing the agreed transformations. However, while this implementation may be facilitated by an effective use of the cybernetic loop, most likely, it will produce soft problems to other participants operating at higher levels of resolution, for whom the same methodological approach may now be useful.

## **2.6 Final Remarks**

This chapter has offered an introduction to the cybernetic methodology. The first part of the discussion permitted to distinguish between hard (control) and soft (communication) problems. The latter problems are inherent to human activities, where, it is natural and desirable for people to appreciate the same situation from different angles. Communication or soft problems can be tackled by improving the communication mechanism between the participants (the cybernetic loop) and by enriching their appreciations about the problem situation (the learning loop). The aim of the methodology is to work out desirable and feasible changes in the situation. However, achieving agreement about change should not be interpreted as an attempt to get all the participants seeing the problem from the same angle, rather it should be seen as an attempt to enrich the participants

specific views, to the point where, they see the advantages of jointly producing agreed changes with other viewpoints.

In the next three chapters, that is, in chapters 3, 4 and 5, we will discuss aspects of the methodology. In Chapter 6 we will put all the parts together and discuss the methodology as a system in its own right.

### 3. About Viewpoints

#### 3.1 Introduction

Underlying this chapter is the view that in studying problem situations it is advantageous to be aware of our mental constructs. This awareness may help both to establish the hidden assumptions we make about the world and to see otherwise unapparent possibilities.

The chapter should permit the reader to appreciate the difference between changes in the "real world" and systems in the "abstract world" of analysis. Since human activities are perceived differently by different viewpoints and, in a general sense, all these perceptions are valid, using different constructs of a situation is all too natural.

The concept of a "system" is used to facilitate work in this abstract world of mental constructs. The concept of a system permits an analyst to structure insightful views about an ill defined situation as well as to direct the clients efforts in the management of the situational complexity. If the purpose in naming a system is to focus the attention of the clients in an insightful transformation, different to that implied by their own viewpoints, then, the named system is a "root definition" (Checkland 1981). On the other hand those systems whose purpose is to focus attention in the management of real world complexity from a particular viewpoint are simply

named. This chapter explains a particular approach to name systems. Several examples are provided to illustrate in practice the use of this idea.

### **3.2 Systems and Multisystems**

The concept of a system is one of the corner-stones of this work. Though widely used, I think it is necessary to develop its meaning from first principles. Most people use the term very loosely. Moreover, even if used by system analysts, the meanings it evokes can be misleadingly different. Its use may trigger the ideas of "systematic" or "systemic". While the former adjective puts the emphasis in the organised, orderly, step by step nature of certain phenomena, the latter puts the emphasis in the relations between these phenomena. Here we are concerned with this latter emphasis.

Each of us is constantly experiencing a range of phenomena of different kind and nature. If these phenomena cannot be explained with reference to the properties of their elementary parts, whether the phenomena are objects, theories, institutions or human activities, then we are experiencing "systems". For instance, we cannot explain the wetness of water by explaining the properties of oxygen or hydrogen alone, nor we can explain the speed of a car by explaining the properties of its independent components, nor we can explain the performance of an organisation by reference to the capabilities of its

individual members. In all these instances the relationships among the parts produce outcomes that the parts could not produce by themselves. Indeed, these are all examples of phenomena that can usefully be described as systems.

The following definitions of a "system" capture the above meaning:

"System is an organised or connected group of objects"  
(Oxford English Dictionary)

"System is a set of interrelated elements each of which is related directly or indirectly to every other element, and no subset of which is unrelated to any other subset" (Ackoff et al, 1972).

"System is a set of objects together with relationships between the objects and between their attributes connected or related to each other and to their environment in such a manner as to form an entirety or whole" (Schoderbek et al, 1975).

Though these definitions are useful in that they highlight the idea of relationship, they appear to reinforce the illusion that the elements we experience in the world are the "real world". There is a danger that we might lose sight of the fact that an individual's "perceptions" cannot capture the totality of these elements, not the least

because such "elements" are being perceived by other people in different contexts and with different purposes.

Because these definitions do not stress the subjective nature of systems they may confuse the use of systemic ideas in studying or designing human activities. Such definitions appear to refer to entities in the world and not to their interaction with those experiencing them.

The view accepted in this work is that a system "is a way of looking at the world" (Weinberg 1975) and that it can be defined:

**"as a mental construct of a whole, for which it is possible to establish a set of interrelated parts that make up a perceived whole"**

The **whole** is that which is captured by an individual's act of distinction in the particular "situation" of interest. The "situation" could be a conceptual framework, an object, a human activity, or more specifically, an organisation.

Experiencing a whole, or for that matter, the elements of a situation is a subjective matter, influenced by our perceptual structures. With reference to an object, we perceive "a side of the object", and the name we give to it suggests a consensus as to the "side" of relevance (figure 3-1). If the purpose of the object I have now in my right hand is to write with it, we may agree that its

name is "pen", yet if I use it for other plausible purposes, it might be properly named, for instance, "missile" or whatever. We are all clear that the name is not the same thing as the object. The tacit purpose we ascribe to an object, regardless of the given name, defines the elements and relationships we are looking at. For instance the purposes ascribed to the object "clock" might either be to tell the time, in which case the parts and relations of interest are its hands and their relative positions, or, might be to exemplify an electromechanical device, in which case the parts and relations of interest are its electromechanical components and the mechanisms relating them. These are two different systems related to the same object. It would thus be a mistake to say that the system is the object. Another conclusion is that an "organisation" is not a system, though might be usefully described as a system.

Hence, the view is taken that a "system" always relates to a "viewpoint", that is, to the constructs of an individual or group of individuals. Of course, an individual may produce these constructs in his personal capacity or as the representative of a larger constituency e.g. company, department, section... In these latter cases the constructs of the individual may be understood as the viewpoint of the larger group.



Figure 3-1: About Systems

Real World: Problem Situation  $\longleftrightarrow$  Abstract Thinking: Systems



The same situation may be perceived or construed very differently by different observers

This is an important methodological point. Systems are always **named** by viewpoints, and, the meaning of a name can only be ascertain with reference to a viewpoint. It is perfectly possible that two different viewpoints attach very different meanings to the same name.

A system can be explicitly named by a participant viewpoint or by an (observer) analyst who names what in his view is the tacit purpose that a participant viewpoint ascribes to a situation. Indeed systems are more often than not tacitly "named" by the de facto 'parts and relationships' that viewpoints look at through their actions.

The **boundaries of a system** are defined by the parts and relationships that the viewpoint "chooses", consciously or not, to look at. For instance in one of the above examples, we said that the most likely parts and relationships that a clock user will "choose" to look at are its hands and their relative positions; these are the variables relevant to the **user viewpoint** and they define the boundaries of the system "clock" for **this** viewpoint. Indeed, these boundaries are very different to those relevant to the **manufacturer viewpoint**; for it, it is not difficult to imagine, the number of relevant parts and relationships are many more. Since the methodological problems of defining the boundaries of a system are considerable the topic will be discussed in some detail later in Chapter 5.

Viewpoints experience wholes with features (i.e emergent properties like wetness or speed) which are different to those of the constituting parts; these features give to the named wholes specific **identities**. However, these identities are not intrinsic to the world but constructs in the mind of an observer. While for objects there might be a large degree of agreement about their identities (most of us would agree that the object in my right hand is a pen and not a missile), for organisations the problem of identity becomes much less clear, and for ill structured situations becomes even more hazy.

It seems important to understand that, somewhere in between the extremes of the apparent reality of well defined objects and the slipperiness of ill-defined human activities, we find social organisations characterised by possessing a closed structure of communications which defines them as wholes independent of any particular observer. Note that this view is not insisting on the subjective nature of the "wholes" emerging from organised human activities. It is accepting the possibility of entities with their own coherence even though such coherence is beyond the experiential reach of any one observer or viewpoint.

The positivistic view that grants a system an almost uncontroversial identity in the world outside the observer, may be useful to study situations with a clear identity, for which there is a high degree of agreement about

purposes. These would be those cases where different viewpoints attach the same meaning to a name. However this view is likely to be very misleading when studying human activities. To make these activities analogous to objects, as a reference for naming systems, is to miss the point about their epistemological status. For these situations the rule is that they are experienced differently by different observers, and therefore we should expect that different, equally valid, names are produced for them; in this case viewpoints name systems **about** a situation and not **of** the situation.

Of course, for organisations in contrast to objects, singleness of purpose or the dominance of a purpose over others, is just not the case. Viewpoints may attach different but equally valid purposes to what appears to be the same organisation. For instance the "university" as a situation may be construed very differently by different viewpoints. It may mean "system to obtain a degree" for most students, or "system to develop and transmit knowledge" for most academic staff, or "system to pay my salary" for most of the ancillary staff. Indeed all of these "names" -and many more for the situation "university"- are equally valid, something which could not be argued in the same way for the names "pen" and "missile" with reference to the object I have in my right hand.

For human activities it is useful to replace the idea of a referent object, for which a name is adequate (though potentially misleading as was made apparent by the name "pen"), by the idea of a **multisystem** i.e. a social reality that is created by on going processes of interaction, for which multiple names are necessary. The multisystem is the dynamic outcome of the multiple viewpoints exchanging descriptions i.e. systems, in their ongoing interactions. As a matter of fact any viewpoint in social intercourse is, ontologically speaking, part of a "multisystem" and not of "a system" in the traditional sense.

If, with reference to particular changes (i.e. tasks) in the world (not necessarily well defined), the multisystem of concern defines a closed network of interpersonal interactions that produces itself, that is a network with autonomy, then, the multisystem is an organisation.

In any case, and this is a fundamental tenet of this work, since all individuals belong to organisations of one kind or another, their appreciations, that is, the ways in which they construe situations, depend upon the exchanges and relationships that are allowed to them by the communication channels available in those organisations; at this level there are constraints that are independent of the perceptions and perceptual capabilities of the particular individuals in those organisation. The constructs of individuals, that is the

systems that they name tacit or explicitly, are strongly influenced by the communication channels available to them in those organisations.

### **3.3 Naming Systems: The Use of Systems in the Study of Problem Situations**

It is suggested that a good deal of the methodological problems faced in studying problem situations could be traced back to a poor understanding of what is a system. This elusiveness of systems relates to the multiple forms of description that are possible in any situation. Confusions may emerge, not only from the epistemological constraints limiting the analyst capabilities to know about the world, but also from the analyst lack of clarity about the ontological status of the situation being described. The purpose of the analyst may be describing an entity in the world, like an organisation, or may be creating a system, like when he works out his views about a situation. Moreover, when he is describing "the real world" his purpose may be to describe it "as it is" or "as it should be" or "as it ought to be" or "as someone else imagines it to be"... Indeed the constructs of an analyst may be about his perceptions of the constructs made by other individuals or groups, or about the constructs that other viewpoints make of their own constructs, and so forth.

Since the possibility of multiple descriptions is inherent to the complexity of the world, it is methodologically useful to establish the **fit of the name to the world**. In the extremes the options are:

-that the purpose of the name is to describe the world as it is perceived by a viewpoint. In this case there is "name-to-world" fit e.g. a viewpoint can say "the purpose of this hospital is to produce its own input" by observing that a large proportion of its admissions are in fact readmissions, or it can say "this other viewpoint thinks that the purpose of the hospital is..." by expressing its views about the views of another viewpoint.

-the purpose of the name is to define a notional, perhaps desirable world, with no reference to actuality. In this case there is a "world-to-name" fit, e.g. a viewpoint may ascribe to a hospital the name "system to maximise the productivity of people in the community" with the purpose of designing a system that fulfils that role in the community.

Of course the truth value of a name in the former mode of description is not guaranteed; the name may be either the **espoused purpose** that the viewpoint ascribes to a situation (which can be falsified by evidence) or the **perceived theory-in-use** (i.e. what the viewpoint perceives is happening in the situation). The truth value of the name in each case may be very different. However, in the "name-to-world" fit the inference is that the intention

of the viewpoint is to describe the actual world, while in the "world-to name" fit, the inference is that the intention of the viewpoint is to change the world from a current state to a new one.

In later chapters the former mode will be related both to **descriptive models and a diagnostic mode** of intervention, and the latter mode to both **conceptual models and a "design" mode** of intervention.

Studying a situation may either imply the need to elicit the names tacitly held by different participants of perceived real world situations, or to create names **about** relevant situations. The former approach aims at describing a real world situation e.g. an organisation or an organisational part, the latter approach aims at creating new insights -from different worldviews- about the situation and not of the situation. Perhaps one of the most important aspects of the work by systems analysts, management scientists, researchers...is precisely the **naming of systems or problem structuring.**

### **Root definitions**

The naming of systems in practice is an important methodological problem. Checkland and colleagues at Lancaster University (Checkland 1981, Wilson 1984), have suggested the use of "root definitions" as a means to name systems.



Checkland defines a root definition as "a concise, tightly constructed description of a human activity system which states what the system is..." (Checkland 1981, page 317). From his point of view "root definitions have the status of hypotheses concerning the eventual improvement of the problem situations..." (Checkland 1981 page 167).

The crucial features which should be explicitly included in a well formulated "root definition" are (Checkland 1985):

- Customer: Who would be the beneficiaries or victims of this system were it to exist?
- Actors: Who would carry out the activities of this system?
- Transformations: What input is transformed into what output
- Weltanschauung: What image of the world makes this system meaningful?
- Owners: Who could abolish this system?
- Environment: What external constraints does the system take as given?

These six characteristics form the mnemonic CATWOE. The above definition of "root definitions" appear to be saying that human activity systems are change processes and, therefore, that names are bound to capture either real world transformations (i.e. primary tasks based root definitions) or transformations in the viewpoints themselves (i.e. issue based root definitions). In all cases a system is change, is transformation. Moreover the idea of transformation suggests, as made explicit by its definition, the transformation of input into output. In the next chapter it will be argued that for any root definition the complexity of these transformations cannot be made fully transparent to the observer and therefore that a "black box", in between input and output, is inherent to these human activities.

Perhaps the most important element of the root definition is the W. The Weltanschauung implicit or explicit in the root definition is what gives meaning to the named transformation. No doubt the personal histories of those making use of the root definition is critical to their interpretations. Making explicit the W is like making explicit the hidden assumptions underlying the root definition. Hence the need to make explicit the W, otherwise, most likely, people will not share the meaning of the transformation. This is indeed very important when the root definition is offered as a hypothesis to support further debates.

## **Naming systems**

In this work the idea of naming systems is extensively used, however it is used in two different senses, one is that of a hypothesis, as intended by Checkland, the other is that of a description of a "chunk" of complexity in the real world. This latter use is particular to this work, and relates to the idea of managing complexity.

Thus, naming a system gets a wider status than that of a hypothesis concerning the eventual improvement of a problem situation, it is also a shorthand to describe the real world as perceived or intended by a viewpoint. When used in this latter sense we only talk about the **names** relevant to a situation. These are the "names of both the transformation and participants that a viewpoint perceives as relevant with reference to the situation".

A root definition is offered as a hypothesis for debates and therefore it may not be helpful if it reflects the viewpoint of one of the clients. Clients need to maintain their independence from particular "solutions" to the situation and evolve their views as new root definitions emerge from the debates.

On the other hand, a name (as produced by a viewpoint) is only offered to study the management of the complexity entailed by its transformation.

In this latter context **naming a system** should help to make explicit:

- Transformation:      What input is transformed into what output?
- Actors:               Who carry out or would carry out the activities of this system were it to exist?
- Customer:            Who are or would be the beneficiaries or victims of this system?
- Owners:               Who controls or would control this system?

The mnemonic TACO is suggested instead of CATWOE.

Though it is perfectly possible that a named transformation (T) may mean very different things to different viewpoints, the emphasis in relating the name to one particular viewpoint overcomes this indetermination. In the case of root definitions an explicit definition of the "W" should help to remove this uncertainty. So for instance, if the name is "system to co-ordinate the activities between

departments in a company", the meaning of the transformation "to co-ordinate" can be very different for different managers; while some managers may interpret co-ordination as the task of achieving consistency in departmental activities from above (i.e. by direct supervision), other managers may interpret it as achieving consistency by inducing self regulation among departments (i.e. by mutual adjustments). While the first interpretation suggests a hierarchical, centralising "W", the second suggests a decentralising "W". A root definition, to be well formed, would need to make apparent this "W" in the name itself. In the case of "naming the system" this "W" is likely to emerge when the viewpoint is asked to work out the activities implied by the named transformation (see conceptual modelling in chapter 5); up to that stage the name is always related to a particular viewpoint.

Actors, customers and owners are the **participants** implied by the named system. If the viewpoint names a transformation already happening, then it should be possible to identify the actual participants. On the other hand if the viewpoint names a notional transformation then the participants would have to be inferred from the context of the situation. Of course it may happen that there is not enough information to recognise the participants with any precision. In this case the analyst would have to work out, with the clients, the details of the named system. The clients are in general the "customers" of the system "analyst-clients interaction" owned by the analyst.

Customers are those immediately affected by the named transformations. Equally, owners are those directly controlling the transformations. This is another departure from Checkland's root definition; it is clear that for most situations in which the system is a shorthand for a real world process, the "owners" will not be in the position of abolishing the named system. If customers, actors and owners are very different sets of people the likelihood is that the owners will only control, within certain limits, the named transformations. While it may be perfectly possible for the owner of a system to abolish it if he is the sole user of its transformation (i.e. customer), it may not be possible (for that owner) to stop the real world transformation if other customers are involved.

If the owners are also the sole customers, then by not making use of the transformation the owners would be stopping it.

Of course, while there are cases in which the purpose of the name is capturing a well recognised transformation in the world and therefore the name could be interpreted as the name of a situation, there are many other cases in which the purpose of the name is to provide an insightful view **about** a situation. In this latter case, clearly along the lines of Checkland's root definition, the purpose is to produce an unexpected view about the situation.

These "unexpected" names may relate to transformations happening in the world or to notional transformations. Indeed any situation can trigger the naming of several transformations by any one particular viewpoint.

As for the environment "E" of a named system, it can be better studied at the time of defining the boundaries of the system and not at the time of naming it, thus, it is not considered essential to the name. We will discuss this aspect later in Chapter 5.

### 3.4 Examples of Names

Some examples of names, mainly centred in the idea of managing complexity, should help to make more clear the idea of naming systems.

1) If the role of any of the participants in a situation is well defined then it may be possible to work out the transformation that is consistent with that role.

A manager in a geological institute was invited to name the **system he was accountable for** in the organisation. He produced this name:

"Assessment of mineral resources in the country with the aim of supporting planning and private

decisions on land use".

Further elaboration of this name through discussions with the manager permitted to establish that the related TACO was as follows:

- Transformation: from the assessment of mineral resources, through the elaboration of research data into transmission of information.
- Actors: those within the geological institute taking geological samples, doing chemical analysis, doing data processing and transmitting the results.
- Customers: planning authorities and private investors.
- Owners: Director of Geological Institute.

In fact, at this point it became clear that he had not been answering the posed question; had he done it properly he would have been the owner of the named transformations. In fact he was not. When this became clear to him, he produced a second name:

"Management of information necessary for the assessment of mineral resources in the country,



with the aim of supporting planning and private decisions on land use".

Implying the following:

- Transformations: geological data into decision support information
- Actors: data processing people and information analysts
- Customers: planning authorities and private investors.
- Owner: the manager answering the question.

In the discussions it became clear that the manager was tacitly assuming that he had control over the actors implied by the first name, something that became apparent by the nature of his interactions with them: this behaviour was creating problems in his interpersonal interactions.

2) If the transformation of a system is fixed, then it should be possible to work out the assumed participants necessary to make such a transformation possible.

The production manager of a plant within a division of a large multinational corporation asked the analyst (a doctoral student) to:

"design and implement a system to support his information needs in controlling shopfloor activities".

These were in brief the analyst's terms of reference. The implied TACO was as follows:

Transformation: information requirements into reporting systems

Actors: information analyst (the student) and computer specialists from the division's Management Services Unit

Customers: the production manager and people in the shopfloor.

Owner: the production manager

In this case the transformation was fixed. The production manager perceived himself as the owner of this system. However the specialists from Management Services did not report to him (they were operating one structural level above the plant). When they were required to come in, at a later stage in the development

of the project, they were not ready for it. In the event the transformation did not happen as planned; the underlying **assumptions** that either management services were going to co-operate or that the production manager controlled the implied actors, proved to be incorrect.

3) In establishing the participants implied by a named transformation it is necessary to name the immediate participants and avoid the naming of too general or remote participants. This is particularly a problem when discussing customers or owners. Customers because often it is easier to see remote victims or beneficiaries, linked somewhere along the line of upstream or downstream transformations to the particular one of concern. The same is the case for the owners but in addition there is a tendency to name "the organisation", or "the division" or any other organisational entity... as the owners. This ownership is too global to be of any use in the analysis of interactions (i.e. management of complexity); it is necessary to recognise a viewpoint as the owner.

A researcher was asked to name her research concerns. She produced the following name:

"To investigate ways of improving road safety for cyclists, looking particularly at the behaviour and attitudes of all road users and how these maybe influenced

through education, enforcement, engineering and encouragement".

In this case it was easy to name the cyclists and other road users as the customers and Friends of the Earth as the owners. It was more difficult to recognise that the immediate beneficiaries or victims of the investigation were not road users or cyclists, but those policy makers or support staff using the results of the investigation. Equally Friends of the Earth was too general an owner, their Transport Campaigner was a more precise viewpoint.

4) Naming systems at the "right" level of generality is another possible difficulty in using this tool.

The Head of Management Services in a publishing company was asked to help corporate management in responding to a decline in the circulation of their publications (Gomez 1982). As an answer he named the following system:

"development of a system for the timely detection and effective control of disturbances or dangers in the process of managing the circulation of publications"

He was implying the transformation of requirements of internal and external data into a reporting system. While it is not disputed that this name could be an appropriate answer to the request from corporate management, the

modelling that ensued the production of this name was focused at a more general level of resolution, suggesting that perhaps the name was one level of resolution below that that was necessary. A more general name like "system to increase or maintain the circulation of publications" might have produced other responses different to the "development of an information system" e.g. better marketing systems, thus avoiding an unnecessary foreclosure of options.

5) A classical story in Operational Research may help to illustrate the idea of producing very different names in the same situation (Ackoff 1978). This example illustrates both the relevance of creativity in problem solving and how the same physical transformation can be perceived very differently by different people.

The story is that of a "estates administration" faced with an increasing level of complaints about one of its building's "lift services". In this situation, the most obvious name for a relevant system was that of "system to improve the rate at which people are moved from one floor to the others". It took a little more insight to name the system "system to affect the users perceptions of the services". In this particular story, so it goes, the latter name not only implied another "worldview" (i.e. "W"), but the possibility of finding a viable solution whereas the former offered none. Indeed, while the cost of implementing "more efficient lifts" was

prohibitive, the cost of installing mirrors in lobbies (let's make the waiting less boring!!!) was trivial. This story illustrates both the importance of creativity in naming systems and the fact that alternative names may imply very different levels of complexity in the real world.

In general, with reference to the same situation, different names may imply very different levels of complexity. As suggested by this example, it should not be difficult to see that though referring to the same situation, the activities entailed by the transformations "moving people quicker from floor to floor" and "changing the perceptions of the people waiting for the lifts", are indeed very different.

Thus, even if the concern is the management of complexity alone, with reference to any particular situation it may be possible to have not only different viewpoints naming different systems, but also it is possible that the same viewpoint names different systems by discovering different "Ws" while thinking about the situation.

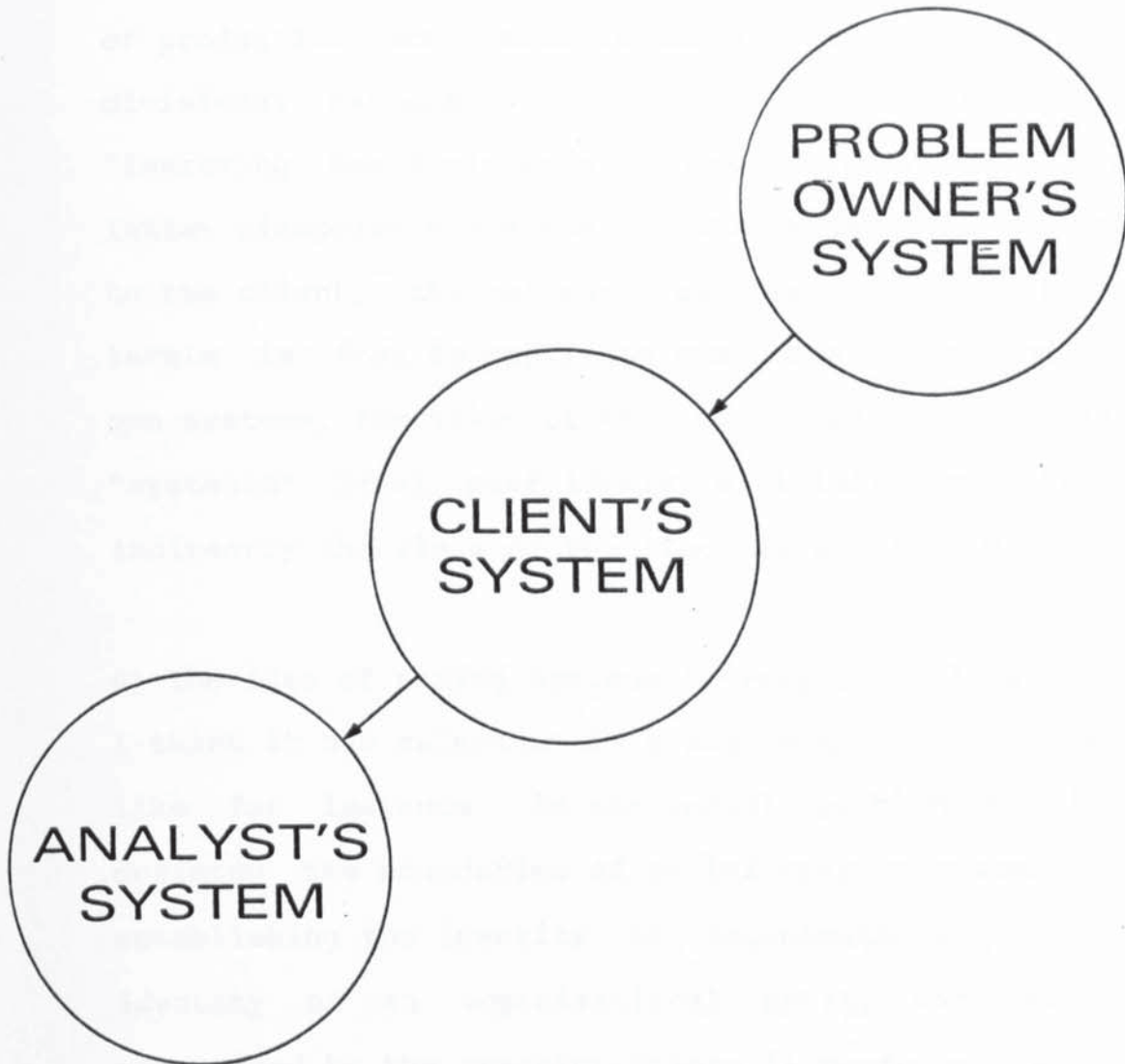
6) The terms of reference for the doctoral student in the example 2 above illustrates the naming of one tacit system whilst naming two transformations.

The tacit name was "the development of an information system". However, in actual terms the production manager was naming two transformations: the "design" and the "implementation" of an information system". Of course each of these is a transformation in its own right that may imply different participants. Hence these two transformations imply two different systems that are entailed by the more global tacitly named system. They are at a higher level of resolution i.e. higher level of detail, vis-a-vis the tacit system. We will come back to this point in chapter 5.

7) In many situations it is necessary to consider the same problem situation from the perspective of different viewpoints operating at different logical levels (hence using different languages). For instance, as implied by figure 3-2, it may well be that in addition to the transformations owned by a group of managers (the problem owners), the analyst should pay attention, in this context, to the transformations owned by one particular manager in that group (e.g. the client) and, why not, to the transformations owned by one of the client's actors (perhaps the analyst himself). This latter example relates to the description of systems and metasystems. Quite naturally, because of the complexity of social situations, one particular name may include the need to elicit transformations for a number of participants, not all of them dealing with the same system in focus.

Figure 3-2: Systems Chaining

## DESCRIPTION OF STRUCTURAL COMPLEXITY





For instance, from the viewpoint of one actor (the analyst) the relevant transformation might be "improving information flows", implying the need to implement an information system within a particular time frame and budget; for the client, who operates as a metasystem to the analyst, the transformation might be "improving his control of production activities in the division"; finally, for the divisional management, the related transformation might be "improving the division's financial position". This latter viewpoint being the one who operates as a metasystem to the client, the relevant performance". While each levels is free to apply its own creativity and name its own systems, the views of the concerned people at each "systemic" level, most likely, will influence directly or indirectly the views of the other levels (Van Gigch 1987).

8) The idea of naming systems is very general and therefore I think it has relevance in a wide range of situations, like for instance in managerial problem solving or in defining the boundaries of an information system or in establishing the identity of organisations. Indeed, the identity of an organisational entity can be recognised by the transformations it performs, as perceived or named by a viewpoint. On the other hand, the transformations ascribed by a relevant viewpoint to an organisational entity may help to make apparent its intended identity. While in the former case the name is a description of perceived transformations in the real world, and therefore defines what the organisation is

(for the viewpoint), in the latter case the name is a definition of the transformations that the organisation should perform if it is going to achieve its ascribed purposes. Chapter 9 makes extensive use of names to study the identity of organisations.

### **3.5 Pitfalls in Naming Systems**

Naming systems and producing root definitions are the methodological aids to structure problem situations. The above examples and the related discussions suggested some of the pitfalls in this process. They can be summarised as follows:

-Unawareness of the assumptions implied by the named systems. Do the owners control the named transformations?, under which circumstances? Are the named actors likely to perform the named transformations? Are the customers of the system likely to support the transformation or not? (This are the 'hidden assumptions' as discussed by Tomlinson in Tomlinson and Kiss 1984)

-Formulating too general or too detailed a problem. If the name is too general (with reference to the clients), then no meaningful identification of "customers", "actors" and "owners" might be possible. This is the case of an irrelevant name. If the name is too detailed then the likelihood is that relevant options will be foreclosed.

-Converging too quickly into a name. This pitfall may inhibit the production of insightful names. There is a great tendency to structure a situation following the obvious cues. The "mirror in the lobby" example makes apparent the need for creativity in problem structuring. In general, it seems that a first stage of high "entropy" is necessary before producing a name.

-Accepting too readily the appreciation of **one** viewpoint. In problem solving it makes sense to see the problem situation from an independent perspective, hence the relevance of root definitions.

-It is not always appreciated that in human activities there is no privileged transformation and therefore that in naming systems from different viewpoints, the problem is to capture genuinely different transformations. Indeed, any situation most likely permits naming a whole range of fundamentally different transformations.

### **3.6 Conclusion**

The above examples assume that there are a range of viewpoints naming systems relevant to them. In that sense the emphasis is in the management of complexity and not in the creation of new opportunities, or the discovery of new transformations to approach an intractable, ill defined, problem situation. In chapter 6 we will come back to the

methodological implications of using root definitions, or simply using names, or both.

However, even within the framework of the management of complexity, problem situations in human activities involve several viewpoints, and therefore, it should be clear that organisational problem solving entails a "multisystem" and not a single system approach. The different viewpoints in a situation will produce and use different names; these are the platform to support the production of insightful root definitions for debates and conversations. Only, it is in the case where there is agreement about producing a transformation that the name can be interpreted as the transformation to be implemented in the real world.

In cases where there is agreement about producing a transformation, most likely, a multisystem will exist at the lower level of resolution; the level implementing the change. This case was referred in Chapter 2 as the case where there might be problems of implementation.

The discussion of this chapter also permitted to establish two modes for abstract work; the descriptive mode and the design mode. The former relates to situations where the purpose of the study is to improve a current situation, the second relates to studies where the purpose is to create altogether something different.

## **4. Complexity and the Management of Complexity: The Law of Requisite Variety**

### **4.1 Introduction**

This chapter discusses management as the management of complexity. In this discussion it will become apparent that any measurement of complexity is meaningful only as a relational statement, between a viewpoint and a situation, and not as an absolute value standing on its own. It will also become apparent that the management of complexity is the management, by problem owners, of their interactions with the actors performing the transformations and the customers being affected by them.

This chapter is focused not only in a conceptual framework to study the complexity of problem situations, but also, in some of the methodological implications of this framework. However it is only in Chapter 6 that the full methodological implications of the framework become clear.

The first part of this chapter offers a discussion about the meaning of complexity in human activities, this is followed by a general discussion of the control mechanisms underlying the management of complexity and finally, the last part, discusses the relevance of the Law of Requisite Variety (Ashby's Law) to human activities, in particular, its value in problem solving.

## 4.2 About Complexity

Conceptually, the complexity of a situation is measured by its **variety**, that is, by the number of possible states in that situation (Ashby 1964, Beer 1966). In simple situations we may be able to count a precise number. For instance, the number of possible signals (configurations of colours) of a traffic light is... eight (eight are the **possible** states, going from all three lights **off** to all three **on**, and not three or four, which are the **actual** states...).

Still the above answer assumes not only a static view of the traffic light, but also that we agree on its purpose... indeed, it may well be that for a viewpoint it is, in addition to a "traffic light", a sign post to turn left, or whatever... the variety of a situation depends upon the purposes that the viewpoint ascribes to that situation (i.e. the systems it names). For instance, it should not be difficult to see that, for a viewpoint, the variety of a house is very different depending on whether the purpose ascribed to the house is to be a temporary accommodation or a permanent accommodation. The states the viewpoint has to see in one and the other system are very different.

Thus, the variety of a situation is not intrinsic to the situation but an outcome of the purposes ascribed to it by a viewpoint (i.e. of the named system). A similar point was

also implicit to several of the examples discussed in the last chapter (e.g. the variety of a clock is very different depending on whether we are talking of the user or manufacturer's viewpoint)

The discussion about systems made apparent that individuals can only see "a side of the thing"; indeed there is no viewpoint that can capture in full the variety of a problem situation. Different viewpoints "see" different chunks of variety, and there is no "god like" viewpoint that can see the variety in full.

Further more, even if the same purpose is ascribed to a situation different observers are unlikely to see the same states in it. It is indeed possible that different viewpoints, all seeing the same "side of the thing", will see different number of states in that situation. In this case the situational complexity is defined differently by each of the viewpoints. This fact makes necessary to distinguish between complexity and variety. Complexity is different to variety; it is more than the enumeration of states in a situation, it is something that results from the interaction of a viewpoint with the situation. Complexity is in the eye of the beholder.

The above point makes apparent, among other things, the relevance of choosing the appropriate viewpoint to measure situational complexity. It is not always the case that the viewpoint able to make the largest number of distinctions is

the appropriate viewpoint. For instance the complexity of "snow" is perceived very different depending on whether the viewpoint lives in a city, in the country, or in the Arctic. So, the thirty odd words that eskimos have (and need) for snow, most likely will not be necessary in London or Cornwall. Hence, the complexity that needs to be seen in the "same" situation ("snow") will be different in all three cases. The complexity that the participants **need to see** in a situation is the lowest that is consistent with their situational stability.

It is also the case that effective communications with other participants may permit the viewpoints to see states (i.e. complexity) that otherwise would be denied to them. The complexity of a situation may be more effectively appreciated if the communication mechanisms between the participants are adequate. **Thus, the complexity of a situation is also a multisystemic property.**

#### **4.2.1 The need for black boxes**

To make operational the idea of complexity it is important to clarify the meaning of "possible states of a situation". In a combinatorial sense the number of possible states of any situation, however simple, proliferates very rapidly. For instance, seven people could interact, **over time**, in two to the power of 42 ways. That is, the situation defined by these seven persons, just from the viewpoint of their **possible** patterns of interaction in time, would have a



variety of two to the power of 42. While as a matter of fact only very few of these patterns may become actual, the point is that any of them could become actual. However, this potential proliferation of states in human activities is totally out of the experiential reach of viewpoints. To have a figure, as in the example above, does not change the fact that the great majority of these states are meaningless to particular viewpoints. Simply, people cannot make all these distinctions; we are constrained by our limited information processing capacity. Hence, since most of the variety being proliferated in real world situations is opaque to us, we have to accept that these situations are, by and large, **black boxes** to us: in a cognitive sense there is no other form to experience the world but through black boxes. This is valid for experts as much as for laymen. We suspend the "need to know" about the full variety entailed in a particular situation, rather than kidding ourselves that we can capture the richness and variety of things. The black box construct is a short hand to account for the complexity of real world situations, that is, for the wide range of transformations actually taking place in it. Since, by definition, we cannot grasp a black box in full, we use the **naming of systems** to focus our attention in those aspects of interest.

#### 4.2.2 Variety and complexity of a black box

We have to accept that in any situation the only states that will be apparent to us, as observers, are some inputs to,

and outputs from, more or less well defined black boxes. And, of course, by naming systems, the viewpoints are choosing the inputs and outputs to observe.

Conceptually, the variety of a black box (as represented by a named system) is defined by the number of its possible output patterns in time (i.e. behaviours). A simple example may help to appreciate this definition of variety, and in particular the idea of "state" of a black box. The viewpoint in this example is dealing with a very simple black box (Figure 4-1): it has two inputs and two outputs, each input and each output has only two possible states, 0 or 1. The variety of the input, that is, the number of possible configurations of the two inputs is 4 (00, 01, 10, 11). The same is the case for the outputs. This could be the case of a machine with one red and one green light as input (which can be on or off) and two different tones as output (which can be on or off). If the concern of the viewpoint were only the state of the output at a given time then the situation would be simple; just a matter of observing the two output variables at the given time (only 4 possible states). However, if the concern were the state of the black box, then the variety of the situation is much higher. Since by definition the viewpoint cannot see what is happening inside the black box, it is now forced to see the "patterns" of behaviour of the black box, that is, the changes in time of the outputs. From combinatorial analysis it can be derived that in fact, for the simple situation under consideration (i.e. 2 inputs, 2 outputs, each with 2

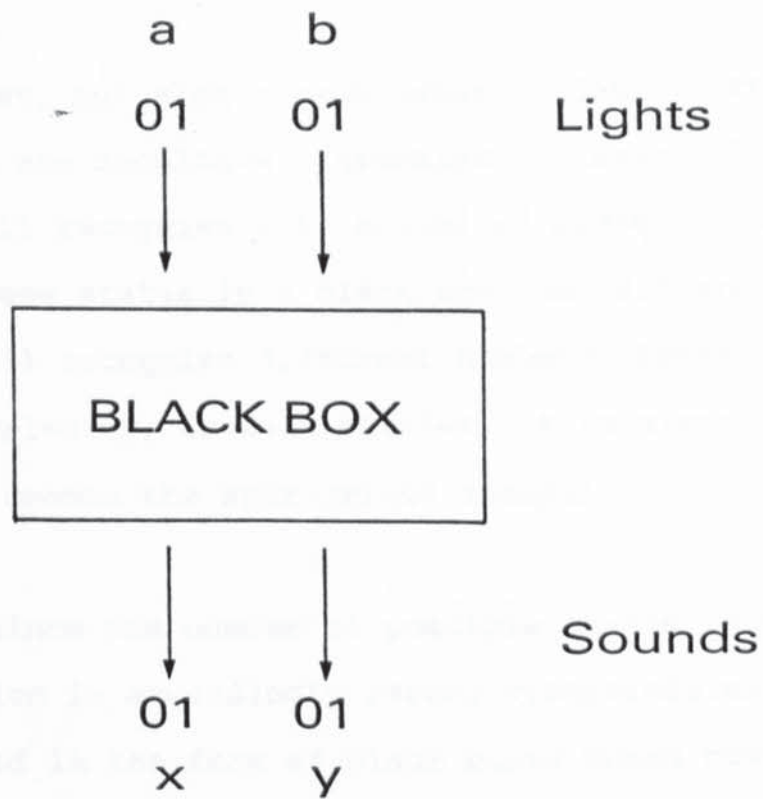
possible states) there are 256 different possible patterns of behaviour, all of them described in the array of Figure 4-2 (see Beer 1966, pp 270-298). For each of the 4 possible output states at time 0 (as represented by the array's upper row) there are 64 possible unfoldings of output states in time, going from the array where all transformations are 00, regardless of the input state, to the array where all the transformations are 11. That is, there are 256 possible patterns of transformation in time. The **states** of the system are defined by the **output patterns** in time, or **outcomes**, and not by the states within the black box itself.

However, though the **variety** of the above black box is 256, the **complexity** that a viewpoint sees in it may be very different; if it can only distinguish, say, 7 different, non equivalent behaviours, then the complexity of the system (for this viewpoint) is 7 and not 256.

The above example helps to appreciate not only the differences between output states and outcomes states but also the difference between variety and complexity. Outcome states are related to patterns in time (i.e. behaviours), and the complexity of the situation is defined by the number of **non equivalent outcomes** recognised by the viewpoint in the situation. In the above example if the viewpoint could only "hear" one of the two tones then the variety of the situation for this viewpoint is that of a black box with two inputs and one output, for which there are only 16 possible output patterns in time. Of these 16 perhaps some of them

Figure 4-1: A Simple Black Box

## A BLACK BOX



will be perceived so alike that the viewpoint will recognise, say, only 7 patterns that make a difference. This is the complexity that emerges from the interaction of the viewpoint with the situation. The complexity of the situation is a contingent property of the interaction. This conclusion is in line with the conclusions of other researchers about system complexity (Casti 1979, 1984).

The significant, but also common sense, point, is that because there are cognitive constraints, always, all viewpoints will recognise only a limited number of the possible outcome states in a black box. But different viewpoints will recognise different numbers. Therefore, in measuring complexity, as said earlier, it is always necessary to choose the appropriate viewpoints.

In summary, since the number of possible states in any real world situation is exceedingly large, viewpoints only see the real world in the form of black boxes whose complexity is a contingent property of their interactions, that is, their complexity is measured by the number of non equivalent "outcome states" that the viewpoints can see in them. However, the identification of outcome states depends on the variables that the viewpoints choose to observe, that is, on the systems they name.

Figure 4-2: Array as a Model of the Black Box

### The Array as a Model of the Black Box

		(x,y)				
		00	01	10	11	
(a,b)	TRANSFORM					
		00	..	..	..	..
		01	..	..	..	..
		10	..	..	00	..
		11	..	..	..	..

### 4.3 The Management of Complexity

There is one aspect of the black box construct that makes it particularly useful; however complex might be the processes within the black box producing the transformations of interest, it is often possible to find an abstract function (or model) that relates inputs to outputs, thus, permitting to anticipate outcomes from known inputs. This is a key to the management of complexity.

This idea is what Beer implies when he states:

"it is not necessary to enter the black box to understand the nature of the function it performs" (Beer 1979 page 40).

For the viewpoint it does not matter how complex might be the processes within the black box -these are, by and large, irrelevant to the viewpoint- for, as long as it knows how to pull the right input strings to achieve the desirable behaviours (i.e. outcomes), it knows how to control it. From the perspective of management **the complexity of interest is not that of the processes within the black box, but that of the inputs and outcomes.**

Because of this fact it is possible for a viewpoint to make global statements about the state of the black box (e.g. the company), like "it is under control", or "it is under

control most of the time", or "it is hardly ever under control". Yet, it may not be possible for the viewpoint to measure these states directly, but only through the use of variables that are **observable** to, and controllable by, the viewpoint. This is the system that the viewpoint is tacitly naming when he utters the above statements. This proposition, assumes a hierarchical structure for complexity. The complexity that is not seen by 'this' viewpoint assumes a next, more detailed level of management. The meaning given to the variables requires naming a set of lower level systems and variables. This unfolding is necessary as many times as required to account for the full complexity of the named transformation.

Hence when the viewpoint is asked "what does it mean to have the situation under control?" an attempt to produce an answer triggers the need to name the variables that the viewpoint encompasses under "control". For instance "the company is under control whenever it makes profits and product quality is adequate". In this answer the viewpoint has unfolded the idea of control into two variables "financial results" and "product quality". Yet if a viewpoint within 'this' viewpoint is asked about the meaning of each of these variables it will be forced to define more precisely the accounting variables used in defining "profits" and the aspects of product quality that influence the statement of "quality"...



While the viewpoint, by definition, cannot 'see' in full this hierarchical structure of complexity, it can have models of it. These models are influenced by its abilities to aggregate information and its shortcomings in processing information. In any case the more this model maps the "actual" distribution of complexity in the world (as perceived by the relevant viewpoints) the better will be the capacity of this viewpoint to regulate the black box's complexity (Conant and Ashby, 1971). We will come back to this point later in the chapter.

#### **4.3.1 The "humanness" of the black box**

Most of the complexity in human activities stems from their "humanness", that is, from the fact that they are nothing else but people in social interaction; they are multisystems. Viewpoints are embedded in situations in which there are other viewpoints with whom they have to develop stable interactions.

By definition no single viewpoint can penetrate the full complexity of a social situation, since this complexity is constituted by the full range of viewpoints in social interaction (the multisystem). Therefore studying a viewpoint's management of complexity is to undertake inquiries about the strategies it uses in its interactions with other relevant viewpoints; viewpoints which most likely will have to take into account other dependent

viewpoints, which in their turn may have other dependent viewpoints... and so forth.

#### 4.3.2 About transformations

The black box construct, as understood in the above context, is a powerful device to study the management of complexity. Contrary to the widely held view that it implies to make of human activities rigid boxes or machines, it implies to make of them flexible, imperfect, limited... humane outcomes of people in social interaction, creating reality. And, most importantly, they are the outcome of the structural constraints limiting the scope of this people to transform, create, the real world. We now concentrate on the meaning of these transformations.

Viewpoints name systems for multiple purposes, not all of them relevant to the management of complexity. It makes a difference if the named systems relate to notional transformations, aimed at exploring possibilities in the world, as it is the case with Checkland's root definitions, or to real world, or intended real world, transformations created, defined, controlled, perhaps even performed... by the viewpoint itself. The transformations may be directly or indirectly relevant to the viewpoint.

For the purpose of managing complexity the transformations of interest are those directly relevant to the viewpoint. For example if the viewpoint names the transformations of an

entire organisation and this viewpoint is not a "corporate manager", then, this viewpoint will not have a mechanism to interact with the named transformation. In order to appreciate the magnitude of this viewpoint's complexity problem a more precise transformation will have to be produced by the viewpoint. This might be "increasing the appreciation by organisational actors of the organisation's identity", in which case "increasing appreciation" is the complexity relevant to the viewpoint rather than the regulation of the overall organisational transformations.

The above discussion is important. Studying the management of complexity does not allow for loose names that confuse the viewpoints' need for interactions, either by not focusing them realistically or by leading to unnecessary interactions.

For example, the "person general manager" (e.g. Fred Bloggs) in a company may need to approach the management of complexity from different viewpoints. One viewpoint is that of Fred Bloggs the 'office manager' responsible for an office. The other is Fred Bloggs the 'general manager' responsible for the overall performance of the company and therefore, in this role he has to find ways of managing the complexity of the black box 'company'. While in this latter viewpoint he is accountable for the whole of the organisation's complexity, and therefore, needs to find, and use, organisational mechanisms to control it, naturally, he cannot possibly match by himself the full entailed

complexity. But, whether he likes it or not **at a personal level**, as Fred Bloggs, he is tacitly matching the complexity entailed by other **transformations** to those performed by the company as a whole. These transformations are at the core of his management strategy; they should be the concern of his "management of complexity". The complexity he is "seeing" could be, for instance, the quality and commitment of the people working directly for him. By and large we can expect that he is not directly implementing in the "shopfloor" the company's policies. He is relying on others for this implementation, and the quality of his management is related to the complexity that he can see in the interactions with these participants. It is through the management of this complexity that he is controlling the whole company.

#### **4.3.3 The management of the black box**

The above discussions have established the concepts of a "black box" and "complexity". It is assumed that viewpoints are responsible for transformations of one kind or another in the world, that puts them in interaction with actors, customers and other owners. Naturally in managing these transformations viewpoints aim for performances that are consistent with maintaining stability in their interactions with the other viewpoints, that is, they want to **regulate/manage their black boxes.**

Management of the black box means to maintain its outcomes within an acceptable range for the participants as a whole, and not only for the viewpoint. In what follows the mechanism invoked to make this possible is explained. For the purposes of this discussion the black box is construed as a system with one varying input and one varying output (of course this is a simplification, but it does not alter the nature of the argument). See Figure 4-3.

The viewpoint sets, as an outcome of complex negotiations -with other viewpoints- the criteria of acceptable performance for the system. This is the definition of outcomes which are perceived as adequate; this definition could take the form of targets, plans, policies, agreements... or in more general terms, criteria of stability. Comparison of the outcomes now (that is, the actual outcomes), or in the future (that is, the expected outcomes), with acceptable outcomes may trigger errors. These actual and anticipated errors require the production of responses either to bring back the system's outcomes within the acceptable range or to anticipate potential problems in the future. We talk of error-control and anticipatory regulation. If the nature of the errors is known then, the viewpoint, most likely will be able to develop adequate responses to maintain performance. Its model of the black box is adequate. A simple (feedback-feedforward) adjuster, based on this model, should permit to change the variables under the viewpoint's control (i.e. the

varying input) in order to keep the outcomes in line with expectations (Figure 4-3).

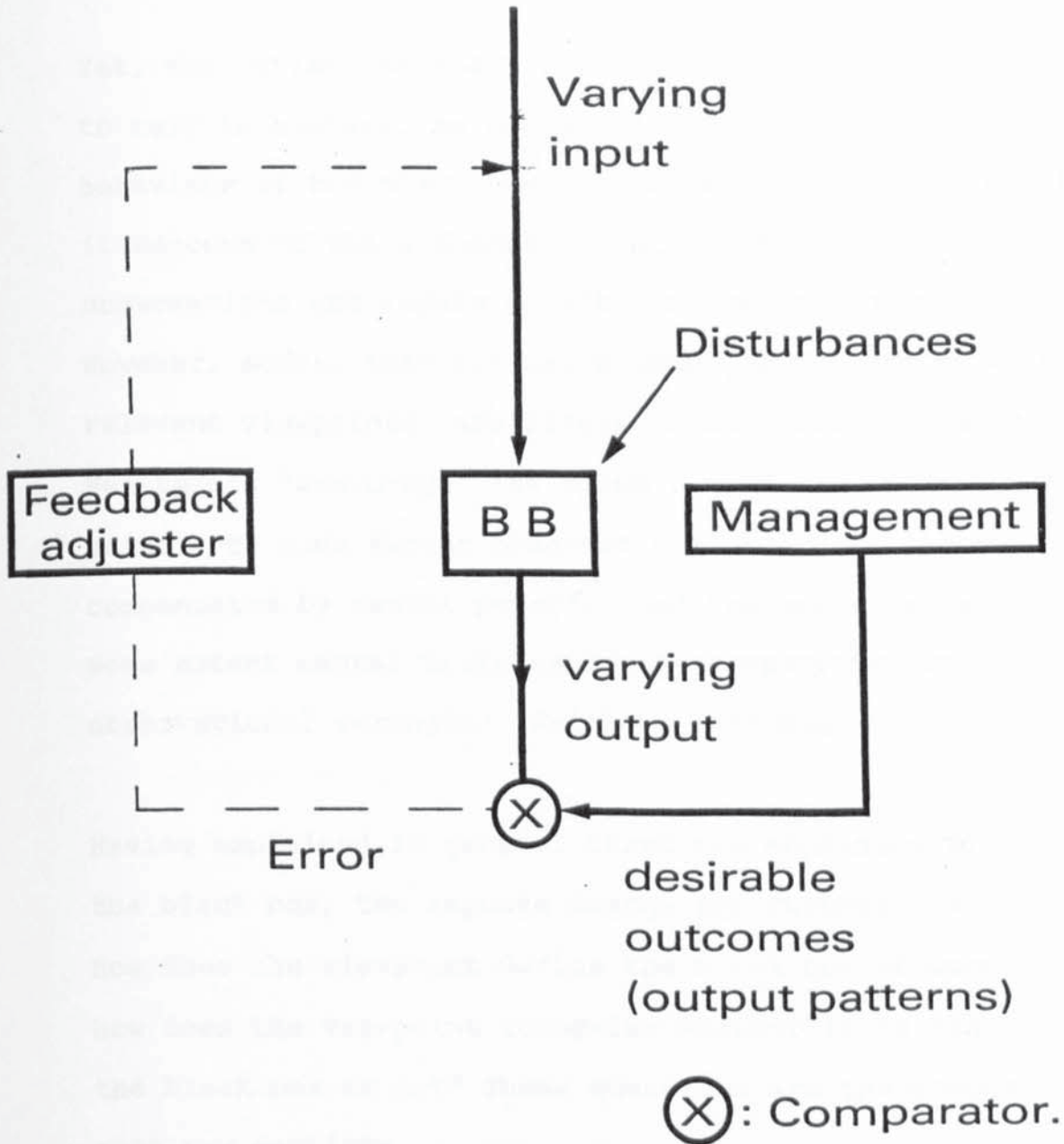
However, this deceptively simple mechanism is constantly upset by unexpected **disturbances** or changes in the **system's environment**. These are changes outside the control of the viewpoint. If these changes knock the system's outcomes outside the acceptable range then, either the viewpoint finds new responses or it loses control. The adjuster needs a better model of the system. The mechanism to adjust these models will be discussed in chapter 5.

Desirable outcomes are not the same as acceptable outcomes. It is perfectly possible to have an acceptable outcome that is not within the set of desirable outcomes. This is the case when the objectives (i.e. desirable outcomes) of the viewpoint are more stringent than those implied by the criteria of stability with other viewpoints. However, in general, in spite of claims to the contrary, people adjust their desirable outcomes to their perceptions of stability.

Since the concern is the achievement of acceptable outcomes, and not of particular outputs, it is necessary to have both, memory of outputs in time -to work out outcomes, and check for errors- and models of the black box transformation, to anticipate the possibility of unacceptable outcomes. The poorer is the memory, the better should be the model to achieve the same level of performance. In the extreme, when outputs are also outcomes, the model would have to be

Figure 4-3: Management of the Black Box

## Management of the Black Box



extremely powerful as to overcome the lack of history to interpret the meaning of errors. Of course, this extreme is not possible in human activities, and therefore the management of the black box is always a balance between error control (history) and anticipation.

Yet, the better the model is, the less the viewpoint needs to rely in history, to recognise that a change in the behaviour of the black box has occurred; the more sensitive it becomes to these changes. This juxtaposition observations and models permits inferences and anticipation. However, models that are not related to the histories of relevant viewpoints are likely to be irrelevant models. Weinberg's "brain-eye" law seems a good way of making this point; "to some extent observational weakness can be compensated by mental power". And the other way round "to some extent mental weakness can be compensated by observational strength" (Weinberg 1975 page 96).

Having explained in general terms the mechanism to regulate the black box, two aspects emerge for further discussion; how does the viewpoint define the black box of concern? and, how does the viewpoint recognise whether it is controlling the black box or not? These questions are the concern of the next two sections.

**How does the viewpoint define the black box of concern?**



In the argument that follows it is assumed, only for explanatory reasons, that the viewpoint is dealing with a well defined black box (e.g. a company). The question is; what are the implications for the viewpoint should it attempts to deal with the complexity of transformations at a higher level of resolution to those of "this" black box? The point to make is that however obvious the definition of the situation might be, in the end the "size and shape" of the black box, for this viewpoint, is defined by its actions and responses.

We must keep in mind that one of the conditions for a viewpoint to manage effectively a black box is that it must have a good model of that situation (i.e. of how inputs are transformed into outputs).

In this case, with a well defined box, with clear transformations, but with a viewpoint concerned with transformations one or more levels of resolution below "these" transformations (i.e. those of the company as a whole), it is likely that the models to emerge in the viewpoint's mind will be only adequate to produce responses to disturbances at those (relatively low) levels of complexity, thus hindering the chances of controlling the appropriate higher order transformations. The wrong black box is being focused upon.

Of course, a person may need to see a situation from several viewpoints, and therefore, may be dealing simultaneously with several black boxes, at the same or different levels of resolution. However the point is whether there is consistency between the viewpoint in use and the produced regulatory responses. If there is inconsistency the likelihood is that the situation relevant to a particular role will go unmanaged.

It is a fact that we are always dealing with black boxes, at whatever level of resolution we operate, and de facto our behaviour stipulates the black box that we will not enter. If that definition is consistent with the expectations held by other viewpoints about this viewpoint, then the viewpoint may perceive stability, and the situation may appear to be under control. However, if this is not the case the viewpoint will have to change its black box to one consistent with the stability of its interpersonal interactions. If the definition of these new black boxes is not matched by a parallel development of a model to permit its regulation, then, the viewpoint has a problem. This is for instance the case of a general manager well acquainted with the operational realities of the company but with a poor appreciation of market trends; while he may find easy to deal with the black box "plant", he may find it more difficult to deal with the black box "company". In this conditions, he may find very difficult to cope with the corporate job.

**How does the viewpoint recognise whether or not it is controlling the black box?**

Assuming that the viewpoint is dealing with the appropriate black box; does the viewpoint perceive that it is achieving both adequate performance and stability in its interactions with other relevant viewpoints? It should be clear that control is not a unilateral enforcement of criteria of performance, but rather, the maintenance of a dynamic stability in the interactions among multiple viewpoints with reference to tacitly accepted, more or less flexible, criteria of performance.

The complexity perceived by viewpoints is a function of their capacity to discriminate transformation patterns in time. Thus, "seeing" transformation patterns does not imply peering inside the black box; it rather implies seeing the unfolding in time of those output states seen as relevant to the situation. Indeed different managers, with reference to the same transformations, will discriminate a different number of "states" in the situation. This different capacity to appreciate states implies a higher or lower capacity to discriminate situational outcomes, that is, more or less capacity to see complexity.

A viewpoint's expectations about the outcomes of a situation - that is, its criteria of stability- define the reference it uses to assess whether the situation is under control or

not. As said earlier, if outcomes and expectations are in line, then, the viewpoint can say that the situation is under control. In other words, this means that the complexity of the situation is well managed by the viewpoint responses (Figure 4-3). Or, the other way round, if outcomes and expectations are out of phase, then, the viewpoint needs to work out new responses in order to be effective in the management of the entailed situational complexity. Of course these expectations are not arbitrarily defined, they are perceptions of stability held by the viewpoint with reference to the views of relevant, often environmental, viewpoints. It is clear, as said several times before, that targets or objectives are in general secondary to the viewpoint's perceptions of stability. Hence, it is normal that the objectives i.e. desirable outcomes of a transformation, will be adjusted towards acceptable outcomes as the viewpoint's perceptions of stability change.

A total control of the black box would suggest that the viewpoint is creating its social reality, on the other hand a poor control would suggest that the viewpoint is trapped by the tide of events.

#### **4.4 The Law of Requisite Variety**

Several of the insights offered in Section 4.3 emerge from the law of requisite variety. In fact this law underpins all the above discussions. The status of the law, and its relevance to human activities, is somehow controversial.

There are a number of authors who think it is trite and irrelevant (Checkland 1980, Zeleny 1986), others like Beer (1979) think that this law is to the social sciences what the law of gravity is to physics. The purpose of the discussion below is to explain my own understanding of the contribution by this law to management sciences.

#### **4.4.1 What is requisite variety?**

Requisite variety is so natural to us that it is taken as a given. However, for instance, if a door's handle were designed in any form which did not match the hand's capabilities it would be impossible for us to open that door (... with the hands, of course). This example may be trivial, common sense, but it becomes less so when we think in all those activities that we perform poorly or fail to perform all together... It is natural to us to work out our way "solving problems", either by increasing our capabilities to perform more and more complex activities, or by finding ways to simplify them. This kind of problem solving is done most of the time intuitively, without recognising that the efforts to increase our capabilities should be tightly interrelated to the efforts to simplify the activity's complexity.

What is common to successful problem solving is the ability of the problem solver to produce responses to different states in the activity: minimally to the number required

for an adequate performance in the activity. If the person had fewer responses than those implied by the complexity of the situation, then, the logical conclusion would be that the problem will not be satisfactorily solved.

#### **4.4.2 The Law**

The law was first formulated by Ross Ashby in his book "An Introduction to Cybernetics" (Ashby 1964). The law tells us about minimum necessary conditions to achieve an acceptable performance. This law is about the amount of regulation that is necessary to achieve acceptable outcomes in the world, or in other words, it is about the necessary capacity of a regulator (R) to regulate successfully a real world transformation.

Ashby's formal statement of the law was focused in communication processes:

"R's capacity as a regulator cannot exceed R's capacity as a channel of communication" (page 21)

For instance, if the regulator happens to be a person, and his performance is defined by the number of different statements he can produce about a situation in a given time, we can say that no matter how rich his mental models might be, his regulatory capacity cannot exceed the number of statements that his effectors (writing, talking...skills) permit him to produce in that time. In a way, it can be

said, that some mental states are lost in the process of communication if those that are communicated are less than those in his mind.

Since interactions in the real world are always regulatory , in one form or another -in the sense that they always change the states of other interacting viewpoints- the problem of requisite variety creeps into all forms of communication. A necessary condition (but not sufficient) for effective communications, whether these are interpersonal interactions, interactions of one person with a group of people, or of one organisation with another, is whether or not they comply with Ashby's law. He himself captures this all pervasive nature of requisite variety by stating:

"To put it more picturesquely:... only variety can destroy variety" (Ashby 1961, page 207)

Stafford Beer has made apparent this more general meaning of the law in many publications, most notably in Chapter 4 of "The Heart of Enterprise" (Beer 1979). At a methodological level he has made the distinction between the regulator as a variety generator, as a communication channel and as a transducer.

Ashby in his original formulation of the law put the emphasis in the channel capacity of the regulator, however it should be apparent, thinking again in terms of our earlier example, that if the number of statements generated

by a regulator were less than the statements that its efferent communication channels could accommodate, his regulatory capacity would be constrained by this factor and not by the capacity of the communication channels. Moreover if the regulator's variety could not be effectively encoded (by the regulator) and decoded (by the viewpoints being regulated) then again, however large this variety, and the variety of the communications channels, might be, the overall capacity of the regulator will be constrained by the capacities of these encoders and decoders i.e. transducers. For instance, this limitation would affect the conversations among experts in the same subject if one the speakers made his statements in Chinese while all the others could only understand English.

#### **4.4.3 Status of the law**

This law is more than a logical tool with a prescriptive value, it is more than just one among several logical possibilities to think about a situation; it is about on going relations in the "real" world. It tells us something about the world and our interactions in it; it is much more than a way of modelling the world. Individuals in a social group **are** (as a matter of fact) in some kind of stability with each other: each member of the social group **is**, at one level or another, in balance with all the other members. Moreover the group as a whole **is** in some kind of stability with its external world or environment: otherwise it would not have a distinguishable identity. The stability of these



interactions may be very precarious but, for as long as they exist, Ashby's law will be asserting itself.

Stability in any situation implies that there is some kind of balance in the interactions between the multiple viewpoints defining the "real world" situation. However, in an epistemological sense because the limited information processing capacities of all viewpoints, this situational stability is going to be perceived differently by each of them, thus requisite variety can only be ascertained with reference to a model of the interactions, and not with reference to the interactions themselves. Yet this subjectivity in the appreciation of requisite variety does not mean that stability in the interactions is subjectively defined; this stability is the outcome of the multiple, complex and (variety) constrained interactions, defining that social reality. Stability may exist in spite of the fact that one or more of the viewpoints in the interaction may perceive that the relations are inadequate or do not exist at all. Such perceptions emerge, as it is discussed below, with reference to subjective appreciations about that that is acceptable, but, for as long as the relations in the world are maintained there is a tacit agreement about "acceptability". This is the case however great might be the mismatch between the "espoused" and "tacit" (theory-in-use) criteria of stability.

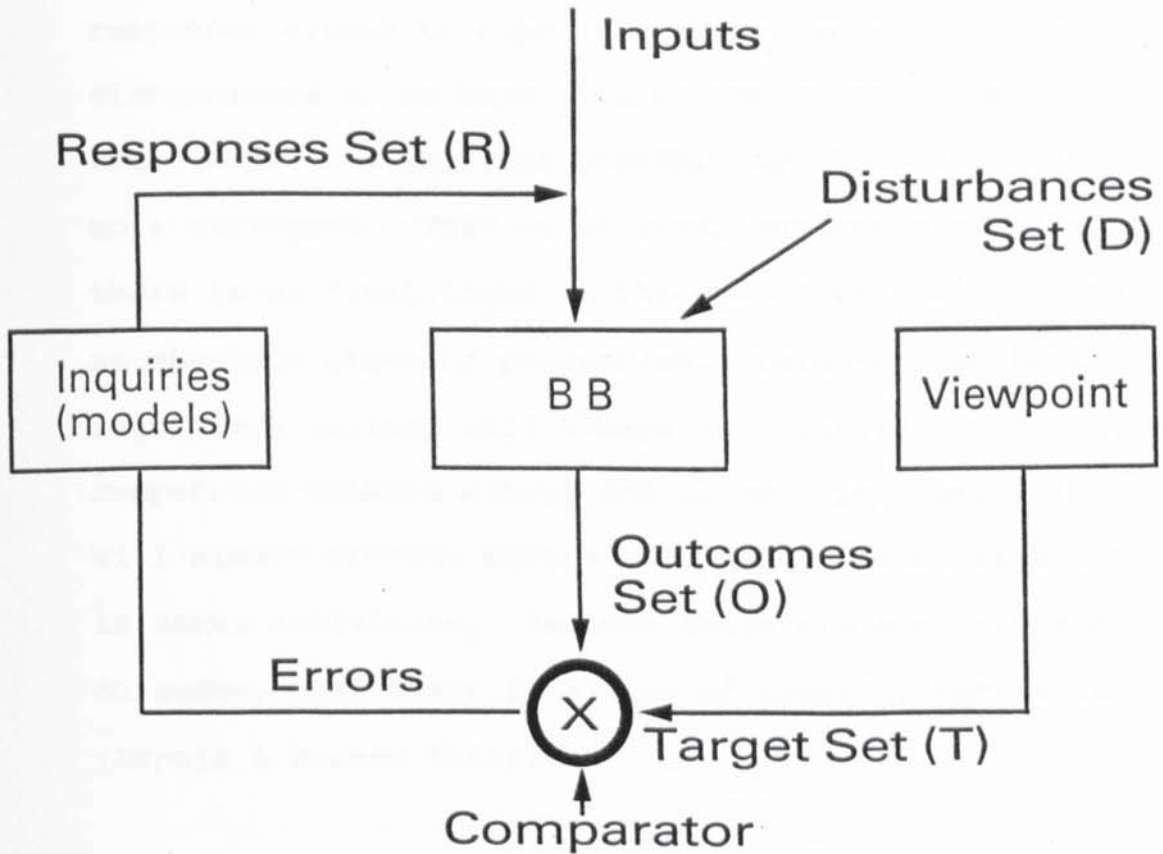
#### **4.4.4 Requisite variety and the management of complexity**

For methodological purposes we use again the construct of a viewpoint trying to "control" a black box (figure 4-4). The viewpoint observes over time the "states of the output of the black box", and from there it works out the "states of the black box". We called these latter states "outcomes"; they define the set of actual outcomes (O). These outcomes are the complexity that the viewpoint sees in the situation. Naturally, of the set of outcomes only a sub set is likely to be perceived as adequate. This sub set is, as explained earlier, defined tacitly by the viewpoint's perceptions of stability in its relations with the black box and the environment. It implies its criteria of "performance" and is named the target set (T) (Espejo & Howard 1982). If defined explicitly this set may have fewer states than those necessary to maintain the black box's stability; the viewpoint is defining a sub set of both **acceptable and desirable** outcomes. The more stringent are the criteria of performance the fewer states belong to the target set; "perfect" regulation would be the case where the regulator is able to achieve always an optimal outcome regardless of the environmental disturbances; it would have an optimal response strategy for all eventualities. Of course, for human activities this is never the case.

In general, the set of such strategies is called the "responses" set (R). The minimum number of necessary responses will depend upon the desirable performance and the

Figure 4-4: The Black Box and Requisite Variety

## The Management of the Black Box and Requisite Variety



number of factors upsetting the stability of the situation. These factors affecting significantly the outcomes of the situation are part of the "disturbances" set (D).

It is a fact for human/social activities that the variety of disturbances (D) is going to be larger than the variety of responses (R), that is, that there will always appear new, unexpected, disturbances, for which no adequate responses are yet available. There is always room to find other responses either to cope more effectively with known disturbances or to cope with as yet unknown disturbances: thus there is always the possibility of making the set (T) more stringent. This is an invariant state of affairs i.e. there is no final light at the end of the tunnel, there is no absolute state of perfection. This implies that regulatory variety will always be insufficient i.e. the comparator between actual and acceptable/ desirable outcomes will always produce errors. This fact makes apparent that in human activities, because there are always unacceptable outcomes, that there is a "law of insufficient variety" (Espejo & Howard 1982).

As established earlier, (T) in general is not defined arbitrarily. It is the outcome of the demands from the multiple relations relevant to the viewpoint, and of course it is in constant evolution. If the responses (R) produced to off set the disturbances (D) maintain outcomes within set (T), then the viewpoint has de facto control capacity (i.e.

requisite variety). On the other hand, if the set of actual outcomes (O) goes out of (T), then the viewpoint has lost control. In other words, if the residual variety left after taking away the responses variety from the disturbances variety, leaves an amount of uncontrolled variety that does not push the situational outcomes out of the area of acceptable outcomes, then the viewpoint has requisite variety. Yet, this uncontrolled variety defines not only the space for possible improvements but also the space for potential instabilities (Strank 1982).

Thus, in this context, the law of requisite variety is about the amount of response capacity that a regulator (in our case a problem owner) needs to have to maintain outcomes within acceptable limits. In set theoretic terms, the law of requisite variety establishes that (Espejo and Howard 1982):

$$(O) \geq (D) / (R)$$

The set (O) is always larger, or at best equal, to the ratio between the set of disturbances and the set of responses. And, the conditions for a problem owner to have requisite variety is:

$$(T) \geq (O)$$

If the problem owner does not have means to make the set (O) smaller or equal than the set (T) -as defined by its

stability in the interactions with other situational participants and the environment- then, the owner does not have requisite variety in this situation. The options open to this viewpoint are either finding ways to reduce the variety of disturbances, or finding ways to increase the variety of its responses, or indeed any mix of these two strategies.

Methodologically, this discussion offers a truly systemic approach to problem solving; it focuses the problem owner's attention in a transformation, for which he is responsible to produce the necessary responses to make it happen, at an acceptable level of performance, in its environment. This is the problem owner's 'management loop'. This construct is useful simply because it focuses the owner's attention in a system (and related environment) that he owns (i.e. controls).

#### **4.4.5 Discussion of the Law**

The theme of requisite variety has been extensively, and insightfully, developed in the field of management sciences by Stafford Beer (1966, 1975, 1979, 1981). However, the strength of his work is more in the logical use he makes of the law than in the methodological support he gives to use it. Beer makes a most powerful use of requisite variety, particularly while developing his model of the organisation structure of any viable system (to be discussed in chapter 7) but he does not always spell out the details of the

mechanisms invoked. This is apparent in his different statements of the law, all of them reinforcing the view that to have control (i.e. requisite variety), the variety of the controller must be at least as large as the variety of the controllee:

"the capacity to proliferate variety within the control box must be as great or greater than the capacity of the situation box to proliferate variety". (Beer 1966, page 282)

Though there is some truth in this statement, it is misleading to say that the usually lower variety side (i.e. the control box) will proliferate greater variety than the higher variety side (i.e. the situation box). For instance, if a company survives in its environment (i.e. has requisite variety), it does not mean that its variety is as great or greater than that of its environment. It simply means that of "all" the huge number of possible environmental states, the large majority are either irrelevant to the company, or if relevant are absorbed by the interactions within the environment itself. Only the **residual states** -those states which are relevant for viability but are not absorbed in the environment itself- must be absorbed by the company itself to remain viable. If the company is viable then the law of requisite variety says that this residual variety **is matched** (absorbed) by the company's variety. The residual variety is the set of disturbances (D) for which the company needs to produce responses (R), to keep the outcomes of the company

within the set (T), consistent with its viability. This interpretation of the law is further discussed in chapter 7.

The same argument of **residual variety** is valid to the relations between a viewpoint and the situation of its concern: the varieties that are equated - where Ashby's law asserts itself - are those of the viewpoint itself and the residual variety that is not absorbed in the situation itself. This is the complexity that the viewpoint has to see and respond to in the situation. Otherwise stability, with reference to a desirable/acceptable set (T) may be lost. However, this argument makes apparent that the more effective is the absorption of variety in the situation itself, the less problematic the situation will be to the viewpoint. In human activities, these absorption of variety within the situation itself, could be related to self-regulating and self-organising processes.

The practical implications of this discussion will be fully appreciated in chapter 7, where we will discuss in detail the organisational mechanisms by which requisite variety is achieved in situations where the parts in interaction have inherently different varieties. However, in the next section we will discuss the general mechanism underlying the interactions of viewpoints with different varieties.



## 4.5 Variety Engineering

The discussions of this chapter have yielded, first, a definition of complexity in human activities, secondly, a model to understand the management of complexity and, thirdly, a law to assess the adequacy of this management. The purpose of this section is to discuss how to use all these results in the study and design of more effective human activities. It is inherent to these activities that those aiming at managing them will have a complexity (i.e. response capacity) orders of magnitude smaller than the complexity of the tasks they want to manage. This situation goes against the law of requisite variety, yet we know that in the 'real world' people do manage these situations. As explained by Beer in Chapter 4 of *The Heart of Enterprise* this management defies the law of requisite variety in the same way that flying objects defy the law of gravity. What in the physical world may be achieved by electromechanical design, in human activities may be achieved by **variety engineering**.

### 4.5.1 The case for attenuators and amplifiers of variety

Ashby's law says that a viewpoint will maintain a situation under its control if and only if it can produce - directly or indirectly - as many different responses as significant disturbances hit the black box. The meaning of "significant" being that of a disturbance which produces an outcome outside the target set  $T$ ; that is, a disturbance for which

the black box does not have absorption capacity within itself. In other words, to maintain the outcomes of the black box within a target set T, the viewpoint has to be able to generate, itself or with the support of other viewpoints, at least as many different responses as the number of disturbances that might produce undesirable outcomes.

The discussion of the management of the black box made apparent that as a condition to produce effective responses the viewpoint needs capacity both to detect errors and to model the black box. Depending upon the situation, the viewpoint may or may not have itself this capacity. The former case would be the case if in addition to being the owner of the situation, the viewpoint were by itself, with no further support, the controller of the transformation. The latter would be case if the viewpoint were supported by other resources in controlling the black box. If the viewpoint regulates itself the situation then, it is the sole **attenuator** of the relevant (for the viewpoint) situational complexity. On the other hand if the viewpoint manages (i.e. sees) the complexity of the situation through other viewpoints then, these other viewpoints are also responsible for the attenuation of the relevant (for the viewpoint) situational complexity. The viewpoint is using their models of the situation to learn about it.

The same distinction applies to the response capacity of the viewpoint; it may be possible that the response capacity is

either in the viewpoint itself, or in the viewpoint plus external **amplifiers**. While in the former case the viewpoint may produce direct actions or response strategies to maintain the outcomes within the target set T, in the latter case it may only act as the trigger of the responses.

In both cases, the use of attenuators and amplifiers will be effective only if the mechanism linking them to the viewpoint has requisite variety.

The **designing of mechanisms** to link a viewpoint with other viewpoints in order to cope with a situational complexity that is beyond the regulator's own capacity is a means to perform complex tasks. This is not different to the possibility of performing tasks far beyond the physical capabilities of an individual. This would be the case of a crane driver moving from one position to another a load orders of magnitude beyond his physical strength. We know that while by civil engineering it is possible to design smooth roads to simplify the transportation problems, by electromechanical design it is possible to engineer a successful lifting of the load. Thus at the same time the crane driver has his own capabilities amplified by a cascading of mechanisms linking him to the load, the task is made simpler by an attenuation of its environmental complexity.

The above discussion establishes that the viewpoint, in order to regulate transformations beyond its immediate

regulatory capacity, needs to couple itself to external attenuators and amplifiers. Attenuators are all types of structural, operational and informational mechanisms reducing the complexity of the situation vis-a-vis the viewpoint (Beer 1981). Amplifiers are all those mechanisms increasing the viewpoints capacity to affect the situation. Attenuators are necessary to **appreciate** the situational complexity i.e. to appreciate the transformations and complexity of a situation; amplifiers are necessary to **affect** this complexity i.e. to keep the situational outcomes within the target set T.

Managers always operate, albeit to different degrees and forms, with external attenuators and amplifiers; **the regulator's capacity** to reduce and generate variety, as well as to receive input and transmit output variety may be held by different people. Indeed all combinations of attenuators and amplifiers are possible. For instance if the viewpoint is the "production manager" with reference to production (the situation), then, while the "regulator's" attenuation of the situational variety may be done primarily by the manager's support staff (vis-a-vis production), the "regulator's" output variety may be performed only by the manager himself. This suggests that the staff's regulatory capacity may be attenuated by the manager's channel capacity. This is indeed a common situation.

The point that Ashby's law permits to be seen in this context is that, while the variety of situational outcomes

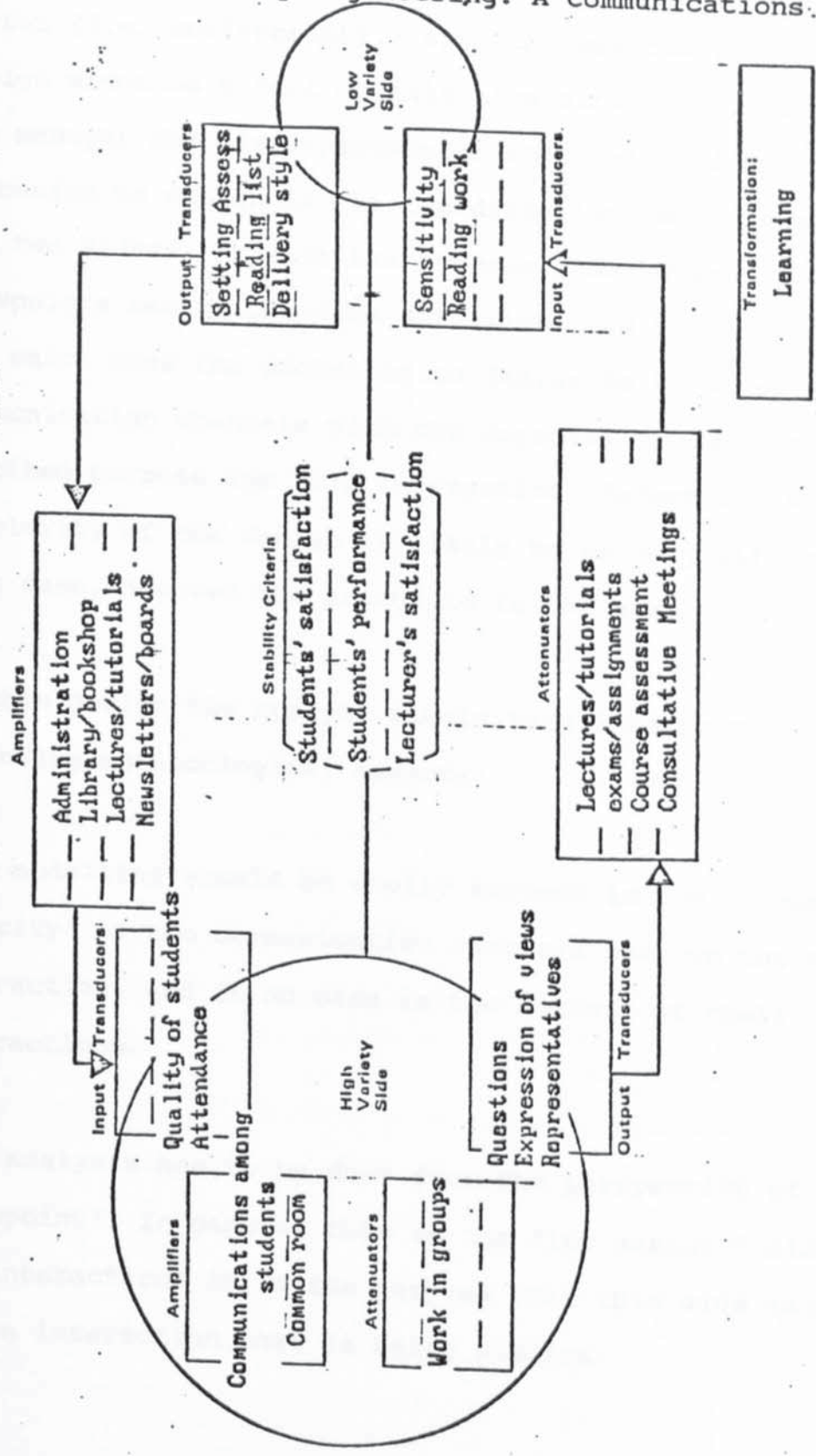
emerges from the intersection between actual disturbances and available responses (D & R), there is the possibility of "engineering" -for one particular viewpoint- either more response variety or less variety in the disturbances, so that the actual outcomes are limited to those within the target set T. This possibility has great social implications.

#### **4.5.2 The design of mechanisms**

The elementary mechanism, recurring in this cascading of links, to and fro, between those viewpoints defining possibilities to those implementing them in the real world, is the **communications (stability) mechanism** relating a 'low variety' viewpoint to a 'higher variety' viewpoint.

A template to describe these mechanisms is that of the communication channels and transducers between the two viewpoints as illustrated in figure 4-5. In this case, concerned with the interaction lecturer-students, the problem is to study the amplifiers and attenuators producing the balance in their interactions, and, if necessary, to design the amplifiers and attenuators that would imply the lowest cost consistent with desirable performance: this latter design could be called, as a derivation of Beer's first principle of organisation (Beer 1979 page 97), the **first principle for problem solving**.

Figure 4-5: Variety Engineering: A Communications Mechanism



This principle applies whether the "engineer" is concerned with the interactions between a management-viewpoint and the market (i.e. environment) -in which case the mechanism to design might be a full organisation structure-, or between the manager and his departmental staff -in which case the mechanism to design is the immediate interactions between the two sides-, or with the interactions between two viewpoints seeing the same situation from different angles -in which case the mechanism to design is a set of communication channels with the capacity to support the ascribed purpose for this interaction. Naturally, the complexity of the design is likely to be very different for each case, however the principle is the same.

In this design the analyst should take into account the following methodological aspects:

-The modelling should be wholly focused in the 'channel capacity' of the communication channels between the parts in interaction, and in no case in the content of their interactions.

-Any analysis has to be done from the perspective of one 'viewpoint'. In general this is the 'low variety' side in the interaction; it is the purpose that this side ascribes to the interaction that is being studied.

-The assessment of the interaction is a function of both the 'transformation' and the 'criteria of stability' defined by the viewpoint.

-The argument of 'residual variety' suggests that it is relevant to study the amplifiers and attenuators of complexity within the high variety side. This is particularly the case if the interactions between the low and high variety sides do not depend on external attenuators and amplifiers.

#### **4.6 Variety Engineering and the Problems of Implementation**

The production of transformations in the real world requires of viewpoints with the capacity to control the complexity entailed by these transformations. This is the case whether the situation is the implementation of a well established transformation or the implementation of a new transformation, perhaps one of those "culturally feasible" changes emerging as an outcome of a problem solving process (see Chapter 2 and also Chapter 6).

In either case the problem is to design and maintain mechanisms with the capacity to produce the defined transformations. However, it is all too natural that the performance of these mechanisms will be the outcome of a learning process, perhaps painful, where problems are detected and corrected. The following problems are likely to emerge:



#### 4.6.1 Performance Problems

This is the case when the situational complexity recognised; and/or the complexity generated, by the problem owners is inadequate.

This is the case when the problem owners are unable to perform well because a) they do not recognise enough states in the situation i.e. they cannot "see" the distinctions made by their external attenuators though these may be more than adequate, or b) because they do not know how to activate their external amplifiers i.e. they cannot trigger enough different responses through the amplifiers, though these may have more than adequate capacity to produce a larger set of responses. The problem is in the problem owners themselves, either in their "transducers" vis-a-vis their external amplifiers and attenuators or in their own amplifiers and attenuators. An 'incompetent' manager provides a typical example of a performance problem. In this case variety engineering may imply among other things designing a training programme for the manager.

As a matter of fact, over time viewpoints tend to adjust the amount of complexity that they see in a situation to both their perceived response capabilities and their performance requirements. In general viewpoints should not attempt to penetrate the complexity of a situation far beyond their

capacity to control outcomes (i.e. produce responses). Such efforts would put them in non learning situations.

#### **4.6.2 - Environmental Problems**

The viewpoint does not deal with enough complexity in the situation because attenuation is inadequate.

The capacity of its external attenuators is inadequate. Because of this, the demands of its environment, pushing the outcomes outside the target set  $T$ , are beyond its discrimination capacity; the problem is that the viewpoint cannot produce responses to undetected disturbances. The viewpoint has an "environmental problem". This is the case when a general manager loses touch with the market simply because the marketing people do not have enough resources or skills to monitor changes in the environment.

#### **4.6.3 Response Problems**

The regulatory capacity of the viewpoint is limited by the inadequate capacity of the amplifiers.

The viewpoint may see disturbances for which it knows how to produce responses but it does not have external (support) capacity to implement them. The viewpoint has a "response problem".

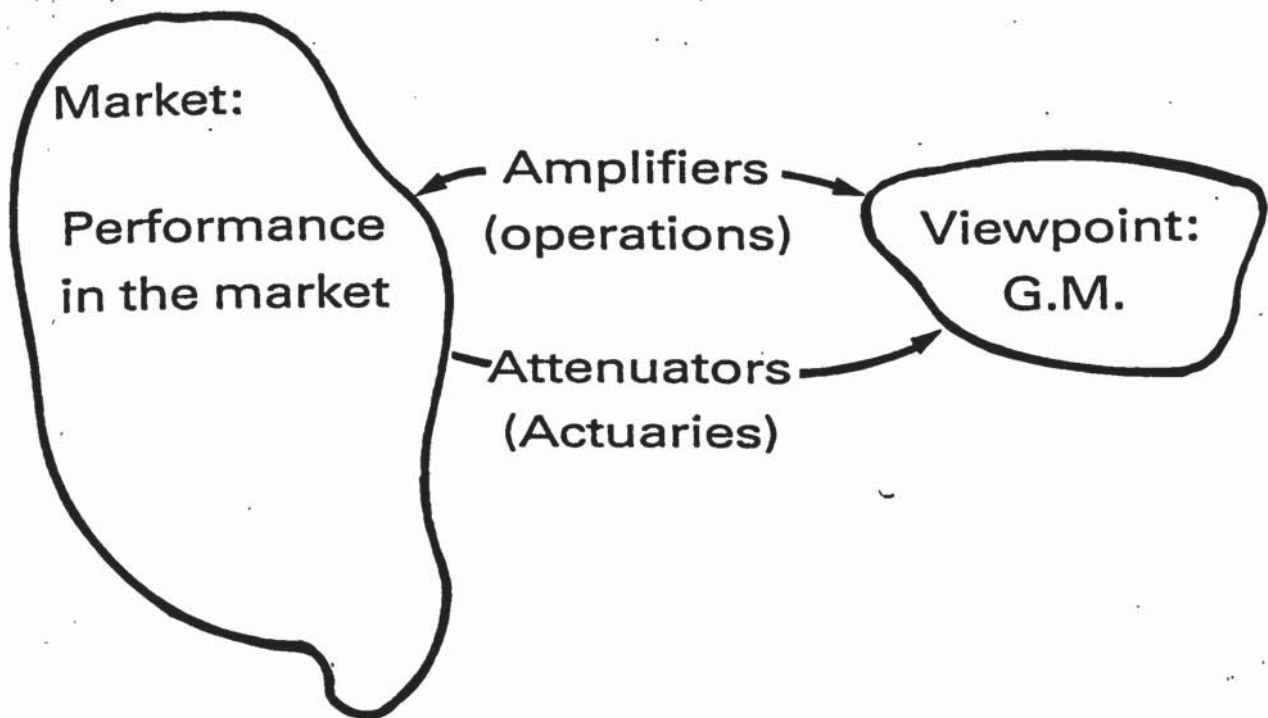
Response and environmental problems are common when an organisational viewpoint is supported by a range of external viewpoints (attenuators and amplifiers) which do not perceive directly the closure of the information loops in which they are involved. It may be difficult for them to appreciate whether they are producing too many environmental distinctions i.e. overattenuating, or too few responses i.e. inadequate amplification.

For instance, in an insurance company, the viewpoint "general manager" may regulate the company's performance through the work, among others, of the actuaries and operations people (see Figure 4-6). If the actuaries, that is those designing the company's products, develop distinctions of possible risks, and make proposals for policies, far beyond the implementation capabilities of the operations, then there will be an imbalance between the complexity that the company sees in the market and the complexity that the company can produce through its operations. These imbalances in complexities have a cost. In this example the complexity of the market is perceived by the viewpoint "general manager" through a high resolution (in relative term too expensive) attenuator and the complexity of its related responses is amplified by the

Figure 4-6: Problems of Implementation: Insurance Case

## Variety Engineering

Case of insurance company:



relative low variety of the company's operations. Variety engineering would imply designing the balance of these varieties in line with the viewpoint's purposes. This is a particular instance of a situation in which the regulator's capacity is limited by its capacity as a channel of communication. In this case the regulator's state capacity is defined by the actuarial work, while its channel capacity vis-a-vis the market is defined by the operational work.

This instance gives us an insightful view about the scope of variety engineering. However, the full implication of this type of engineering only emerges when it is appreciated that there is a wide range of viewpoints and that, accordingly, any situation may be structured in multiple forms. This fact implies the next and final category of problems.

#### **4.6.4 Identity Problems**

If the viewpoint is interacting with other viewpoints but is unclear about the purpose of this interaction, that is, does not have clear the transformation they are involved in then, the viewpoint may have an "identity problem". These are our soft problems.

In this case the need for variety engineering emerges from the very fact that individuals create "social reality" as a result of multiple interactions. This reality is, by definition, beyond any one of the individuals making up the

grouping and therefore its creation is a function of 'the cybernetics of the situation'.

The available control and communication mechanisms supporting the viewpoints define the "systemic constraints" for these interactions. The meaning of "systemic (structural) constraints" can now be made more apparent. A human/social situation is real in an ontological sense and depends not only on the viewpoints' mental states but also upon the capacity of the communication channels available to them in the relevant situation. The individuals' variety in an organisation may suffer the attenuation and amplification not only of their own afferent (inwards) and efferent (outwards) communication channels, but also of a whole range of distant communication channels linking them within an organisation. The created "social reality" is not only an outcome of the mental states of the individuals but of the constraints imposed upon them by the organisational structure; different organisational structures support the structuring of very different situational "activities". Hence the "solution" of identity problems is a function of the structures underlying the related debates.

#### **4.7 Conclusion**

This chapter helped to make apparent a few relevant conceptual and methodological aspects related to the management of complexity.

Firstly, the management of complexity made apparent that there is no choice; all viewpoints know reality through black boxes. Managing complexity is controlling the boxes' outcomes and not the states within them. Therefore, there is no need to enter the black box to control it, but, on the other hand, the viewpoint needs models of how inputs are transformed into outputs.

Secondly, the discussion about complexity concluded that complexity is not inherent to the situation itself, but is in the eye of the beholder. Therefore, any measurement of complexity should be done by the appropriate viewpoint, and the appropriate viewpoint is that responsible for controlling the black box. This is the viewpoint closing the loops necessary to manage the situational complexity.

Thirdly, the law of requisite variety permitted us to see that the problem owner cannot aim for a better performance than that defined by the ratio between the variety of the disturbances buffeting the situation and the variety of the responses it can produce. If this ratio is not within the space of acceptable outcomes, then, the problem owner is unable to solve its problems.

Finally, the natural imbalances in the complexities of the parts in a human situation offered the chance to engineer the stability of their interactions; variety engineering was offered as an approach to deal with problem situations.

The next two chapters will help to make more clear both, the meaning of models as aids to the management of the black box, and the use of these concepts as a framework for problem solving.



## 5. Producing Relevant Models

### 5.1 Introduction

The discussions in chapter 4 made apparent that viewpoints need to use models to manage black boxes. These models are necessary to regulate the outcomes of the boxes. The aim of this chapter is to explore more in depth the meaning and relevance of models in managing human activities.

The first point to be explored is the distinction between managing and modelling the black box. While we know, from chapter 4, that diving into the black box to produce responses for lower level transformations is likely to produce a mismatch between the espoused and actual transformations that are managed, there is no similar problem if the diving intends only the modelling of the processes within the black box. On the contrary, since self organising and self regulating processes within the black box are likely to have an important effect in the complexity that is relevant to the viewpoint, there are positive benefits in doing this modelling; it may help to define desirable changes in order to make these processes more effective, (i.e. to make them more adequate in coping with complexity), thus, making more manageable the viewpoint's management of complexity.

In this chapter we explore the 'inside' modelling of black boxes only in general, the details and practical

implications of this modelling are discussed in the second part of this thesis. In addition, in this chapter, we discuss the use of models in the processes of changing the inputs to the black box, that is in the processes of producing responses to achieve desirable/acceptable outcomes.

We discuss the use of models in two different modes; the descriptive and conceptual modes. Descriptive models are particularly useful when the concern is the management of complexity. On the other hand, conceptual models are particularly useful when the concern is to explore the unconstrained implications of creative thinking.

To develop a deeper understanding of models in supporting the regulation of the black box we discuss three different types of models; the explanatory, predictive and control models.

However, producing models to regulate a black box requires to establish its boundaries. This is done by naming systems and choosing the variables necessary to monitor and control their transformations. The same approach, of course, also permits to define the boundaries of the activities within the system, and the boundaries of the activities within the activities and so on. This discussion will permit us to develop further insights into the measurement and management of complexity.

Finally, we discuss some of the dangers and misconceptions in using models, in particular, the problem of using outdated models. This problem points to the need of maintaining the relevance of the models in use. We discuss criteria to change these models as the situations change.

## **5.2 Models for the Regulation of Human Activities**

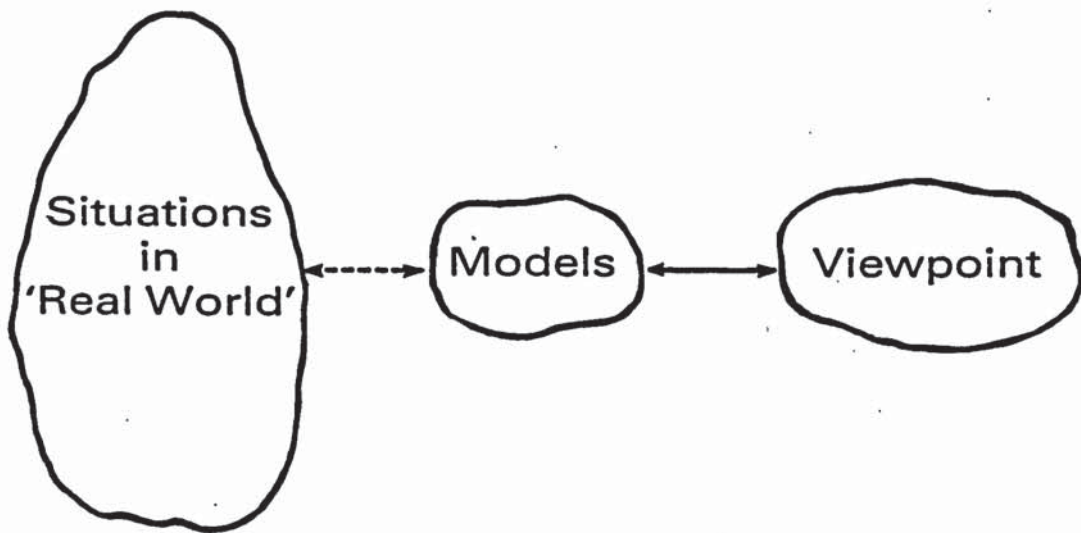
A Viewpoint to regulate the transformation of its interest depends on models; it cannot do this by dealing directly with each event and situation within the black box. These models are the feedback/feedforward adjusters, supporting the production of responses to regulate the black box. They are used to adjust inputs to produce, achieve acceptable and desirable outcomes, as close to the viewpoint's expectations as possible.

Viewpoints have no alternative but to experience and interact with the world through models (figure 5-1). Individuals to be effective need to have adequate models of their "task environments". Similarly, companies, to survive, need good models of their environments; there is no choice in this requirement; it is a necessity in a complex world. This point is made by the Conant and Ashby's theorem, which states that:

"Every good regulator of a system must be a model of the system", (Conant & Ashby 1971)

Figure 5-1: The Real World and Models

## MODELS



However, a common interpretation of this theorem is that the regulator needs a "representation", within itself, of an outside system. These representations being the multiple forms in which outside events, transactions, are abstracted to make them accessible to the regulator. Thus, the accounts of a company are a representation of its internal and external monetary transactions, production flowcharts are representations of its material flows, and so forth. This clear cut distinction between the "system" and the regulator might be useful in the physical world of artefacts, where, a representation of the system, within the regulator, permits to achieve desirable outcomes. However, for human activities, where the "system" (i.e. black box!) is formed by multiple interacting people, the regulator cannot possibly develop a representation of the black box; people are creating and recreating their reality (i.e. the black box) as they interact, there is no landscape to represent. The above theorem, thus, suggests that the "models" used by the viewpoint to regulate the black box are more than just abstract representations of the transformations in progress; they can only be interpretations of the transformations in progress. Though useful, representations are only heuristics for problem solving, they are not enough to produce the necessary "regulatory" responses. The models used for regulation, are those emerging from the viewpoint's on going interactions with the other participants in the multisystem; these models are not representations of the black box, but interpretations of the viewpoints

interactions with the other participants. These models are inserted in a **hermeneutic mechanism** (Harnden 1987). Thus, we make the distinction between interpretative and **representational models for regulation**. This chapter is mainly focused in the latter models, it is only in the next chapter that we will discuss more in detail interpretative models for regulation.

### **5.2.1 Further about interpretative and representational models**

A common meaning given to models is that they are descriptions, simplifications, abstractions,... of "real world" situations. This meaning fits our intuition of models as abstract representations of "things" in the world, of the reality outside the viewpoint. For a number of practical purposes this is a useful insight, there is no doubt that without that insight it would be difficult to conceive a clock as a model of the Earth's rotation. Nor, would it be possible to work with scaled representations of objects, to test some of their properties. However, this conception of a model is inadequate in the context of human activities, where the main concern is the interaction of multiple viewpoints, all of them creating, through these interactions, the "reality" to be modelled.

The role of representational models is that of an anchor, or a pointer, to support the on going processes of social

intercourse. However, it is in their interpretation, while in social intercourse -interpretation based on the personal histories of the people involved- that they are transformed into regulatory models. In this sense, interpretative models do not exist independent of a multisystem, whose operation is responsible for the constant creation and development of the models in use, nor do they exist as representations of "objective" processes, outside the reality of the viewpoint.

Models to be useful they need to be inserted in the intercourse of the multisystem (i.e. the multiple management loops in progress). It is in this intercourse, that different participants give different interpretations to these models, thus, using them as contributors to the understanding of the situation they are creating. The response actions stemming from this interaction, will most likely change future interpretations of these very same models. Naturally, these interpretations, which open evolving meanings for models, are triggered by the viewpoint's perception of stability in its interactions with other viewpoints.

The methodological implications of these views about modelling are discussed in Chapter 6. At this stage, the important point to realise is that the models supporting the viewpoint's management of the black box are not technical models representing the transformation taking place in the real world -they lack completely in complexity-, but are

those supporting the interpretation of the situational stability.

The discussion of this **hermeneutic mechanism** gives a much more powerful meaning to the general control mechanism used in this work.

### **5.3 About Representational Models**

Despite the above comments representational models are useful to different degrees. They might support the production of interpretative models.

The relevance of some Operational Research and Systems Analysis techniques stems from their aim to make extensive use of **explicit** models of a situation (i.e. black boxes). At least when models are made explicit it is possible to question their underlying assumptions.

#### **5.3.1 Modes of modelling: conceptual and descriptive models**

Conceptual and descriptive models are elaborations of a system's transformation. Conceptual models state the activities that are, for a viewpoint, logically necessary to produce a transformation. Descriptive models state the activities that a viewpoint recognises in the black box (i.e. real world) as directly contributing to the transformation.



The purpose of the analyst in naming a system defines whether descriptive or a conceptual models are relevant. If the purpose is to name a perceived transformation in the world, then, a descriptive model is necessary, and the activities to be included, are those which appear to exist in the real world. On the other hand, if the purpose of the analyst is to name a transformation unconstrained by the real world, then, a conceptual model is necessary, and the activities to be included are those that are logically necessary to make it possible.

Moreover, the same name may generate both, a descriptive and a conceptual model. The former would be the case if the purpose of the analyst is to name a transformation as it is currently being implemented, the latter would be the case if the purpose of the analyst is to name a transformation as it would be desirable - according to some criteria- to implement it. The viewpoint may then compare the conceptual and descriptive models to establish discrepancies between abstraction and reality. Methodologically, the overlay of these two models may permit to recognise desirable changes. This point will be discussed further in the next chapter.

In Checkland's methodology after defining what the system is, the analyst is advised to work out what the system does by producing a conceptual model of the named system (Checkland 1981, Wilson 1984). These conceptual models may or may not relate to the management of complexity; thus, it

is possible to have conceptual models of transformations for which the management of complexity is irrelevant (i.e. for which descriptive models may not be useful). For instance, the name triggering the conceptual model of figure 5-2 is:

"A user-owned system for the rapid professional provision of information generated outside the company, in sifted/digested form which is relevant to the user's work",

for which the transformation is "better informed user" (Checkland 1985). In this case the purpose of the conceptual model is simply to define the logical activities necessary to have a better informed user, and not to manage their entailed complexity.

In the cybernetic methodology, for those systems focused in the management of complexity, the modelling can be done either with reference to logic or reality, thus producing conceptual or descriptive models. While in the former case the activities are defined with no other constraint but their logical consistency, in the latter case the activities are intended to be a reflection of the way things appear in the world to the viewpoint.

Conceptual and descriptive models are formed by a number of activities; these activities may require themselves further elaboration to establish their meanings. For each activity one or more names may be produced, and for the related transformations, conceptual and/or descriptive models may

help to work out their meanings. According to the nature of the problem situation it may be necessary to work out several levels of resolution. This process can go on as many times as it is perceived necessary to work out in detail the problem situation (see figure 5-3). The analyst is modelling the complexity of the problem situation. Each new unfolding of the activities defines a new level of detail for the discussion (by the appropriate participants) of the problem situation. Different levels of resolution emerge in this unfolding of complexity. If the problem relates to the design of an organisation, or the development of an information system, it may be necessary to model several resolution levels. This type of modelling is used and discussed throughout the second part of this work (chapters 7 to 10).

Thus, the activities named in these models will themselves be black boxes (i.e. human activities) in their own right, with owners, customers and actors.

Conceptual and descriptive modelling is a method to handle the potential or (perceived) actual complexity of problem situations; it helps to work out the unfolding of complexity in the problem situation and with that the levels at which particular activities should be taken into account.

Figure 5-2: A Conceptual Model

### CONCEPTUAL MODEL

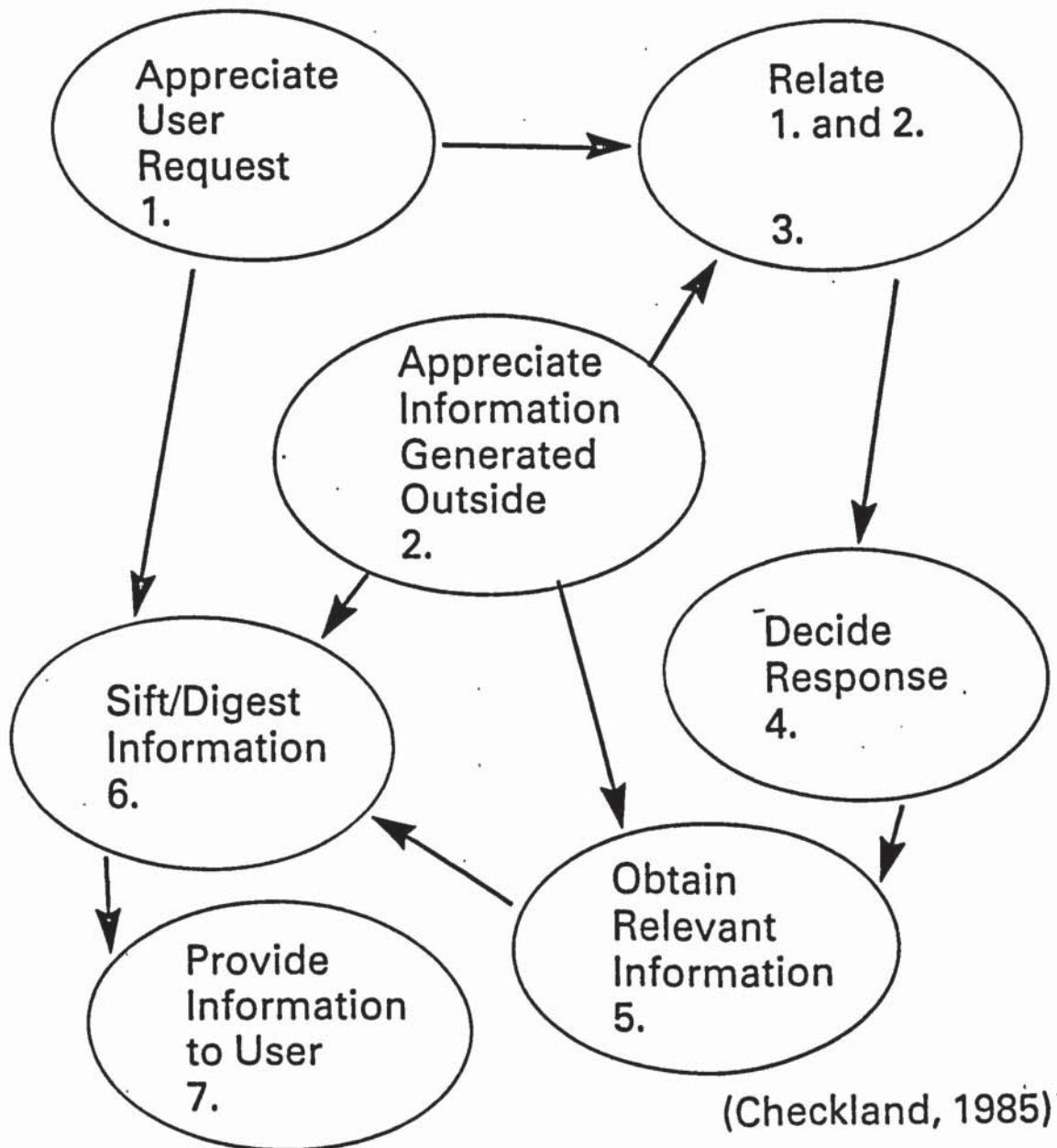
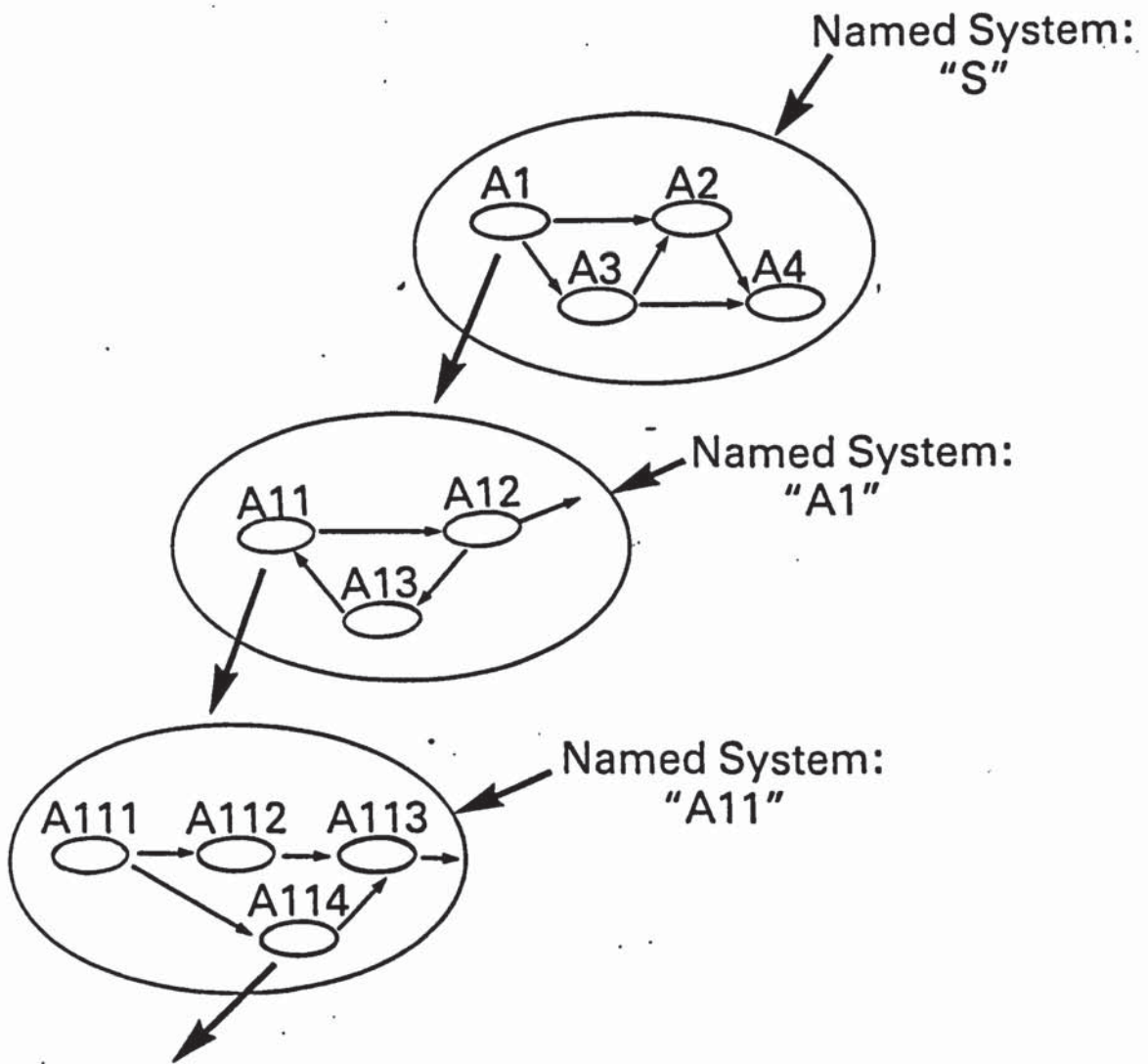


Figure 5-3: Levels of Resolution in Conceptual Modelling

### CONCEPTUAL MODELLING CASCADING OF COMPLEXITY



### 5.3.2 Producing conceptual and descriptive models

Producing a model may be triggered by the need to work out the meaning of a named transformation (logically or in the real world), or by the need to establish the system in focus (tacitly) relevant to a viewpoint. In this latter case eliciting the tacit views of viewpoints about the activities that they perceive as relevant in the situation is a way of hypothesising relevant systems to them.

Techniques like cognitive mapping (Eden et al 1983) permit to produce tacit conceptual models of, as yet, unstructured situations. These models may, then, be used to structure a situation.

The scope and purpose of the problem solving exercise will tell the analyst how far to go in the direction of building conceptual and descriptive models. This assessment is likely to be the outcome of an iterative process, in which more detailed models may appear as necessary, after a good deal of fairly simple and global, but potentially very useful, modelling has been done. It makes little sense to dive into high resolution models before making apparent the concerns of the client.

There is a need for guidelines to proceed with this kind of conceptual and descriptive modelling. How do we establish the activities that belong to such models? If the model is descriptive then the modelling can take place with reference

to observations in the "real world". Still, quite naturally two different viewpoints are likely to see different things, therefore, there is no objective reference point for this modelling. On the other hand if the model is conceptual, how does the viewpoint know which are the activities logically necessary to achieve the named transformation? In this latter case, most likely a good deal of previous expertise will be required to build up a useful model.

There are a few rules of thumb to help in this modelling.

Firstly, how do we know whether one activity (X) depends on another (Y)? An answer to this question is necessary to establish logical relationships. A simple answer would be; "Can I think of a significant output of matter, energy, or information from Activity X which I can also conceive as a significant input to Activity Y?". A yes answer implies logical dependency (Woodburn 1985). Of course, if the model is descriptive then these relationships would be observable.

Secondly, when the concern is the management of complexity, the idea of establishing resolution levels is an important heuristic. Though a viewpoint may see, at an abstract level a large number of activities, it may not have the capacity to manage them and their entailed relations, at that level. In practice, it makes little sense to develop models of more than, say, ten activities at one resolution level. Of course, all those activities entailed by an

already named activity should not be made explicit at "this" level of resolution. Thus, the named activities have to be not only logically dependent but also focused at the same level of resolution, and when appropriate they should be, of more or less, the same complexity. The latter requirement is not easy to fulfil unless the viewpoint has had experience with the transformations of concern. Yet again the relevance of expert advice in building these models.

Thirdly, and also for the purpose of managing complexity, the analyst should name both, the activities producing the transformation, and the activities servicing or facilitating the production of the transformation. The former are called primary activities, the latter are called regulatory activities. All those activities indirectly contributing to the transformation are of a regulatory kind. If the model is focused only in primary activities we call the model a transformation flowchart, on the other hand, if it is focused in the regulation of the transformation, we call it a regulatory model.

Extensive use of these modelling principles is made in the second part of the thesis.



### 5.3.3 Types of models: Explanatory, predictive and prescriptive models

While in 5.3.1 our concern was to study different modes of modelling, depending on the purposes ascribed by the analyst to the named system (i.e. whether it was a description of reality or a notional system), in this section our concern is to study different types of models depending on what aspects of the "black box" the analyst is interested in.

The analyst may be interested in:

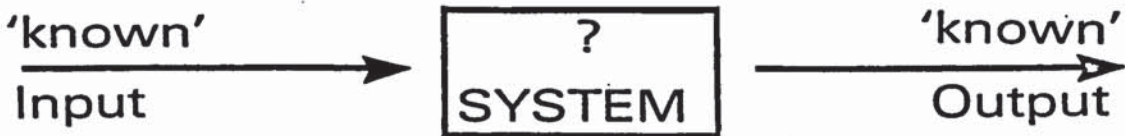
- the "system" itself (i.e. the black box),
- the outputs of the named system, and,
- the inputs to the named system.

Each type of study suggests a different type of model (Braat et al 1986). In the same order these are (see figure 5-4):

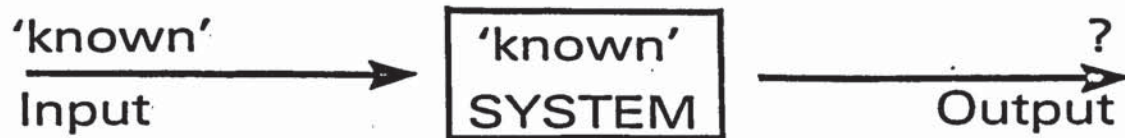
- the explanatory models,
- the predictive models, and,
- the control models.

Figure 5-4: Types of Models

*1. Explanatory Models*



*2. Predictive Models*



*3. Prescriptive Models (Control)*



## Explanatory models

The first type of models are those where the analyst can observe, over time, the inputs to, and outputs from, the black box, and his purpose is to deduce an invariance in the transformation performed. If the analyst modelling the system finds an invariance, of any kind, that explains how the transformation is produced, then, he has produced an explanatory model. An explanatory model may be evaluative or prescriptive, that is, it may permit either to assess whether a black box is working well, or, to define how should the black box work to perform effectively. Indeed, there is an explanatory model underneath any conceptual or descriptive model; the analyst producing the model is tacitly making apparent his view as to how a transformation ought to be, or, is produced. However, there are different kinds of explanatory models.

The recognition of different constraints (i.e. invariances) in the world may permit to produce conceptual and descriptive models of different explanatory power. This is indeed one of the aims of scientific discovery. For instance, if the named system is an existing organisation then, the conceptual (or descriptive) model can be either a set of weakly interrelated activities, like "activity to transform the expectations of the stakeholders into company aims", "activity to define end products and allocate resources to achieve them", "activity to sell end products", "activity to produce end products" and "activity to monitor

performance" (Wilson 1984), or they can be, at a more abstract level, the set of **necessary and sufficient** activities - held together by regulatory mechanisms- that define a viable organisation (Beer 1979, 1981, 1985). The latter model -to be developed in chapter 7- has a much higher explanatory power than the above conceptual model.

### **Predictive models**

The second type of models are those where the person modelling the situation knows the inputs to the black box, and also has an explanatory model of how the black box performs its transformation. The purpose of the model is to predict the outputs. Hence if the system is a kettle and the input is energy (e.g. electricity), then, we can predict that the kettle's water will boil after a few minutes; it is not necessary to experience the real thing to know that that will be the outcome. Simulation models are used for this purpose in human activities; in this case the black box (i.e. real world) is replaced by an explanatory model, which is, then, used to anticipate outcomes under different input conditions. Statistical forecasting models are also used in this mode.

### **Control models**

The third type of models are those where the analyst knows the output that is desirable, knows the way the black box works (i.e. has an explanatory model), and the problem is to

define the optimal input necessary to achieve the desirable results. These are prescriptive models; they prescribe the combination of inputs that will permit to reach a particular outcome (e.g. objective function). Important use of these models is made in resources allocation. A number of mathematical models are used to this effect.

#### **5.3.4 Characteristics of models**

##### **Algorithms and heuristics**

Well defined situations, with well recognised objectives, may lend themselves to the use of mathematical models. In this case it might be possible to find a technique which prescribes precisely how to reach a well defined objective. These well defined procedures are called **algorithms**.

However, as the assumptions about the situation are made more realistic the likelihood is that it will become harder to find adequate algorithms. Problem solving starts to rely more and more on **heuristics**, that is on methods of behaving which help the viewpoint to move towards particular defined objectives. A heuristic can be a flexible procedure to relate numerical models to organisational conversations or simply a rule of thumb.

##### **Forms of presentation: physical and symbolic**

Models can be expressed using **physical, symbolic and iconic** representations. Early work in these fields made an

important use of prototype machines i.e. physical models, to test different hypotheses about the world. For instance, in cybernetics, Ashby's "homeostat" (Ashby 1966) was instrumental in developing the ideas supporting this work, also, Beer's "algedonode" -a wood and brass machine designed to model the way information affects the behaviour of decision nodes in complex systems, like organisations (Beer 1981 pages 67-72)- was important in the development of his management theories. However, today, supported by developments both, in computer technology and applied psychology, symbolic (either mathematical or verbal) and iconic (i.e. graphical) models are the norm. Today it is possible to recognise an ever increasing use of more, and more, flexible and powerful mathematical models to support problem solving. A number of these models are being structured in the form of **Decision Support Systems** and **Expert Systems** (Sprague et al 1986).

#### **5.4 Modelling Complexity**

It is important to emphasise that, a capacity to model the activities necessary to achieve a transformation, is not the same as managing these activities. The latter implies the need to cope with the full complexity of the recognised activities. In other words, modelling the system of concern does not change the fact that the situation still remains as a black box for the viewpoint. Obviously, the complexity of producing a model is orders of magnitude smaller than coping with the complexity of the activities themselves.

Thus, while managerially it may not be possible to "dive" into the black box, cognitively it may not be too difficult.

This section offers methodological support to model complexity.

Earlier discussions made apparent that the complexity of a black box, for a viewpoint, is defined by the number of distinct behaviours, or outcomes, that it perceives in the situation. Establishing these outcomes, requires defining boundaries relevant to the black box. These boundaries are defined by the variables that the viewpoint chooses to pay attention to. However, attention to these variables only helps to assess the complexity that is relevant to the viewpoint itself, it is not enough to assess the situational complexity, that is, the complexity of the activities within the black box.

Naturally, for most human activities, any attempt by a viewpoint to perceive and enumerate, by itself, the variables relevant to a situation is beyond its possibilities. No viewpoint can see, in full, the complexity managed by other viewpoints. It is necessary to have methods to model this complexity. A method for this purpose, based on the definition of boundaries, is elaborated below.

#### 5.4.1 The boundaries of a situation

For some human activities we may develop an intuitive grasp of their boundaries. For instance, if the named system is an organisation, and the related transformation is its "raison d'être" (i.e. its business areas), then, somehow we develop an intuitive feeling for the boundaries of the related system; as in the case of a cell, everything inside the "membrane" (the corporate body) is within the system, while everything outside the "membrane" is in the environment. The market, the suppliers, the economic context of the company, are fairly easy to recognise as part of its environment.

However, this apparent realism is not only misleading, but also unrepresentative of human activities. Most of the systems we name do not have "clear cut", intuitive, "membranes". The named transformations imply the relevant "slices" of reality to consider, with no reference to existing entities. Indeed, if we think in the systems named in chapter 3, it is difficult to see at all well defined "membranes" for any of them. Systems like "development of an information system to control shopfloor activities" or "development of strategies to maintain and/or develop the circulation of publications" are not referring to any precise "thing" outside there. They are referring to processes that most certainly will be understood very differently by different people. The meaning of "developing an information system" is



different from one analyst to another. In spite of this haziness, to make possible an effective study of a system, it is necessary to know how define its boundaries.

The problem is not only that the boundaries of most systems are not clear cut but, also, that the people naming these systems are tacitly changing their meanings all the time. For instance, while until recently, in many companies, the transformation "data into information" implied the preparation of written reports, today its meaning is the production of computer reports. Indeed the activities entailed in one, and the other, are very different, implying very different boundaries.

As a matter of fact viewpoints, consciously or unconsciously, are constantly "renaming" systems, hence changing the boundaries of the situations of their concern. This renaming is likely to be the outcome of a learning process where both, understanding and assumptions about the situation are improved.

And, as they change the boundaries of the system, they also change its complexity.

#### **5.4.2 Boundaries and the complexity of a situation**

The aim now is to discuss a method to model the complexity of a situation; how can an analyst know what to account

for?, that is, what is within the named system, and, how complex it is.

#### 1- Naming systems

Metaphorically, naming a system is like making a mark in a blank sheet i.e. it's an act which produces a distinction in a background. At a general level, in spite of the fact that a statement of the transformation performed by a system is not enough to know what it entails, naming the system is a first step in defining its complexity.

#### 2- Boundaries and activities

The name permits to produce conceptual and descriptive models. However, the same name (system) may trigger different models; indeed, if the viewpoint ascribes different purposes to the same system, the related "transformation" models are likely to be different. If the purpose is to name an existing transformation, the activities of the model are the actual activities responsible for the transformation of concern. On the other hand, if the purpose is to name a notional system, the activities are those logically necessary to produce the transformation. There is no reason to think that actual and logical activities will be the same. Naturally, the same transformation may have not only different meanings, but, also practical implementations.

In broad terms, it can be said that the boundaries of the named system are defined by the activities that produce the transformation of interest (Jones 1982). On the other hand, all those activities that have an influence on the transformation, but are not producing it, define the environment of the system. Hence, if the named system is the development of an information system, activities like feasibility study, analysis and design, evaluation, and programming may be within it. On the other hand, activities like development of information technology, organisational adjustments, definition and implementation of personnel policies are outside it.

Then, the second step is to distinguish between inside and outside activities. This step assumes that the viewpoint either is able to see how the transformation is achieved, or knows how to produce such a transformation.

But, more precisely, how does the viewpoint know which particular activities are entailed by the named system? and, how does it know which are the outside activities likely to influence, in one way or another, the named transformation? The answer to these questions is methodological; if the viewpoint is the owner of the system, or is an expert in the transformation, the owner itself may have the answers to them. However, if the viewpoint is not the system's owner, (this is the case of an analyst studying a problem for a client), or, even if the viewpoint is the owner, but, does not have an in depth

knowledge of it, then, it is necessary to elicit the views of other viewpoints (i.e. owners of activities or experts). This latter option is likely to be the most common one.

### 3- Boundaries and variables

However, the distinction between inside and outside activities may not be enough to model the complexity of a system.

How is this view consistent with the earlier proposition that the boundaries of a system are defined by the variables that the viewpoint chooses to study?

The third, and more detailed step in this method, is to define for the system as a whole, and for each of the activities -at all relevant levels of resolution- the variables that the problem owners control and monitor.

This shift from activities to variables permits to focus attention and also grasp the variety of outcomes of the problem situation. Figure 5-5 is used to support this discussion.

Naming variables permits focusing attention in the observed variables defining the behaviours of interest, these are the monitored variables. It also permits focusing attention in those variables affecting these behaviours, at the same time of being controlled by the (owner) viewpoint.

Figure 5-5: Boundaries of Named System

## Boundaries of named system

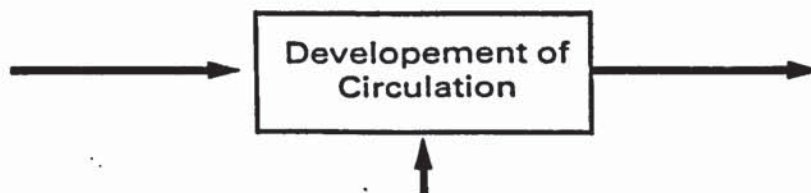
Named system:  
"System to develop a financially acceptable level of journals circulation"

*Controlled variables*

- sales effort
- editorial changes
- personnel policy
- diversification

*Monitored variables*

- volume of advertising
- costs
- profit
- level of circulation



*Disturbances*

- economic changes
- new government regulations
- consumer behaviour
- competitors behaviour

-the monitored variables are the output variables that are recognised as defining the behaviours of interest (i.e. the outcomes of the transformation), and, that are, should be, or, ought to be, monitored by the owner. In figure 5-5, the monitored variables for the divisional managers (i.e. the owners of the system), are the volume of advertising (in the company's journals), costs, profits and levels of circulation.

-the controlled variables are those that can influence the variables defining the behaviours of interest and are, or should be, or, ought to be, controlled by the owner. In our example these variables are, sales effort, editorial changes, personnel policy and diversification. Note that "volume of advertising", in other media, could have been named as a controlled variable.

This definition of variables is affected by aspects like, the time scale perceived as relevant to the transformation, or, the resources available to make it possible. Of course, there is the need to elicit the assumptions implicit in choosing variables. Under what assumptions are the owners controlling the named transformations? It does not help to name transformations underlined by unrealistic assumptions.

The attention of the analyst is now on the whole rather than on the parts; the emphasis is no longer in defining the parts within an activity, but in the regulatory relation

between an activity and its owner. Each activity, at whatever level of resolution, is a whole for the owner giving closure (i.e. regulating) to its transformation.

For the analyst viewpoint, the boundaries of the system are now defined by the variables that he assumes are under the direct or indirect control of the owner. While the former are the independent variables, the latter are the dependent variables, and in between them, there is a set of activities producing the transformation. As said earlier, each of these activities is a black box in its own right (in fact a sub system of the named system), whose boundaries could be established in a similar manner, with reference to their own owners.

Methodologically, these variables should be defined by the owners. However, if we are talking about notional systems, experts should be responsible for them.

Naming a system implies a mark in a domain; this domain defines the environment of the named system. Any environment, potentially, includes an infinite number of variables (or activities) affecting the system's transformation. However most of them will have a minute impact on the transformation. Therefore, to make useful the naming of environmental variables, it is necessary to recognise a limited set of them, relevant to the participants (actors, customers and owners) of the system. These are the non controlled variables, or

external (input) parameters. To take any of them into account they should not only have an influence in the transformation, but also be expected to vary in the time frame of the transformation. If an environmental variable is perceived as relevant, but is unlikely to change in the expected "life" of the system, then, it does not need to be considered.

Non controlled variables are input variables that affect and/or constrain the system's transformation i.e. altering the behaviour of the system (see the example in figure 5-5). These variables are called disturbances. However, there are different types of disturbances. In any situation there are some variables that, though far removed from the owners, do affect the transformations of concern. For instance, in figure 5-5 this is the case of economic changes. On the other hand there are variables that, though outside the owners' control, can be influenced by them, for instance divisional managers in the company of figure 5-5, can influence the variable "consumers behaviour" by affecting the company's marketing policies. Thus, environmental variables can be totally uncontrollable or can be, to different degrees, under the influence of the owners. Disturbances are the outcome of relevant transformations taking place outside the system's boundaries.

In practice the distinction between controlled and non controlled variables is far from being clear and precise.



Both are input variables. Aspects like the time scale of a particular transformation may make of an input a constraint (i.e. uncontrolled variable) or a manageable resource (i.e. controlled variable). Anticipating problems may transform non controlled variables into controlled variables. Of course the opposite argument is also true. For instance, in one of the examples of chapter 3, had the divisional production manager anticipated the non commitment of "management services" (i.e. the fact that they were behaving as non-controlled variables), and had he negotiating in advance their support, he could have made of the resource "computer specialists" a controlled variable. In the event this variable was an environmental constraint.

Summing up,

The possibility to model the complexity of a situation follows the naming of systems. For this purpose it is necessary to work out their boundaries. Defining the boundaries of a system, in a general sense, implies defining the activities producing its transformations. This definition may be necessary at several levels of resolution; those implied by the purpose of the study. If the purpose of the study is the design of an organisation or the development of an information system the number of relevant resolution levels may be several, on the other hand if the purpose is to study only the global transformation (i.e not to study the situation "in depth"), then, this definition

might be necessary only at one level (to work out the meaning of the transformation). Defining the boundaries at an specific level requires naming the controlled, uncontrolled and monitored variables for each of the named systems.

The above methodological discussions permitted to see how to proceed with all this modelling. The modelling was always related to the appropriate viewpoints. In the context of this work, their most important contribution is their experiential "measurement" of the complexities involved. While they may have difficulties in giving precise figures, they usually have a grasp for the orders of magnitude involved, particularly when requested to assess complexity in a relational sense (i.e. is the complexity of this activity higher than the complexity of this other?). The practical implications of this views are worked out in the second part of this thesis. However, in general, the benefit of this modelling is in making the management of complexity more manageable. The heuristic is to organise the distribution of complexity in such a way as to match task complexity with regulatory complexity.

### **5.5 Making "Representational" Models Relevant**

Explanatory, predictive and control models are required to support the regulation of the complexity entailed by the named systems. A viewpoint may:

1) Use models of the system itself to improve it, this is the meaning of conceptual and descriptive models, when used as explanatory models;

2) Use these models and its knowledge of the available inputs to anticipate possible outcomes, this is the meaning of predictive models;

3) Use explanatory models and knowledge of necessary, desirable outcomes to define the necessary inputs, this is the meaning of control models.

However, if these models are going to be relevant to problem owners, and remain as such, then, there is a need to build them up, and adjust them continuously, taking into account both, the owners' interests and capabilities, and, the changes and disturbances that may render the models irrelevant. These are problems relevant to those analysts, responsible for the building and maintenance of "representational" models.

There are a number of potential pitfalls in the process of modelling that an analyst should be aware of;

Firstly, the fact that all of us use in one form or another tacit models of the world makes plausible the confusion of models with reality. While we are all too aware that "the map is not the territory" we are all too often prepared to use "the same map for very different territories". The

discussion of complexity made apparent that time is the main dimension for complexity unfolding, therefore the models used for problem solving need to evolve with time.

Insensitivity to changes in the conditions that permitted to accept certain assumptions while building the models may lead to this type of pitfall.

Secondly, it is not uncommon that analysts appear to be unaware of the purposes of the models they build (i.e. of the modelling mode). Are these models intended to describe the world as "it is" or as some viewpoints would like it to be, or as some abstract prescriptive criteria would suggest it should be? For instance, to use a prescriptive (explanatory) model of a situation for predictions may be totally an exercise in wishful thinking and may have no logical relation to actual existing trends.

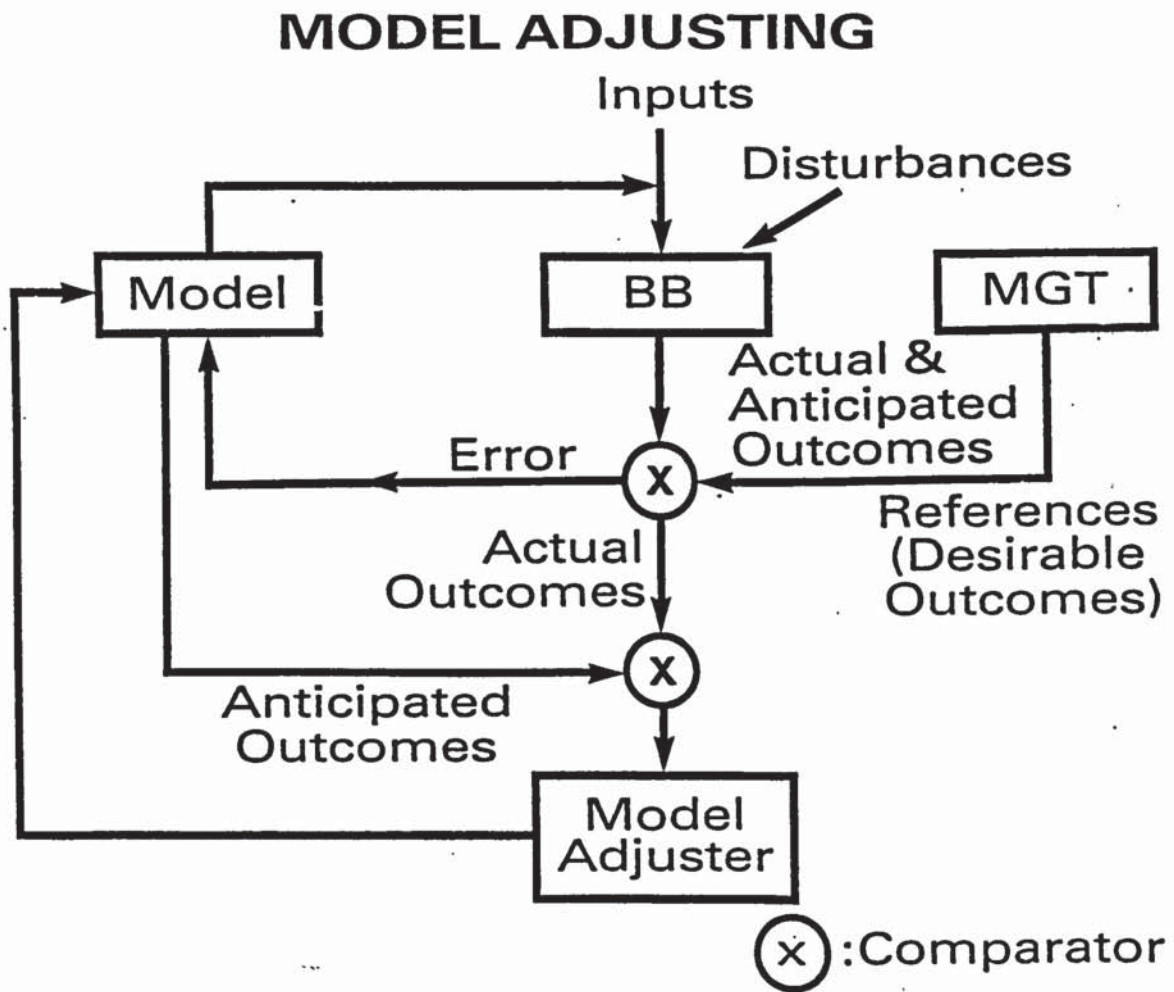
Thirdly, if models are developed outside their organisational context we may have very sophisticated models that are out of touch with the realities of the situation. For instance, a model that models more complexity than that under the control of the intended user may create a barrier in having this model as part of his management loop. This is the case when modelling is insensitive of the "hermeneutic mechanism" in use.

Finally, those models that are successfully supporting a management loop need to be updated constantly, to produce more, and/or different responses, to new disturbances,

and/or new criteria of performance. Detecting the need for updating, or changing, should be strongly influenced by the viewpoint's anticipation of outcomes; if owners expect that future "actual" outcomes will be in line with their current expectations, then, the models in use are perceived as adequate. However, if these expectations are disproved, then, the models in use may not be adequate; important discrepancies between anticipated "planned" outcomes and "actual" outcomes, is a sign that the models in use need updating. Detecting these mismatches is the role of the **model adjuster** in problem solving.

In figure 5-6 we can appreciate the working of this mechanism. The viewpoint (MGT) has some expectations (Desirable outcomes), which are compared with either the actual outcomes (today) or the anticipated outcomes (if nothing is changed). The comparison produces errors that affect the "interpretative" models (supported by representational models) used by the viewpoint; the outcomes are, in general, responses to change the inputs in such a way that, on the one hand, undesirable anticipated outcomes do not happen, and, on the other, anticipated desirable outcomes do happen. (i.e. actions are taken to get future outcomes in line with expectations). However, whether because the conditions have changed (i.e. there are new disturbances), or, the black box is not behaving to form, if the comparison between "actual" and "anticipated" outcomes produces unacceptable errors, the **model adjuster** will need to offer ways to improve the models in use.

Figure 5-6: Model Adjustment



To have an effective model adjuster, the problem owners need to be informed about the views held by problem owners of systems embedding this system of concern. This is perhaps one of the most important skills to have in problem solving; problem owners need to be aware of situations beyond their immediate concern.

### **5.6 Conclusion**

This has been a complex, but also, most important chapter to understand how models can help in the management of complexity. The distinction between "representational" and "interpretative" models is central to the argument. To manage the complexity of human activities there is no option but to rely in the history of the people involved to give meanings to the transformations of interests. However, the use of representational models to organise real world complexity in different forms -something that in the last chapter was referred to as variety engineering- may permit to make more manageable the management of complexity. This latter was the emphasis of this chapter.

## 6. The Cybernetic Methodology

### 6.1 Introduction

Chapter 2 made the distinction between single viewpoint and multiple viewpoints problems. The former were related to control problems, where one viewpoint was aiming at controlling the successful implementation of a real world transformation, the latter were related to stability problems, where several viewpoints were aiming at finding a space for stable interactions. More precisely, the latter problems were focused in producing real world transformations taking into account the natural differences in the preferences, beliefs and values of viewpoints.

The emphasis of chapters 3, 4 and 5 was in control problems, that is, in the management of complexity. However, our discussion of models made apparent that this management was supported by "interpretative models", and not by simple "representational models". This meant that even when the focus of the problem solving exercise was in the control of a transformation by one viewpoint, it was necessary to take into account the multisystemic nature of the entailed regulatory responses.

The purpose of this chapter is to relate control and stability problems in the context of the cybernetic methodology introduced in Chapter 2. This methodology should



help in tackling organisational problems -in particular those soft, ill structured, wicked problems stemming from differences in beliefs, values, preferences, histories...

In this work I take the view that just and equitable human activities are those giving to all participants the possibility to influence effectively the on going creation of reality. This aim requires not only the possibility to articulate views and positions, but most importantly, the possibility to transform them into desirable action and change. A viewpoint's participation in these processes means its involvement in the management of complexity, to the best of its possibilities. In other words, this involvement, implies that all viewpoints should have the means to participate in those hermeneutic mechanisms that affect their interests, that is, should have the means to actively participate in relevant, for them , learning processes. And, the "means" to make this participation effective are cybernetic mechanisms with the necessary capacity to support the viewpoints' requisite communications.

The argument in this chapter is organised around the activities of the cybernetic methodology as seen in figure 6-1, which is basically the same as figure 2-4.

The chapter gives first an overview of the methodology, this is followed by discussions of how to find out about problem situations and how to structure them effectively. However, the core of this chapter, is the study of the cybernetic and

learning loops in problem solving. The final section discusses some of the issues relevant to the production of change in human activities.

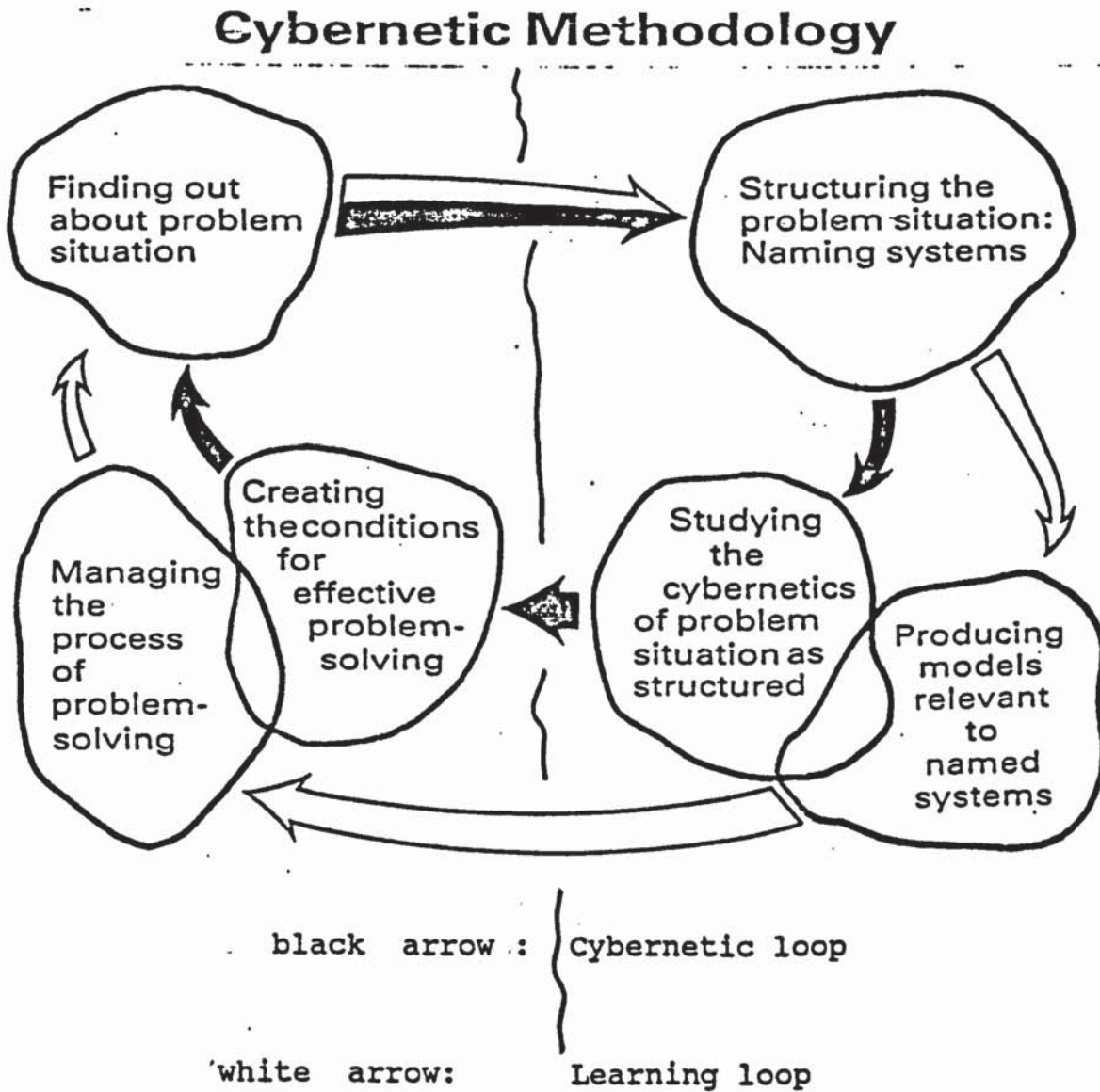
## 6.2 An Overview of the Methodology

This section highlights those aspects relevant to the process of problem solving as made manifest in figure 6-1. In this figure the inner and outer loops are the cybernetic and learning loops respectively.

It is in the systemic nature of human activities that the network of communications affecting a viewpoint's appreciative processes involves people beyond its immediate environment. The complexity that the viewpoint sees in a situation, and therefore the quality of its appreciations depends not only on the immediate interactions but also on the structures supporting its links with distant viewpoints. In general, for good problem solving it is not enough to have adequate 'debates' with those close to the viewpoint, it is also necessary to operate in an effective organisation structure.

Indeed, it is common that the appreciation developed by a group of participants about a situation, perhaps through some highly regarded problem solving exercise, is frustrated by the structural realities of the organisation in which they operate. The spirit created by these group

Figure 6-1: The Cybernetic Methodology



meetings may wane as the "hard reality" of the organisation structure imposes its heavy inertia.

The methodology to be unfolded in this chapter offers guidelines to improve both, some of the structural limitations underlying problem situations, and the appreciative processes producing meanings for human activities. Thus, the cybernetic methodology is concerned with problem situations at two epistemological levels; firstly, at the level of the mechanisms supporting communications between the people involved in a situation, and secondly, at the level of the content of these communications.

The former level relates to the cybernetic loop in problem solving; this is the loop which allows us to improve the way the organisational system (i.e. black box) works. inadequate communication mechanisms create among other things misunderstandings where there could be understanding, conflict where there could be co-operation, reduced potentials where there could be synergistic interactions. This loop is all about understanding how the "system" works and using this understanding to improve it. The overall purpose is to achieve a more effective management of the situational complexity.

The latter level relates to the learning loop; it is not enough for successful problem solving to have an organisational context with adequate communication

mechanisms. It is also necessary to know how to discover relevant processes (i.e. transformations) and how to respond to actual or possible disturbances affecting their outcomes.

Naturally, the cybernetic loop is in itself part of a learning loop, however, it is argued that there is a cybernetic loop underlying all problem situations. This is the loop dealing with the context rather than with the content of the situation; this is the loop concerned with creating conditions for effective problem solving rather than with solving specific situations.

In figure 6-1 the left side activities describe the situational interactions themselves (the organisational system for this situation), the activities in the right side describe the analyst's thinking and modelling about the situation. Thus, the activities of the methodology take place both in the situation itself, that is, in the full complexity of the real world situation (the multisystem), and in the representational world of systems analysis, that is, in the world of models and information. Using an earlier metaphor, the right side is to the left what the map is to the territory. If the purpose of this figure were to make manifest the huge difference in the complexity entailed by the activities in each side of the figure, then, in general, the activities at the left side would have to be several orders of magnitude bigger than those at the right side.

While a systems analyst intervening in a problem situation should be in direct control of the right side activities, that is, of problem structuring and modelling, he can only be a catalyst or facilitator of the left side activities. However well the analyst performs the right side activities, the success of his intervention will depend on his abilities to interact with the situation itself.

Systems analysis needs a range of tools and methods to support their interaction with the left side activities. These tools and methods should help both to "attenuate" the variety of the situation e.g. methods for data collection to build up a rich picture of the problem situation, and to "amplify" the analyst's variety vis-a-vis the situation e.g. methods to produce desirable changes in the situation. Of course, as a particular intervention goes deeper, the problems of variety balance become more difficult.

The use of the methodology is iterative. Its use is iterative in the sense that it is part of a learning process which is making apparent the constant need to modify the platform for debates.

Finally, at the general level, the content of the methodology is recursive; the content is recursive in the sense that "each viewpoint is a multisystem" and therefore even if a soft situation is reduced to a control problem, under one viewpoint, the implementation of any agreed

transformation is bound to entail problems of stability within the 'single' viewpoint.

These characteristics of the methodology will become more apparent in the discussions below.

### 6.3 Activity 1: Finding Out About Problem Situation

This activity of the methodology is concerned with building a rich picture of the situation. Problem situations take place in a human context which is inherently complex. Developing a good appreciation of this context is a must for the analyst. For this purpose he needs to collect relevant "facts and data". A number of methods are available for this purpose, going from the observation of processes, activities, interactions, results..., passing through the study of documents, hand-outs, minutes... and, perhaps, ending with structured and unstructured interviews of the main actors.

To study the cybernetics of the situation entails interviewing the actors themselves; they are the ones in the best position to assess (i.e. measure) the complexity of processes, products used and produced, and the capacity of the communication channels in use.

The analysts involved in data collection should be able to separate the espoused theories of the concerned people from their theories in use (Argyris and Schon 1978). That is,

they should be able to separate what these people would like the situation to be from what the situation appears to be to the analyst. Also they have to be able to detect gaps and inconsistencies in the data. Naturally, this suggests that the methods for data collection need to have means to produce all these consistency and completeness checks.

For the purpose of working out problematic issues (i.e. hypotheses) analysts need to detect situational 'errors' and work out their meanings, hence they need to develop an appreciation of situational issues as well.

Naturally, most of the time, the data collection activity will require several iterations. Initially the collected data will lack in 'in-formation'; it is only in later iterations, after consistency and completeness checks have been done and different views have been cross checked, that a rich picture is likely to emerge in the mind of the analysts.

#### **6.4 Activity 2: Structuring Problem Situations**

The discussions in chapters 3 and 5 made apparent that problem situations may be structured as transformations of some input variables into some output variables (the monitored variables). The latter variables are those that should be maintained within acceptable levels. Individual viewpoints construe these situations with reference to



particular transformations and/or behaviours of their interest, and, naturally these constructs may vary in time.

Hence, in any situation not only there are a number of possible viewpoints, and viewpoints within viewpoints, but further each viewpoint can generate a variety of possible constructs. However, while there is this rich pool of possible transformations, it may be difficult to discover insightful transformations. Naming systems requires both creativity and adequate methods to overcome the risk of stating the obvious.

#### 6.4.1 A method to structure situations

An obviously apparent problematic transformations (e.g. a company experiencing a drop in sales) may hinder seeing more subtle and relevant transformations. On the other hand, a transformation perceived as non problematic may hide an unexpressed problem related to the participants values or the time frame in which it is seen. What appears today as a stable transformation may turn out tomorrow as a painful instability. These underlying, less obvious transformations, are the transformations of interest to the investigator.

In practice, the naming of insightful transformations poses difficulties. Naturally, it is easier to think about manifest transformations than it is about relationships among the participants or other non trivial linkages. Hence it may be easier to name systems such as system "to make a

decision...", "to select an option...", "to achieve a result...", "to prepare recommendations...", than to name systems that capture 'hidden' transformations, like system "to change the preferences of decision makers". Yet, it is these latter transformations that are likely to offer possibilities for improvement. This was clearly instantiated in Chapter 3 when the obvious transformation "moving people quicker between floors" was replaced by the transformation "changing the perceptions of the people waiting for the lifts".

Equally, if the situation of concern is traffic congestion in a city centre, systems like "a system to keep cars outside the city centre" or "a system to influence the behaviour of car-owners" or "a system to link different forms of transportation" are likely to be more insightful than "a system to take decisions about how to deal with car congestion...", particularly if the procedures for decision-making are beyond the concerns of the relevant viewpoints.

An analyst dazzled by the obviousness of one transformation, should look for more insightful lateral systems. Root definitions should not be constrained by the apparent reality of the situation, hence it may well be that the transformations implied by metaphors, stories or experiences elsewhere offer far more powerful insights about the situation in hand than the apparently 'real' transformations (Davies and Ledington 1987).

Based on these considerations the following method is offered to support problem structuring:

1) Establishing perceptions about the situation: the data collection process should permit to establish the transformations that are perceived as relevant by the viewpoints. Though analysts may produce a large number of apparently different names from the interviews with the viewpoints, the likelihood is that useful names will only be a few. It is natural that similar concerns may be expressed in different forms; while some viewpoints may focus their concerns in results, others may talk about the processes producing these results; while some may use precise terms others may be more undefined; while some may use several verbs to express one transformation of interest others may refer to global transformations. At this stage the interest is to work out genuine differences among the viewpoints.

2) Naming "organisational systems" embedding the situations. These names are useful to study the cybernetics of the problem situation; they should not necessarily be the names of specific 'real world' structural units (e.g. institutions, companies, divisions). In some cases, for instance, the organisational system may well be a system of structural parts cohering temporarily around a common purpose (e.g. a project organisation). In any case, naming the organisational system is naming the context in which the problem situation is perceived. Hence, even if the "root definitions" relevant to a situation were names of

organisational systems, still there would be an underlying organisational context for the related debates.

3) Producing insightful names or root definitions about the situation; these are the hypotheses offered by the analyst to the clients for them to explore in more detail the problem situation. Since root definitions are not related to particular 'client' viewpoints it is essential to make explicit the "worldviews", hidden assumptions, that make them meaningful. These root definitions may be "issue-based" or "task-based" (Checkland 1981). An issue-based root definition describes a "notional system chosen for its relevance to what the investigator and/or people in the problem situation perceive as matters of contention". A task-based (or primary-task in Checkland's terminology) root definition is one "which carries out some major task manifest in the real world" (Checkland 1981 page 317).

#### **6.4.2 An Example**

For instance, let's imagine that the context of the problem situation is in the Library and Information Services (LIS) of a university,

As a result of the data collection process the analyst may be in the position to produce several names relevant to the situation, each reflecting a relevant viewpoint in the situation. Among others, the following are two possible names:

The academic users' viewpoint:

Name 1: System to facilitate both the delivery of teaching services and the production of knowledge, by making available, at the right time, the information required by students and academic staff.

The LIS management viewpoint:

Name 2 System to acquire "information" in the external world based on internal demand and within budgetary constraints.

Since the context of this situation appears to be the Library and Information Services Unit we may elicit from its main role (i.e. the Director of LIS) an organisational name:

Org-Name: University-based system to support the work of individual academic staff, students and research groups with information services aimed at contributing to the overall university's performance.

The TACO for this name is:

- T: information demand into information provision
- A: all people working in the LIS, including management
- C: all users of the LIS
- O: university's management (those responsible for the allocation of resources to LIS)

The maintenance of the service (i.e. LIS) as provided may depend on the organisation's perceptions about its contribution to the university's performance. This name implies relationships between the university's management and the LIS personnel, and between this personnel and the internal users of information services and the external providers of information.

Based on these, and perhaps other names, the investigator may produce several root definition to help the debates in LIS. If the perception is that the main problem is in the interactions between LIS personnel and the users of their services, then, the following root definition may be of interest:

**Root Definition:** A user-owned system for the timely and appropriate provision of information services as required by the owner's effective performance.

The CATWOE for this definition is:

C: user

A: professional providers

T: 'better' informed user

W: that the user's performance depends  
on being provided with timely and  
appropriate information services

O: user

E: the university, its budgetary  
constraints, the external providers  
of information services...

In this case the emphasis is in the user himself and in the relationship "user-LIS" and not in whether this service is well phased with the university's purposes, i.e. with the wider organisational context.

### 6.5 The Cybernetic Loop in Problem Solving

By studying the cybernetics of a situation a number of shortcomings in communication and control mechanisms may be detected, which under closer scrutiny may be recognised as

factors inhibiting an organisation's capacity to discover errors and produce solutions. Indeed, unwittingly, these factors might have been responsible for creating the sense of unease that triggered the need for an intervention.

### **6.5.1 Activity 3: Studying the Cybernetics of Problem Situations**

The less adequate is the overall structure of an organisation the more likely is that its member will perceive problems beyond their own problem solving capabilities. Thus, improving the organisation structure is a way of dissolving a number of the perceived problems in a given situation.

In Chapter 4, while discussing problems of implementation, we discussed identity problems, that is, problems triggered by hazy relationships, where the participants are unclear about the purposes of their interactions. These are the 'hidden' aspects hindering stability. Indeed, these are the 'soft problems' natural to human activities. It was argued at that point that the best option to deal with identity problems was to create such structural conditions as to permit the participants in the situation to discover by themselves the relevant systems (i.e. purposes) and to produce the required solutions. No amount of creativity or insight by the analysts will be good enough if the context of the problem situation is not supportive of effective communications. Hence the relevance of naming organisational



systems as a platform to improve the background for problem solving. Studying the communication channels and regulatory mechanism in use should permit to establish possible situational improvements, improvements aimed at creating conditions for better debates and problem solving. This study is the study of the cybernetics of the situation.

Studying the cybernetics of the situation is studying the actual mechanisms supporting the communications between the participants in the situation.

More specifically, studying the cybernetics of the situation means studying the interactions among and between the participants from the viewpoint of the capacity of the communications channels and the control mechanisms in use. Hence, this activity is not concerned with the specific content of the interactions, but with the channel capacity of the mechanisms underlying them.

Establishing whether a communication channel has enough capacity, or whether a control mechanism is adequate in a human activity is made particularly difficult by its multisystemic nature. As different purposes are ascribed to an organisational unit, different communication and control mechanisms will appear to be appropriate.

Studying the cybernetics of a situation does not necessary imply studying the full organisation, more often it implies studying a particular mechanism or set of mechanisms which

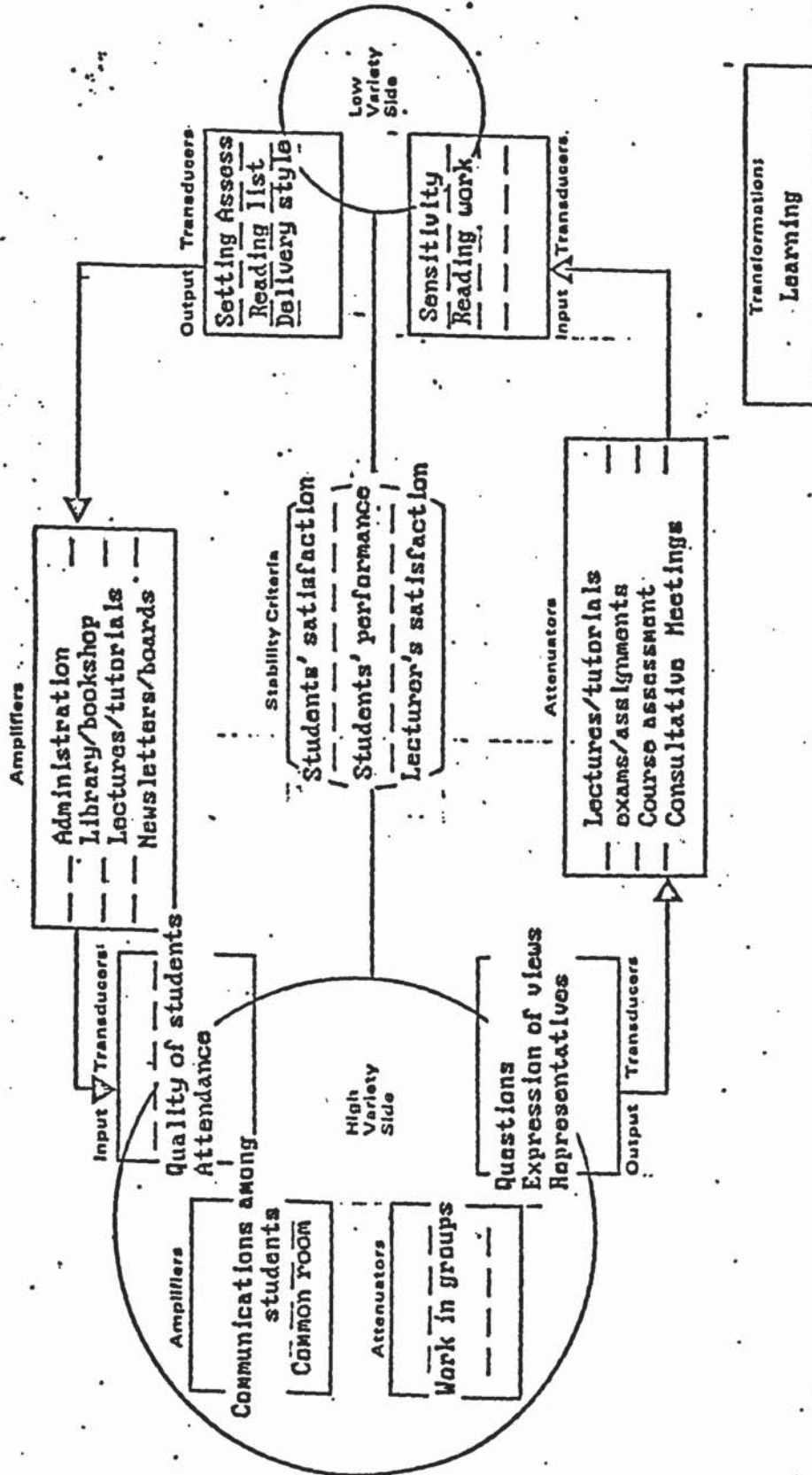
appear as relevant to understand the communications among the main actors. Thus, **organisational names** may be focused in specific organisational transformations (e.g. a company's sales function) and not necessarily in the overall organisation.

### **Modelling communication mechanisms**

For this modelling the general template is the stability mechanism as discussed in chapter 4 (figure 4-5), which describes the communication channels and transducers between a low variety participant and a high variety participant. It is illustrated again in figure 6-2; the analyst purpose may be either diagnostic, that is, to study the amplifiers and attenuators actually producing the de facto balance between the two parts in interaction, or designing, that is, the definition of amplifiers and attenuators to achieve balance in the interaction at the lowest possible cost.

It is noteworthy that in this modelling, equally as important as modelling the interactions between the participants, is the modelling of the attenuators and amplifiers of complexity within the high variety side. This is particularly interesting when the interactions between the low and high variety sides do not depend on external attenuators and amplifiers. The stability criteria in this model is defined with reference to the monitored variables as implied by the named organisational transformation.

Figure 6-2: Example of Stability Mechanism



#### **6.5.2 Activity 4: Creating the Conditions for Effective Problem Solving**

The aim of studying the cybernetics of a situation is to create the conditions for effective interactions between the participants, thus increasing their own capacity to discover problems and produce solutions. To make this aim possible it is necessary to compare, in the "real world" the actual mechanisms as described above with some kind of criteria of effectiveness. Mismatches between actuality and the criteria of effectiveness should permit to establish, and most importantly implement, possible structural improvements to the situation.

Basically, as said above, there are two modes for such comparisons; firstly, there is the **diagnostic mode** which is used when the named transformation is actually happening in the real world; secondly, there is the **design mode** when the transformation is not happening, but there is the intention to make it happen.

##### **Diagnostic Mode**

In the diagnostic mode the comparison is between the actual capacity of the operating mechanisms (i.e. communication

channels, transducers..) and the capacity required in these mechanisms by the nature of the real-world interactions, as perceived by the appropriate viewpoints.

This comparison permits to define possible improvements. For instance if the formal communication channels between two departments in a company are reduced to the channel capacity of one individual (who incidentally has other responsibilities) while, on the other hand, the actual operational (real world) interactions between these departments are of high variety, (as perceived, say, by the main roles of each department, that is, they perceive a complexity that requires much more than the channel capacity provided by a single individual), then there is room for improving the cybernetics of the situation by providing a larger communication channel between them (see chapter 8).

This mode demands a distinction between the **espoused theory** and the **theory in use** about these mechanisms. For instance, the espoused view may be that the communication channel between two departments is provided by the interactions of their bosses, while the theory in use may show that there is an extensive use of lateral interactions between the people operating within both departments, by-passing their bosses. If the intention is to stick to the espoused theory then it is necessary to design a mechanism that gives requisite variety to the bosses' interactions. If that proves to be impossible or too costly then, it will be necessary to

adjust the espoused theory. In general it makes sense to close the gap between espoused theories and theories in use.

### **Design Mode**

In the design mode the capacity of communication channels is designed by the problem solver based on expert advice.

Experts are the ones who can measure best the transformation's complexity. In all instances the problem is to design communication channels that are consistent with the complexity of the interactions as implied by the on going processes making possible the transformation.

It is necessary to design amplifiers and attenuators likely to produce an adequate performance at the lowest cost.

Designing mechanisms suggest the need to know how "to measure" the complexities involved. The answer to this point, as implied by the above examples, is to choose the appropriate viewpoints. The arguments for this were given while discussing the meaning of complexity in human activities: what is important, it was argued, is the discriminations of outcomes that relevant viewpoints can make in particular relational situations. Complexity, it was said, is a contingent property of the interaction between a viewpoint and the situation of its interest i.e. multiple other viewpoints. It does not make sense to talk about absolute values, but rather whether the viewpoint's capacity to distinguish situational complexity is perceived

as adequate by the related viewpoints. The only concern is to have the appropriate viewpoint for a particular purpose. We have abundant examples of people in isolation of the complex web of social relationships, perceiving, albeit in particular dimensions, more complexity in a situation than those responsible for the response variety. In this sense the complexity of a situation is not defined arbitrarily by any viewpoint, but precisely by the viewpoint giving closure to the situation, i.e. the viewpoint producing the responses to maintain the situation within the viewpoint's perceived area of stability.

A detailed application of the communication mechanism of the previous section, to the management of complexity in a 'viable system' will be studied in Chapter 7. The outcome of this application will be further, and much more powerful, criteria of effectiveness to improve the cybernetics of the situation. Indeed, Beer's model of the organisation structure of any viable system is a concrete application of the Law of Requisite Variety to communication and control processes in an organisation.

Improvements in the cybernetics of the situation may be achieved by comparing the organisation structure of a company, as perceived by an analyst, with the criteria of effectiveness as implied by Beer's model of the organisation structure of a viable system (see chapters 7 and 8).

Methodologically, the implementation of cybernetically sound communication mechanisms implies creating the conditions for effective problem solving; they remove the systemic constraints affecting the participants' chances to develop a rich appreciation of the problem situation. By improving the cybernetics of the organisation it is possible to create problem solving capabilities in the organisation itself, precisely where most matters to have capacity for problem solving. In general, there are no better people to solve problems than the problem owners themselves!

The extent to which it is feasible to "dissolve the (apparent) problem" depends on a range of factors, but mainly it depends on the politics of the situation. Indeed, dissolving the problem implies solving the underlying cybernetic problem. These are systemically desirable changes but not necessarily culturally feasible.

Hence, while improving a problem situation starting from an organisational name may be desirable, it may not be always feasible, either because it is not realistic to expect structural improvements, or simply because the overwhelming concern is with a non-structural issue. However, this priority does not change the fact that no amount of hard work is likely to put a situation right if its underlying cybernetics is inadequate.



## 6.6 The Learning Loop in Problem Solving

This loop is concerned with the content of people's interactions. The investigator's job is to support the debates between the participants, facilitating the discovery, and production, of necessary changes to maintain, or bring back, stable interactions between them.

At the centre of problem solving is the need to improve the appreciations that viewpoints have about the views of other viewpoints and about the situation as a whole. In fact the purpose of developing an effective network of communication is none other than to make more effective these appreciative processes. If viewpoints are going to control their social reality (i.e. create it), they need to develop both understanding and foresight of the transformations of interest to them.

Names and/or root definitions, as explained earlier, are used to focus further inquiries. They are used to elaborate models aimed at increasing the viewpoints understanding of the problem situation. These models can be used in a diagnostic or design mode. In all cases the idea is that they will be used by the participants to develop new insights about the situation. The simple point is that though the complexity of human activities suggests that viewpoints should be very selective about the transformations they manage, that restriction should not deter them from inquiring the meanings of a whole range of

other possible transformations, including those managed by other viewpoints. Stability in their interactions will be influenced by this wide spread understanding. A key aspect of the process of problem solving is precisely to support these appreciative processes. However, better appreciations are only a means to cope with problems in human activities; "solving" them implies both discovering desirable and feasible change, and most importantly, implementing this change. It is through the implementation of change that people learn how to cope with problem situations, and also, learn about new problems. This is the meaning of the learning loop in problem solving (figure 6-1).

In the discussion that follows after a short discussion about producing relevant models, the attention will be focused in managing the process of problem solving, in particular, in the "discovery of feasible change" and the "implementation of change" in human activities. I will argue that while the discovery of feasible change is an stability problem, the implementation of change is a control problem.

#### **6.6.1 Activity 5: Producing models relevant to named systems**

Chapter 5 offered a discussion about models, in particular it made the distinction between representational and interpretative models. The former models are intended to be either logical deductions or to represent in abstract terms real world processes. These models are in the world of

abstract thinking, that is, in the world of the analyst, and as such they can be used as aids to explore the implications of different transformations with no immediate concern with reality. Representational models, because their capacity to simulate reality, offer a powerful means to deal with the complexity of the real world.

One of the purposes of producing models based on the named systems is to make more clear the logical implications of different views. Hence by producing conceptual models the analyst is defining the activities that, in his view, are logically necessary to produce a transformation. If the named system is a root definition, then the conceptual model is used to generate, support debates about relevant improvements. If the named system relates to the management of complexity, that is, relates to an organisational system then, the conceptual model may be compared with a descriptive model; the discrepancies between reality and logic are used to generate, support debates about possible improvements.

Another purpose of producing models is to explore alternative solutions, under given assumptions. For instance, the analyst may wish to work out the resources implications of particular targets or goals, or to explore the implications, for a viewpoint, of particular courses of action, based on the assumed preferences of the other viewpoints, or to simulate the likely outcomes in a particular situation under different assumptions about

resources allocations... In these cases, models based on linear programming, games theory, simulation, systems dynamics, would be, among others, possible aids to explore the situation with reference to particular names. In all these cases models are only flat representations of the fully fledged reality of the viewpoints. These models are possible "maps of the territory" and as such may be used by individual viewpoints.

All these models have in common that viewpoints (analysts or individual clients) use them in the analysis of their interactions but not in the interactions themselves. They are aimed at informing the debates about possibilities.

#### **6.6.2 Activity 6: Managing the Process of Problem Solving**

**The discovery of desirable change: debates about appreciations**

Problem solving is the process of discovering desirable and feasible changes. However, 'discovering' should not be the discovery of the 'minimum common denominator' among the viewpoints, or the discovery of those changes where they hold similar views, or share preferences and values. People often thrive, and develop the best of themselves in variety.

Problem solving is not an attempt to bring all the viewpoints to a common, shared view of reality -far from it- it ought to be an attempt to make sense and take advantage of diversity. By increasing the chances that the participants will develop different views -something that is more likely to happen if the cybernetics of the situation is good- viewpoints may discover synergistic changes that would make no sense in a 'one viewpoint' situation. Indeed, the scope for growth and improvement is not in unanimity but in diversity.

Hence, while a good cybernetics may dissolve some problems, it also creates the need for more problem solving, it shifts the grounds from problem solving to prevent threats to problem solving to exploit opportunities; if anything it increases the scope for learning.

Coping with diversity is helped by abstract thinking but, naturally, the process of problem solving is much more than the abstract thinking suggested by producing names and models. Analysts should create the conditions for situational learning by acting as catalysts of debates and organisational conversations. For this they need to move, back and fro, from the relative low complexity of abstract analysis to the high complexity of situational interactions. The intervention is more likely to succeed if the analysts manage to produce debates where the participants confront their rich pictures of the situation to the conceptual models produced by them.

These debates are likely to highlight the stability problems between participants. One of their purposes is to increase the participants appreciation about their beliefs, concerns, values, preferences, with the expectation that they will facilitate the discovery of desirable changes. These changes may altogether imply new transformations, or simply adjustments to existing transformations. However, the outcomes of these debates always relate to 'real world' transformations, that is, to further interactions between the viewpoints.

To close the learning loop it is necessary to implement these changes.

In any organisation, there is an on going, tacit, problem solving process which is constantly naming (creating) transformations, defining target sets and producing responses. This process is the outcome of on going conversational processes of one kind or another. The point of all the above discussion is that there is no need to leave the outcomes of these conversations to chance, the management of the problem solving process is the conscious management by each viewpoint of these conversational processes in order to increase the likelihood of effective responses.

Problem solving may benefit out of an effective management of the conversations; such management should reduce the cost of discovering desirable and acceptable changes.

The management of conversations may need to overcome weaknesses in interpersonal interactions, responsible for all kinds of games and deceptions. Problem solving depends on effective **organisational learning**, that is, in the ability to discover those errors hindering the flow of valid organisational information. In Argyris and Schon's terms, problem solving will depend on the organisation's capacity to produce **double-loop learning**, that is, learning based on the questioning of the assumptions underlying the debates (Argyris and Schon 1978). Failure in double loop learning would produce appreciative processes supported on doctored, invalid, or, inaccurate information.

But, even if appreciative processes and the organisation's double loop learning are adequate, success in problem solving depends on the **implementation of change**, (i.e. in closing the learning loop). And implementing change is only possible if the complexity of this change is within the control capabilities of the implementation viewpoint. Indeed, while particular responses to disturbances in a situation may be **culturally feasible**, they may not be **systemically feasible**. This would be the case whenever the control viewpoint lacks the requisite variety to produce the agreed responses. Appreciation is not enough for effective problem solving.

The next section will discuss the problems of implementation, that is, the problems encountered by a viewpoint when striving to produce an agreed change. One of the strengths of the approach developed in this thesis is that it offers a means to model complexity and therefore it offers a means to anticipate the implications of alternative 'solutions'. This capacity suggests that the analyst can contribute to debates both with models aimed at establishing the desirability and feasibility of changes.

#### **6.7 Change in human activities: implementation problems**

The implementation viewpoint is concerned with managing agreed transformations, that is, named systems. Agreed changes may relate to new transformations or to changes in existing transformations. In the former case the problem is to design the production of the transformation, in the latter case the problem is to improve its delivery. In either case the implementation viewpoint will be dealing with a problem situation. In either case implementation means producing and maintaining the outcomes of these transformations within the limits of acceptability defined by the participants in the problem situation.

The cybernetic methodology is particularly useful to tackle these kind of problems.



### 6.7.1 Cybernetic loop in Problems of Implementation

#### Analysis of Interactions

Naming an implementation system is naming the participants in the implementation situation, that is, naming the owners, actors and customers that actually interact or are supposed to interact in the real world.

If the named transformation is taking place, the viewpoint should be particularly thinking in its interactions with both the people affected by the outputs of the transformations - the customers in these processes - and the people producing these transformations -the actors.

Perhaps the point to realise is that these interactions can take place in a more or less effective fashion, suggesting the possibility for diagnosis and design.

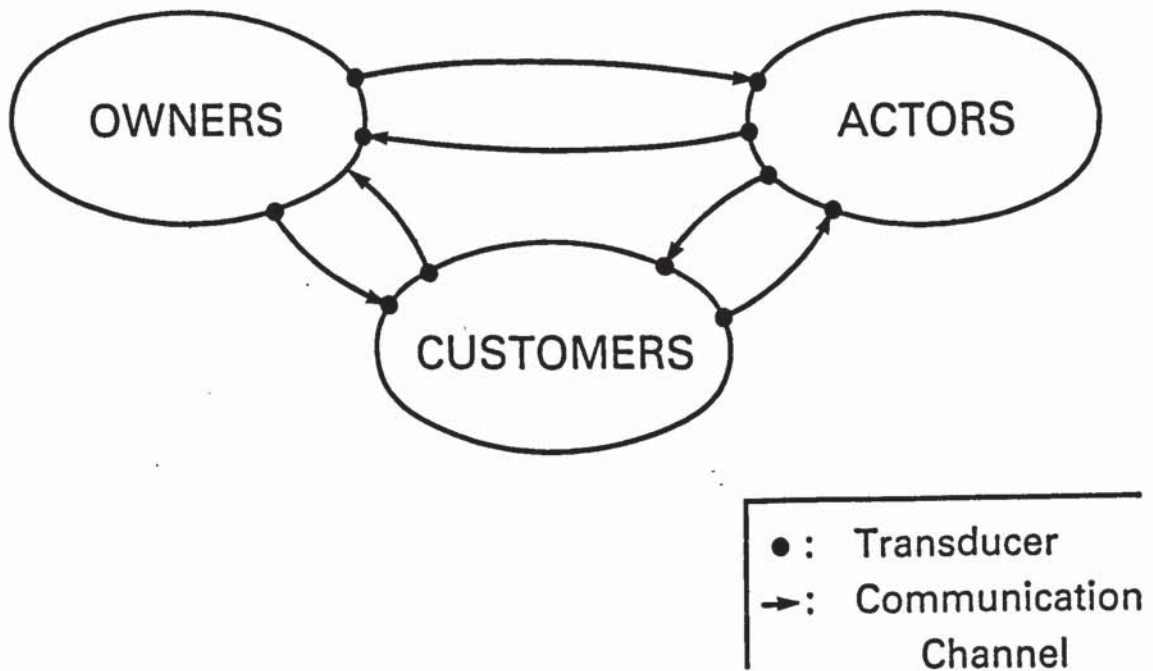
Since different participants see the same "transformation" with different eyes, concern for an effective implementation suggests the need to understand how adequate are their communication channels (Figure 6-3). It is natural for them not only to see the "same" situation differently, but also, as will be explained below, to perceive different target sets for the same transformations.

Hence, once a 'real world' transformation has been named, it makes sense to model the interactions of the viewpoints from

Figure 6-3: Communications among Participants

## ABOUT INTERACTIONS

'Channel' and 'Transduction' capacity in these interactions may produce very different outcomes to the problem situation.



the point of view of requisite variety (Figure 6-2). This modelling should permit to anticipate problems with the intended implementation.

The implementation viewpoint needs to have good models of both the transformations performed by actors and the expectations of customers (this is implied by the theorem "Every good regulator of a system must be a model of the system"). To develop good models the viewpoint needs effective communications with all the participants.

However, naturally, there can be difficulties in the interactions between participants. The channel and transduction capacity in these interactions may produce very different outcomes to the problem situation. Problems may stem from misunderstandings, interpersonal games, difficulties in transmitting the meaning of actions or decisions, or altogether from poor communications among the participants. That is, problems may stem from inadequate communications.

As we know, inadequate communications in human activities is the norm rather than the exception. While the problem owners may be talking with confidence about a "successful" transformation, the actors may be aware of problems that they do not dare to talk about, and customers may not express their awareness about the possible, negative, effects that the transformation today may have tomorrow.

Implementation systems entail participants that may not agree in the criteria of performance (i.e. the target set), or actors that may not be able to produce the necessary responses to achieve acceptable results, or problem owners that may not be able to recognise enough environmental changes. That is, if a problem is construed as a real world transformation, the implementation viewpoint, most likely, will be dealing with performance, response and environmental problems of one kind or another (see Chapter 4). To create effective conditions for implementation it is necessary to deal with these problems. The related discussions and decisions close the cybernetic loop in problem implementation.

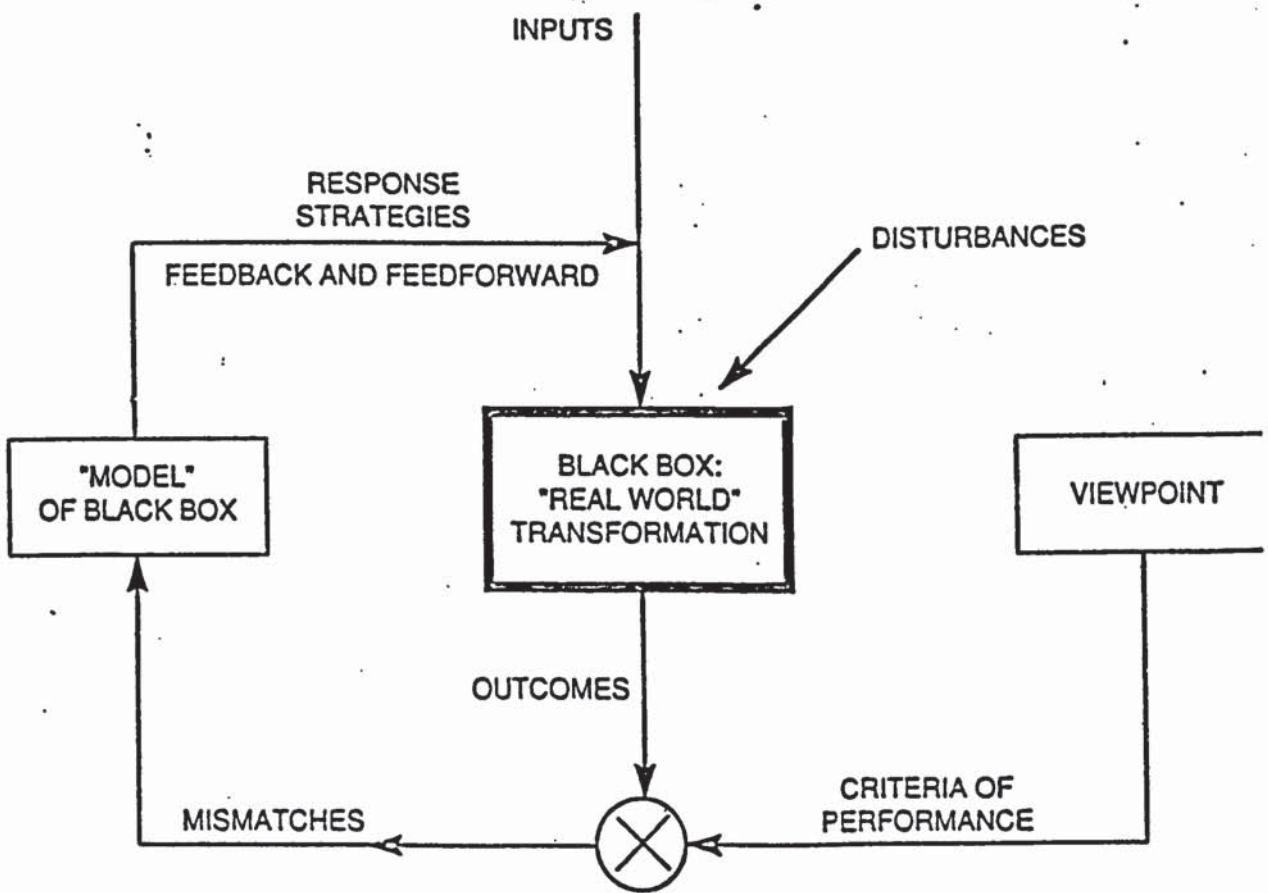
#### **6.7.2 The Learning Loop in Implementation Problems**

The study of implementation problems is focused in the management of complexity. The black box metaphor helps to understand this management. Figure 6-4 shows a variation of the by now familiar management loop of chapter 4; this is the learning loop in which the 'implementation' viewpoint is inserted. From its perspective, keeping the problem solved means controlling the black box; however, it will be argued, this control is far from being the unilateral control that often is linked to the cybernetic ideas of feedback and feedforward.

Based on the elements of figure 6-4 the rest of this section will discuss, first, the meaning of the black box, second,

Figure 6-4: The Learning Loop

VIEWPOINT GEARED TO THE TRANSFORMATION



 : Comparatc

the meaning of criteria of performance and, finally, the production of responses to produce the transformation.

### **The black box as a systems paradigm**

The black box in human activities is a multisystem, that is, a set of viewpoints in interaction. Naturally the complexity of the multisystem is much larger than that of any individual viewpoint; this is precisely why we need the black box to stand for the complexity of a human activity. However, it is important to understand the implications of this construct.

The key concern in human activities is intersubjectivity and not one-sided views which are insulated from other relevant viewpoints. If particular transformations are going to take place in the world, the entailed viewpoints must start, at one "point" or another, interpersonal interactions. If this were not the case then, either the transformations are not taking place or the identification of viewpoints was incorrect. Either case would be contradicting our assumptions. Each viewpoint needs to have direct mechanisms to influence the named transformations. The point at which the 'implementation viewpoint' gets involved in communications is the point at which the management of complexity becomes meaningful to that viewpoint. By definition the viewpoint is now dealing with a black box. Only if the viewpoint could penetrate in full the complexity

of the "other viewpoints" in its interactions, would this not be the case.

These black boxes are in a permanent flux. As interactions make progress the implementation viewpoint will see the need for renaming the systems of interest. This renaming may be the outcome of changes in the participants' appreciations about what is relevant, or simply may be the outcome of their recognition that they cannot match the complexity emerging from the named transformations. This is part of the learning process in dealing with the situation.

Yet, because the complexity entailed by the multiple viewpoints in the black box is beyond the access of the implementation viewpoint, this viewpoint cannot get into the black box. Any attempt to do so would only achieve redefining the black box of interest, that is, changing the system of concern. Indeed the viewpoint may develop models of the transformation taking place within the black box, but it may not maintain constant interactions with the viewpoints within the black box without redefining the black box.

#### **Criteria of performance: the target set**

For human activities the space of acceptable outcomes for a transformation is the "target set". The target set is not defining what the outcome should be but what the outcome cannot be. In this sense the target set is very different to

a goal. A goal is a selected outcome, it is a discriminatory statement about that that needs to be achieved. On the other hand, a target set, is a 'fluid' space of acceptable, and not necessarily desirable, outcomes for a situation. In different words, the target set has nothing to do with specific results, it has to do with perceptions of stability. The target set is about that that the viewpoint perceives is not possible not to achieve, without creating for itself problems with other viewpoints.

Criteria of performance, thus, depend upon the viewpoint's stability in its interpersonal interactions. As argued before, people in human activities are more concerned with the maintenance of stable relationships than with the achievement of goals. The expectations of a viewpoint, whatever it may claim in the open, are formed by its on-going interactions with other viewpoints. If the outcome of these interactions produces unbalances then the viewpoint is perceiving an implementation problem. The options of the implementation viewpoint are 'altering' the expectations of the other viewpoints about 'this' transformation, or, 'finding' alternative ways of performing it, or, 'triggering again' debates to define a new transformation altogether.

Perceptions of "acceptable outcomes" will change in time as the viewpoint interacts with the other participants, and also, with other people in the environment. This will be the case not only because its own appreciations may change, but also because the other viewpoints are bound to change their



own views about "acceptable outcomes" as they adjust themselves to their own situations.

By definition viewpoints cannot define target sets unilaterally, to do so would mean to deny the very essence of human activities, that is, their multisystemic nature. Any attempt to produce a unilateral definition of a "target set" is an attempt to impose one particular view to other viewpoints; this is a trivial extreme which transforms a soft problem into a hard one. In some cases, when (partially) successful it may well imply a dangerous intrusion in the autonomy of other viewpoints.

Even in cases where the multisystem agree to pursue a particular well defined outcome (as in the case of a goal oriented programme), the appreciations about the target set will change in time, creating the need for all kinds of negotiations and therefore creating the possibility for new problem situations. But, the general situation should be one where there are no 'privileged' outcomes; viewpoints should negotiate, and try to influence situational outcomes as they see fit their own interests. In this case each participant, from its own viewpoint, is negotiating a balance with the implementation viewpoint. The outcome of these interactions is precisely what defines the target set for the transformation (monitored variables) relevant to the implementation viewpoint. It is natural for different viewpoints, in the same situation, to refer to different target sets, as each viewpoint is likely to be aware of

different aspects of the transformation. A lack of appreciation of the other viewpoints is enough to trigger unbalances.

Hence, in general, criteria of performance are defined by the positions of stability in the interactions among viewpoints and not by the achievement of a particular result. Targets, or objectives, in their traditional meaning, may be of use to focus the attention of several viewpoints, but it is always the case that such targets will be superseded by the viewpoints' perceptions of stability. Any explicit or formal definition of a target or objective, to remain useful, should evolve gradually in parallel with the problem owner's position of stability. It is interesting to note that, in general, the problematic aspects of ongoing processes are triggered by changes in expectations and not by the failure to achieve particular outcomes or results. In this sense, in line with the work by Argyris and Schon (1978), we can talk of an "espoused" target set, and of a "theory in use" target set. The former is the one left open for inspection and for measurement, the latter is the one that takes into account the multiple dimensions of stability implicit in any multisystem.

#### **Managing the process of Problem Solving: Regulatory responses**

A viewpoint can only develop a model of the black box. If there is a coupling of the viewpoint to the situation, in

the way described above, such a model will be in constant modification;

the viewpoint is learning about the black box while at the same time the black box (as defined by the on going interactions of people) is adjusting itself to both the disturbances in the environment and the action strategies of the implementation viewpoint.

To control a black box the 'implementation' viewpoint uses, in one form or another, models of the box's transformation; these models are part of its management loop. The relevant models are precisely the models that its uses to understand the black box of its concern. This is one of the challenges for systems analysts; if they are going to aid the problem solving process they must succeed in producing or facilitating the production of models that are relevant to the implementation issue.

In complex human activities the models 'used' by one viewpoint to regulate transformations are often the models held by a number of other people who happen to be supporting its regulatory activities. In a way, it can be said that in these cases, models relevant to a situation are distributed among a number of people, and that the aggregated model, used to regulate the transformation, is an outcome of the communication channels between these people. Thus, it is possible to alter these (aggregated) models by changing the communication channels between the people supporting the

viewpoint. Of course this would mean to change the viewpoint's capacity for problem solving as well.

The simple model of feedback and feedforward (figure 6-4) needs to take into account the problems of requisite variety: the requisite models to regulate human activities cannot be computer bound, representational, models alone; by necessity they must be interpretative, history based, models, held in the minds of people. They are distributed. It makes sense, therefore, to understand the organisation and the relationships that are more likely to permit an effective use of these distributed models. For a manager, the problem is to work out the necessary links between a number of people or structural parts to make possible an effective response to the challenges or demands of the situation. However, this assumes that the viewpoint has a model of the organisational system. This model is part of the viewpoint's delivered solution, or response strategy. This model is essential to maintaining the outcomes of a transformation within acceptable levels. In this way the models held by other viewpoints are inserted in the reality of the viewpoint and as such these are models for action; they are intended to support the implementation of change.

The discussions in chapter 7 will provide an instance for the above proposition; if the situation of concern is the adaptation of a company to its environment, and the viewpoint is the company's chairman, the discussion of the Viable System Model will make apparent that an effective

response capacity depends on the chairman's capacity to manage the interactions between those contributing with models of the company's internal affairs and those contributing with models of the company's environment. It is the management of the interaction between these two camps that produces different appreciations about the company's situation.

Indeed, as it will be explained in the next chapter, however good are the models held by each camp independently, if they do not interact as suggested by the cybernetics of the situation, then the overall model used by policy makers is bound to be inadequate.

For any other transformation happening in the real world, the same principle applies. Human activities are of such complexity as to require a flexible and complex model, one which cannot be structured in an algorithmic form; the models of concern are those tacitly held in the minds of people. In this case, the problem solving task is the effort of managing the interactions of these people, and not the production of an elaborated and complex analytical model.

Although it is only for very well structured problems that abstract mathematical models will define the feedback/feedforward adjuster, such models can be very useful in supporting the contributions of individuals to the problem solving efforts. For the problem owners, these models can be either attenuators of world complexity or

amplifiers of their managerial capacity. While explanatory models (like the VSM) reduce the the complexity of the situation, predictive and prescriptive models may permit the production of responses to disturbances quicker than would be the case without the support of these models. In fact, today, this is the relevance of the so call **decision support systems** (Keen et al 1978).

### **6.8 Conclusion**

The cybernetic methodology helps in tackling problems that emerge both from instabilities in the ongoing interactions of people and from the need to implement change.

The process of problem solving is an ongoing task that takes place at multiple levels; finding responses at one level creates problems at another, and finding responses at this new level may create problems at the former and the next one... and, the same methodology applies in iterations and recursively; at all levels there is the need to find out about the problem situation, to structure it, to improve its cybernetics, to model it, to discover feasible responses, and to produce them (figure 6-1).

Whether problems are tackled successfully or not will depends on whether or not the implemented responses produce (for the affected viewpoints) acceptable outcomes (i.e. stability). In contrast to hard problems where the purpose is to achieve measurable results in the 'real world' (i.e.

the goals), the purpose of soft problems is to maintain the stability of those interactions producing transformations in the real world. The focus is not in the achievement of "specific" outside targets, but in maintaining "moving" targets within acceptable (but always variable) limits. Hence, while for hard problems it is usually possible to establish whether the problem has been solved or not, for soft problems this is seldom the case.

The methodology does not produce solutions; there is nothing that the analyst can accept as the solution to the problem. As soon as something is found to improve the situation, new factors (disturbances) emerge, once again introducing unbalances in the relevant relationships. There is no one solution for a problem situation, but rather an ongoing process of problem solving.

However, dismissing the possibility of solving human activity problems with one/off responses, is not the same as dismissing the possibility of simple, elegant, and also effective responses to a situation. Indeed, the variety of disturbances that a single response can cope with may be large or small. In the one extreme, a single response might be enough to deal with a wide range of disturbances, in the other, a different response might be necessary for each disturbance. The former is the case where the problem owner has found an effective means to amplify its problem solving capacity, the latter is the case where the problem owner needs to respond to each individual situation. Indeed, in

order to satisfy an inquiring child, you may either teach him how to use a dictionary or you may offer a meaning, yourself, to each new word he asks for.

Discovering high variety responses may permit to dissolve problems. In human activities, it is not uncommon that the conditions that led to the sense of unease in the first place may be removed by one structural change (Espejo and Howard 1982); this is the case where one structural response may be enough to cope with a range of eventualities. Such a response is the strength and significance of the cybernetic loop in this methodology. At this level the analyst is not dealing with the content of the situation but with the underlying structure that is presumed to be hindering the discovery of solutions by the affected people themselves.

However, while structural changes may dissolve some problems, they also creates new opportunities, and therefore the situation will remain problematic for as long as the participants feel the need to maintain stable interactions. Whether these unbalances emerge as a result of changes in their own expectations, changes in the expectations of other relevant viewpoints, or changes in the environment is irrelevant, for as long as they perceive variables of interest out of 'acceptable' limits, the situation will remain problematic. This latter situation is dealt with by the learning loop in problem solving.



The methodology is completely general, it may be used in all cases where there are people in interaction. However, it is particularly useful when it is used in the context of an organisation striving for its viability. As it will become apparent in the second part of this thesis, the study of the cybernetics of a situation, when the situation is an organisation, lends itself to the application of powerful criteria of effectiveness. The model of a mechanism with a low variety side interacting with a high variety side, is superseded by the model of the organisation structure of any viable system (i.e. Beer's model). This model will be offered as an aid towards designing effective problem solving environments.

It is in these environments that 'individual and organisational learning' are more likely to take place. Problem solving should be seen not only as the task of external consultants or outside analysts, but, most importantly as the task of all those involved in the on going processes of an organisation. Indeed, the problem solving methodology discussed so far, does apply not only as a tool for 'intervention', but most importantly, it applies as a distributed approach, in which all the organisational participants act as problem solvers. In other words, the methodology is not only for the expert analyst, it is for all the participants in a situation. The abstract activities of the methodology, like problem structuring and modelling, are not exclusively expert activities, they are inherent, in one form or another, to all human activities, and, indeed it

does help to be aware of this fact; it opens the gate for design, and thus, for the conscious creation of reality by all of us.

**A CYBERNETIC METHODOLOGY TO STUDY AND DESIGN HUMAN ACTIVITIES**

**PART II**

**DIAGNOSIS AND DESIGN OF ORGANISATION STRUCTURES**

## Part II: The Cybernetics of Organisations

### Summary

The second part of this thesis is focused in organisations. The human activities of our interest, in this part, are networks of people striving for some kind of cohesion, though not necessarily for the same goals. People ascribe different purposes to organisations and belong to them for different reasons. Yet, for as long as they accept their membership, they share an interest in maintaining stable relationships within it. Naturally, in this endeavour people are constantly negotiating their images of the world, as well as trying to produce agreements about acceptable organisational transformations. These negotiations, as all other soft problems, are inserted in particular cybernetic and learning loops, and as such their effectiveness will depend on the criteria discussed in Part I. However, and this is the contribution of this part, when the situations of interest are organisations, there is much more that can be said about both loops.

Part II offers both a conceptual model of the organisation structure of any viable system and a method to use it.

The Viable System Model (VSM) is a powerful tool to study organisations; it permits to see them as cohesive wholes and to establish how adequate are the strategies they use to cope with the complexity of their tasks.

Though the VSM is primarily a tool to diagnose the effectiveness of an organisation's structure, it also offers other possibilities. From an informational point of view the VSM offers a conceptual model for the structure of an organisation's Management Information System. From the viewpoint of policy analysis, it is a tool to assess the organisational implications of alternative policies. Where the concern is the contribution of several institutions and/or institutional parts to one enterprise, like in the case of large scale projects, the VSM offers the possibility to study and design flexible structures and, as a consequence, reduce the chances of costly errors.

Naming organisational systems is not only restricted to the naming of formal institutions, like firms, companies, government agencies, services, but also to the naming of any multisystem aiming to achieve some form of autonomous cohesion. This is the case of some of the divisions, sections within a company, or, the case of some ad hoc multi-institutional projects or programmes. Viable systems are not necessarily related to recognised institutional boundaries. Hence, the arguments of these chapters are not limited to the study of formal organisations.

The versatility of this model is due to its abstract nature. The model is relevant to any viable system, whether biological or social, artificial or natural. Yet its use is not straight forward.

An important methodological problem encountered by analysts wanting to use the VSM derives from their difficulties in seeing that there are many equally valid "viable system models" for any organisation. They fail to appreciate that any organisation can be described, at any moment in time, in multiple forms. The analyst is trapped in a positivistic point of view. As we know organisations are not single systems but multisystems, that is, are the outcome of the negotiations of multiple viewpoints, therefore, any attempt to approach their study from a single viewpoint is bound to fail; it assumes an objectivity that violates the diversity perceived by the participants.

The model produces different criteria of effectiveness depending on the purposes ascribed to the organisation by the viewpoints. These criteria, once it is compared to the 'real world' organisation, as perceived by the investigator, permit to detect improvements to the situation. As such the model offers a powerful approach to support organisational debates. Chapters 7 and 9 present, respectively, the model and a method to use it. Chapters 8 and 10 provide related applications. As a whole, these chapters relate only to problem structuring and modelling, that is to the right hand side activities of the methodology, however, their significance in the real world requires to insert them in the context of the whole methodology.

## 7. The Viable Systems Model

### 7.1 Introduction

Chapters 3 and 4 established that communication processes were responsible for the creation of human activities (i.e. multisystems). Moreover -it was said- modifications in control and communication mechanisms were bound to create different social realities simply because such changes affected individuals' appreciations. Since the context of human activities is given by organisations of one kind or another, it should be beneficial to have criteria to study and design them in ways that both facilitate communications and make control less oppressive.

The purpose of this chapter is to discuss, from the viewpoint of cybernetics, how is that effective organisations work. This understanding should provide criteria to improve the all too natural shortcomings of 'real world' organisations.

Criteria of effectiveness for the design of an organisation's structure, that is, criteria for the design of its communication and control mechanisms, emerge from the desire to maximise individuals' autonomy in the context of a cohesive organisation.

Such criteria have been developed by Stafford Beer's in his model of the organisation structure of viable systems (Beer

1979, 1981, 1985). Beer has offered a most comprehensive set of principles and laws of organisation; as a whole they permit to study and design the mechanisms necessary for effective control and communications in organisations.

These mechanisms go deeper into the management of complexity, and offer more insights about it, than the communication and control mechanisms discussed in Chapter 4. As in the case of those early mechanisms, their effectiveness will be studied with reference to the law of requisite variety.

In Section 4.4.4 I suggested that Beer had made a most impressive use of requisite variety in studying these control problems, and in particular, that this contribution was apparent in his model of the organisation structure of viable systems. However, I also made the point that in my opinion he had not always spelt out in detail the control mechanisms invoked. Hence this chapter while offering a summary of Beer's model, also aims at furthering its understanding.

## **7.2 Definitions**

**Viable systems** are those systems able to maintain a separate existence. Such systems have their own problem solving capacity. If they are going to survive they need not only a capacity to respond to familiar disturbances, but also capacity to respond to unexpected, previously unknown



disturbances. This latter capacity is the hallmark of viable systems, it gives them the capacity to adapt to changing environments. Naturally, this capacity does not make such systems immortal. Not only this capacity has to be maintained in time, but also a catastrophic event may at any instance fracture the coherence of the system. However the fact of viability lessens the vulnerability of systems to chance -indeed, it makes them more adaptive to change.

For human activity systems the organisation of a viable system is defined as the set of interpersonal relations which make of the system a whole, independent of the particular individuals involved in these relations who can be any as long as they satisfy these relations (Maturana et al 1981). The emphasis of this definition is on the relations and not on the parts. For example the organisation of a university is defined by, among others, the nature of the relations between students and academic staff and not by the actual students and staff involved in relationships at any particular time.

However, the particular social forms taken by these relations at a particular time, and in a particular context, define the structure of the organisation. In the above example the concrete teaching departments, committees, groups (formal or informal), services... in existence at a particular time define the structure of the university.

**Mechanism** is defined as any stable form of **communication** or interrelation between parts in an organisation that permit them (the parts) to work together as a whole. With this definition it is possible to redefine the **structure** of an organisation as the **set** of specific mechanisms defining the interactions between the parts of that organisation.

Most importantly, for a viewpoint the **structure** of an organisation is defined by the **actual** parts and **actual** communication channels it perceives in existence and not by the parts and lines of authority formally defined by, for instance, an organisation chart.

### **7.3 Viable Systems and Requisite Variety**

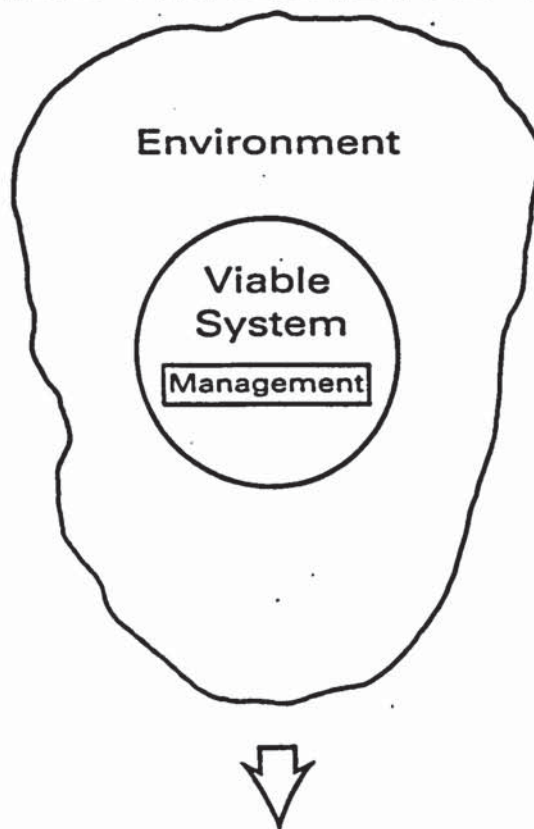
Figure 7-1 describes a viable system within its environment and management within the viable system.

A viable system is embedded in an environment which is indeed complex. The complexity of this environment is beyond the reach of the viewpoints within the system; they cannot "see" all the variables, and their states, as seen by the environmental viewpoints. It is inherent to the situation that the complexity of the environment is much larger than that of the viable system itself.

Similarly, the management of the viable system is accountable for a situation (i.e. the organisation)

Figure 7-1: Viable System within its Environment

## V.S.M. AND REQUISITE VARIETY



inherently beyond its own knowledge capacity. In other words, the variety of management is much lower than the variety of the organisation itself.

We are thus faced with imbalances in the varieties of management, organisation and environment. This leaves us with an apparent paradox; if management controls the organisation and the organisation survives in its environment, then the law of requisite variety implies that their varieties are roughly in balance, at acceptable levels of performance. This latter point is captured by Beer's First Principle of Organisation:

"Managerial, operational and environmental varieties, diffusing through an institutional system tend to equate; they should be designed to do so with minimal damage to people and to cost" (Beer 1979 page 97).

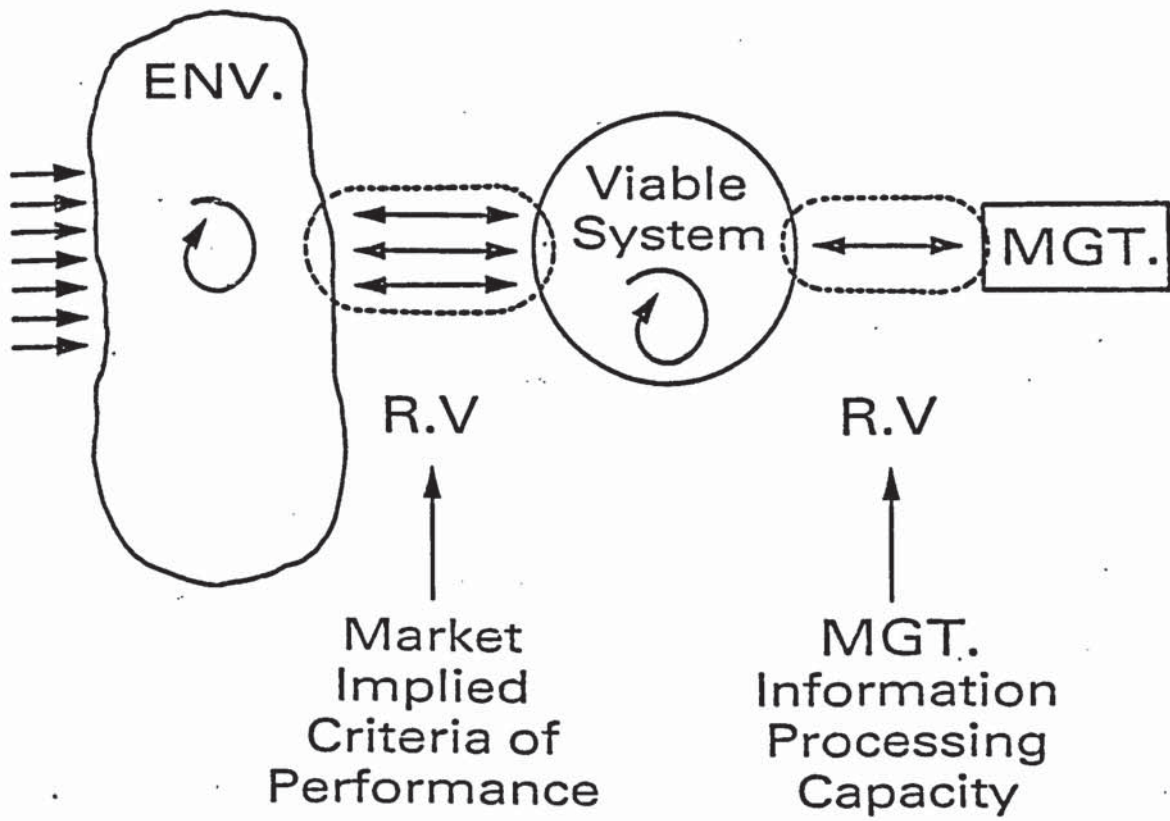
However, as established above, these varieties were recognised to be inherently different. Thus, how can they "tend to equate"? It seems important to clarify this apparent contradiction.

Of all the environmental variety, only part of it will be relevant to the viable system: namely the part producing the disturbances that the viable system has to respond to in order to maintain viability. However, it is not necessary for the viable system to deal with all of this complexity by itself. It is perfectly possible that, to different degrees,

this relevant complexity is absorbed by people or organisations operating in the environment itself. This is the systemic role, for instance, of a network of car dealers vis-a-vis the car manufacturer. Dealers are aspects of the company's environment both attenuating environmental complexity for the company and amplifying the company's complexity vis-a-vis the market. However - and this is the important point- any residual variety, left unattended by these environmental responses needs to be met by the organisation itself; not to do so would imply a lowering in performance and the risk of becoming non viable (Figure 7-2).

The same argument applies to the relationship between managers and the company. To say that management controls the company does not mean that the varieties of both are the same, but that the residual variety that is left unattended by the processes of self organisation and self regulation in the company has to be absorbed, equated, by management. If the information needs implied by the residual variety are beyond the managers' information processing capacity then control will be inadequate or, in the extreme, not exercised at all (Figure 7-2).

Figure 7-2: Residual Variety



The above discussion suggests a slightly different formulation of Beer's First Principle of Organisation:

**The response varieties of a viable system and its management, tend to equate, respectively, the residual varieties of the environment and operations; they should be designed to do so with a minimum damage to people and to cost.**

This statement of the principle implies that the matching of varieties occurs in two phases. Firstly between the organisation and its environment and, secondly, at a much lower level of complexity, between management and the organisation (see figure 7-2). This is in contrast with Beer's formulation which suggests a balance at the same level for the three parts. It would appear that Beer is suggesting that the balances in question are those implied by the complexity that is "seen" in the operations and the environment by the viewpoint management at that level. In my opinion the complexity of the environment can never be meaningfully captured by management alone. Since multiple other viewpoints exist within the operations, they and not management alone, are responsible for the complexity that is seen (i.e. managed) in the environment, at that level of operations.

This view has methodological implications; the above modified first principle of organisation makes apparent that any design of amplifiers and attenuators to match

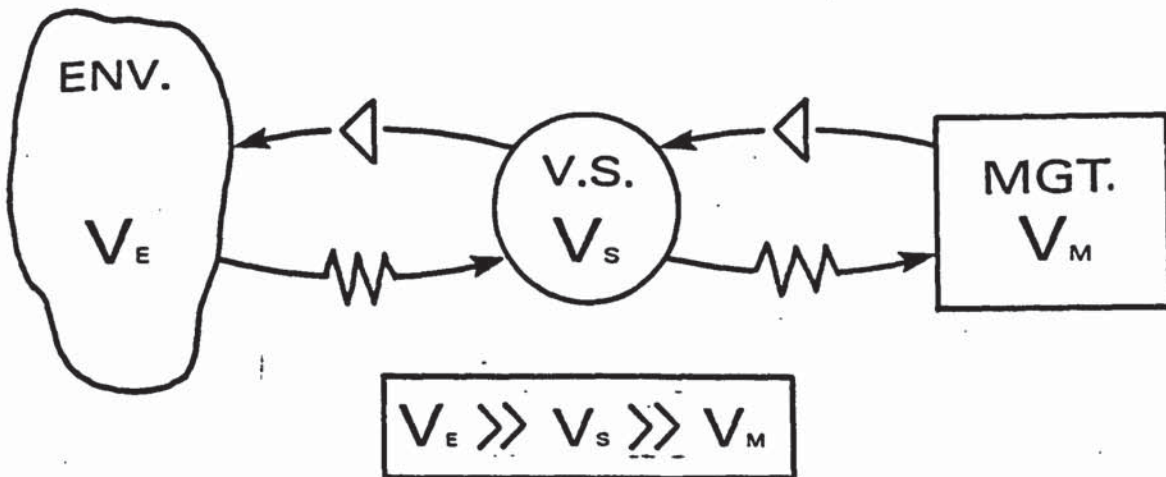
environmental variety should be done with reference to the complexity seen in that environment by the viewpoints within the operations and not alone with reference to the complexity seen by the management of these operations. Thus, if we turn to figure 7-3 it is important to recognise it as a schematic representation of the need for attenuators and amplifiers between the environment, the operations and management. In practice, an in depth study, would have to recognise that most of the attenuators and amplifiers are within the three distinguished domains -environment, operations and management- and only, to a lesser extent, are forging the links between them.

Though no particular reference will be made to Beer's second, third and fourth principles of organisation, (which refer to requisite variety from the perspectives of channel capacity, transduction capacity, and sustainability of regulation), they are accepted unchanged in all the following discussions about regulation.

Finally, in several parts of the discussion residual variety and information will be used as roughly equivalent. However it is important to keep in mind that they are not at all the same thing. Residual variety refers to states of a situation as seen by the appropriate viewpoints, information to representations (e.g. reports) of these states. The residual variety relevant to a viewpoint depends on the purposes it ascribes to the situation, however, the information about the situation is produced by different viewpoints, with



Figure 7-3: Amplification and Attenuation



CODE  $\triangleleft$  : Amplifier  
 $\text{zigzag}$  : Attenuator

different views of the situation, thus, there is always the possibility of mismatches between one and the other. Only if the residual variety of a situation were defined without uncertainty, both this variety and information could, theoretically, be the same. In practice, as the situation inevitably moves away from this ideal the overlap becomes less and less satisfactory and the problem of management is, if it is to avoid the need "to see" every state by itself, to achieve as close an overlap between one and the other as possible.

#### **7.4 Mechanisms for viability**

##### **7.4.1 Adaptation Mechanism**

###### **The problem**

To remain viable an organisation needs to have the capacity to **adapt** to new situations. An effective organisation is not only one that does "things right" but, most importantly, is one that is able to discern the "right things" to do. This capacity for adaptation is normally associated with the strategic levels of management in an organisation.

What can management do if it becomes aware that the organisation is not steering its way in the environment but just reacting to external changes?

How can managers increase the likelihood that their decisions will support the organisation's long term viability?

What is the appropriate contribution of managers to policy processes so to make possible an effective use of their own limited information processing capacity?

How can managers increase the likelihood that people in the organisation will contribute to the best of their abilities to the decisions necessary for an effective organisation?

These are questions of effectiveness that need an answer.

Senior managers are, more or less by definition, confronted with situations that can easily go out of control. For instance, it is not unusual for a board of directors to find out that a new product, in which they have invested large sums, has no market. Equally, it is not uncommon to find boards deciding to invest in the development of new products only to find out much later, after costs have been incurred, that they are technically non feasible, or of boards approving salaries and wages policies that at a later date trigger damaging industrial relations problems.

In such cases, and with the benefit of hindsight, managers often become aware that they not only had been deciding on issues beyond their own expertise, something that is natural in a complex world, but also that in the related debates

they had not used existing organisational resources that had the necessary knowledge to avoid the bad decision.

Regardless of whether the outcomes of a policy were good or not; what kind of mechanisms were used in the organisation to link the so called "policy makers" to the rest of the organisation? How sensitive were people in the organisation to policy issues and options as seen by policy makers? Indeed it is not unusual for policy makers to feel that they are only rubber stamping what has already been debated and decided at lower levels.

These problems seem to be a consequence of ill structured information processes. A particular casualty of this situation is the espoused theory of stake holders' participation in policy making. While democratic organisations espouse the view that their destinies should be in the hands of those representing the stake holders, in practice there is widespread scepticism about this kind of participation. Such a dilemma may be the outcome of a structural inability to link representatives, managers, policy makers to the relevant debates taking place in the organisation. Thus, these people often feel that their "briefings" focus their attention on issues for which they do not have "follow up" mechanisms. The "residual variety" left for their attention in these briefings is beyond their information processing capacity. In these conditions policy makers may either abdicate their responsibility and just

follow the apparent advice of their subordinates, or they may take their own decisions hoping for the best.

Is there any way to increase the likelihood that such briefings, and their study, will progress within the information processing capabilities of policy makers, and therefore make it more likely that they, and not the those under them, will control the related policy process?

#### **The mechanism**

The policy function of an organisation is discharged by those defining its identity (i.e. those making effective whatever degree of autonomy that organisation may have).

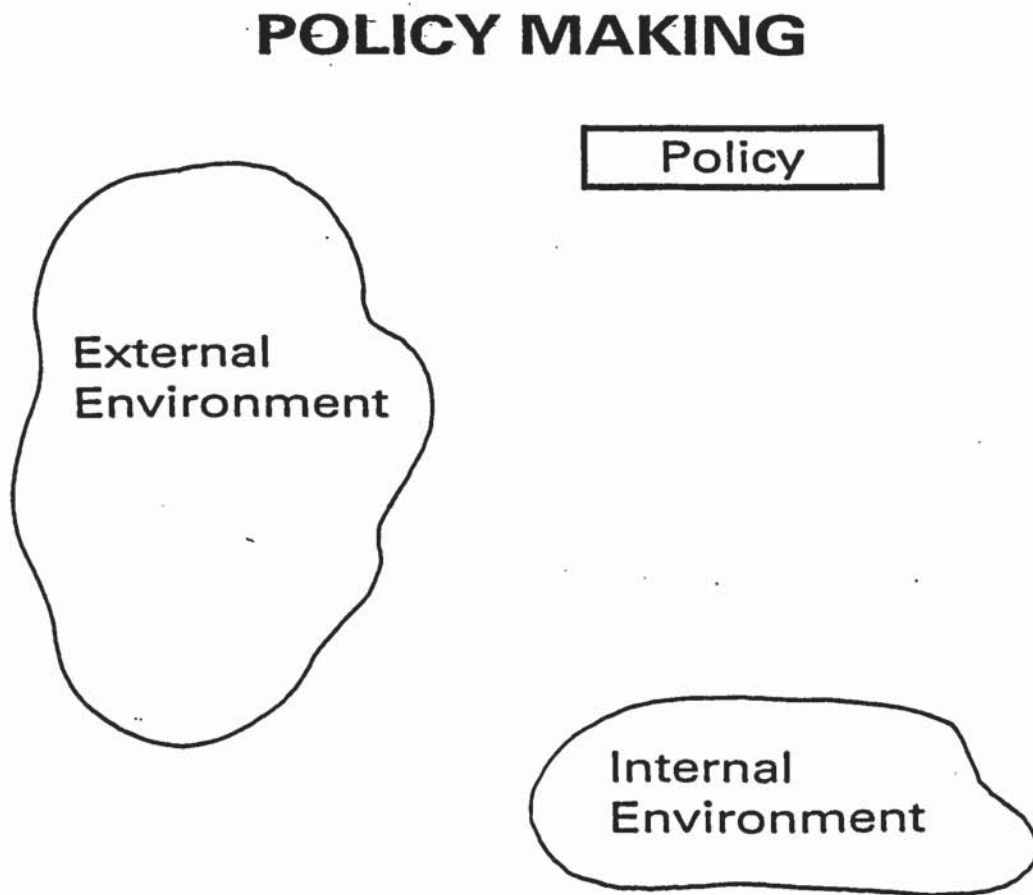
From the viewpoint of complexity it is an inescapable fact that those defining the organisation's "identity" have a limited information processing capacity and therefore, it is a fact that policy makers cannot in general carry out by themselves the studies relevant for policy decisions. They must rely upon the briefings and reports produced for them within the organisation. Most of the time policy makers are in the invidious position of deciding on issues that are beyond their comprehension. If this is so, how can they keep control of these policy processes?

This is a typical case where the variety that can be handled by the relevant viewpoints is much smaller than the variety entailed in the situation of concern. In cases like this,

the law of requisite variety would suggest the necessity to have effective attenuators of complexity within the high variety side in order to reduce the residual variety that the low variety side needs to handle in the situation. Ineffective attenuation would imply a residual variety -to avoid loss of control in the policies- larger than the information processing capacity of the low variety side, that is, in this case, policy makers would have to find attenuators of their own to cope with the options and issues as offered by the organisational briefings.

Thus, to avoid loss of control or unnecessary costs, it is necessary to design effective forms to attenuate the situational complexity. For policy makers there are two main sources of complexity; these are the organisation itself and the environment. On the one hand the states of the organisation today define the "reality" under their control; on the other, the states of the environment in the future define the "reality" of the threats and opportunities that the organisation might respond to in order to remain viable. Whether we are referring to economic trends, annual accounts, budgets, technological changes, personnel matters, or to any other possible form of information, all fall within one or the other of the above categories; they are either referring to anticipated changes in the environment or to actual operational problems in the organisation (figure 7-4).

Figure 7-4: Sources of Complexity for the Policy Function



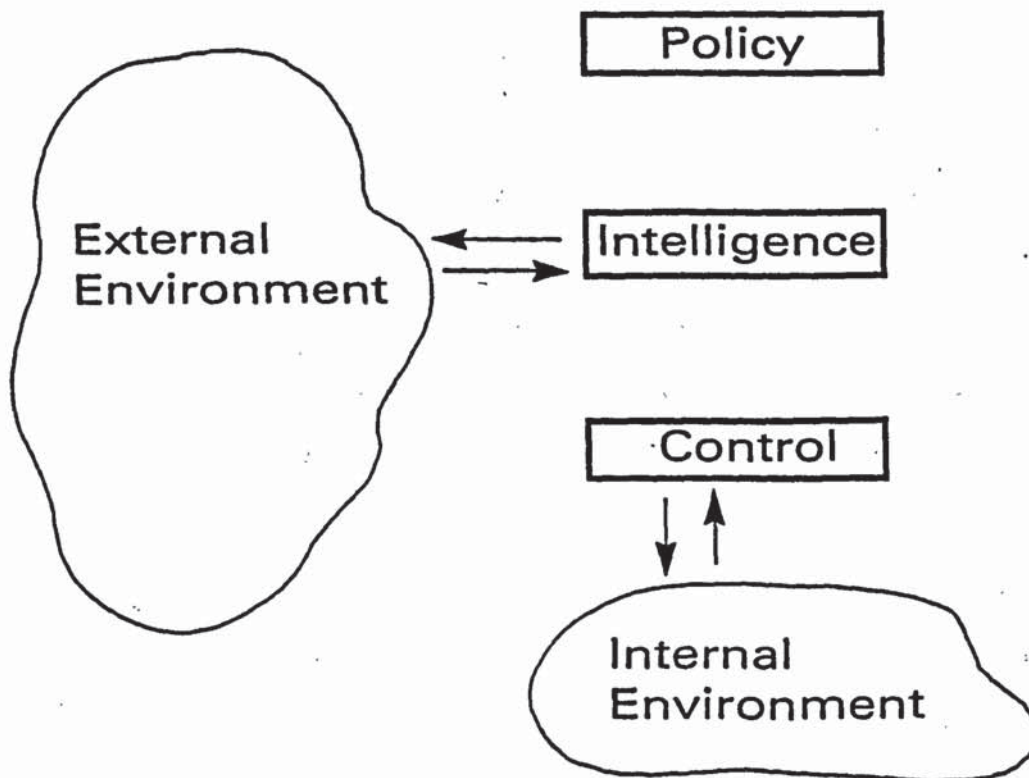
Quite naturally, since policy makers cannot access these sources by themselves, they have to rely on filters provided by the organisational structure for these purposes. It is necessary, for instance, to have a finance department to produce the annual accounts or a research and development department in order to keep in touch with technological changes. I call these two structural filters the control and intelligence functions of the organisation (figure 7-5). They exist in one form or another in any organisation. However, they are not necessarily related to well defined entities in the organisation chart; it is perfectly possible that one department performs the two types of filtering functions or that one person, performs in his different roles both intelligence and control functions or any other combination, including one person performing the three functions of policy, intelligence and control. The problem is how to structure each of these functions and their interactions in order to make policy making more effective.

Firstly, to avoid technocracy (i.e. the view that policy making has to be in the hands of those who know the technologies necessary to carry out the organisational missions), it is necessary to minimise the information needs of policy makers while maintaining their capacity to control the policy processes. It is necessary to design a mechanism that while making minimal information demands on policy makers still permits them to be in gear with those assessing opportunities and threats in the environment, and those



Figure 7-5: Intelligence and Control Functions

## POLICY MAKING



controlling the current state of affairs in the organisation.

Secondly, it is apparent that the intelligence and control functions offer alternative, but complementary, perspectives for the same set of problems -defining, adjusting, and giving meaning to the organisation's identity. It is this fact that suggests the need to design the interactions between them.

Policy making is a process whose outcome is the choice of courses of action for the organisation. Issues of policy concern may have their origin in either the policy makers themselves or in ideas mooted in the organisation. In the former case, there is a need to substantiate these issues if they are going to be more than just ideas; this requires studying the issues from different perspectives, and this entails the involvement of structural parts representing the views of both the control and intelligence functions. In the latter case, when the purpose is to reduce the information demands on policy makers to a reasonable level, it is necessary that those inside the organisation cross examine and veto their own ideas before sending them to policy makers.

In both cases policy making implies the orchestration and monitoring of organisational debates in such a way as to make possible the contribution of the relevant people, to the best of their abilities, to organisational adaptation

and survival. Extensive debates in the organisation, from alternative viewpoints, should produce informed conclusions and improve the quality of the policy briefings. Policy makers should only be exposed to issues and alternatives that have already been processed to the best of the organisational capabilities. They need not get involved in the details of the issues of concern; their job is, firstly, to bring into the debate the relevant structural parts, secondly, to monitor these interactions and finally, to consider alternatives and deciding among them according to their preferences, beliefs and values. This model of policy making is a pointer to avoid information overload.

However, there still remains the problem of how to make effective the interaction between intelligence and control. The effectiveness of their filtering depends not only on the ability and capability of each function in itself, but also on the ability of policy makers to monitor the interaction of both functions together.

The effectiveness of these filters, from the viewpoint of the policy function, relates to their inherent complexity and the richness of their mutual interactions. Using "reductio ad absurdum", if the two filters were completely unconnected then, by definition policy makers would not only be receiving information independently from both sides, but they would be the only ones responsible for giving closure to each information loop emerging from them. This approach implies, for instance, that there is no chance to disprove,

question or refute, at a level other than policy making, the organisational inadequacy of an issue of environmental interest, and vice versa. Policy makers would be the only communication channel between the two sets of people which in general, as we know, deal with far more complexity than they do. This would be a ludicrous situation and suggests that both sets of filters must be highly interconnected. When this is the case, most of the issues (information loops) emerging from each side can get closure with reference to the appreciations of the other filter. For instance, while intelligence may suggest options to diversify the company, control may veto some of them on the grounds of operational and co-ordination difficulties.

With reference to specific policy issues, either there is a balanced interaction between the two filters, or the performance of the policy function is going to suffer. For instance, if intelligence produces and puts for debate issues of policy relevance at a higher rate than that at which the control function can cope with, then policy makers might receive unchecked (from the control's point of view) environmental information. In the light of this, either the policy makers themselves find the likely internal implications or they respond without further inquiries. Either option is ineffective. For the policy makers to find by themselves whether the environmental information makes sense or not from the viewpoint of the internal state of affairs is bound to slow down decisions. The other option of not making further inquiries is bound to produce uninformed,

potentially costly, decisions. As suggested above instances of boards approving investment programmes for products with already declining markets are not uncommon, or of R & D people securing support for a "beautiful" technology at the same time that the production and sales people are aware of a declining market for the related products. Decisions that are over influenced by one of the filters are likely to be costly and ineffective. However, if the two filters are interacting effectively, decision proposals with the above pathological characteristics are less likely to emerge. In other words, if the two filters are highly interconnected and the residual complexity that each function has "to see" in the other is more or less the same, then, the information loops left open for policy attention, that is, the residual variety that this latter function has to deal with directly, is minimised. Such an approach is consistent with the intrinsic limited information processing capacity of policy makers. Their role in this model is to look after interactions and give closure to issues from the point of view of their preferences, values and beliefs. They do not need to have any technical knowledge about these issues.

It is important to understand that complexity in this case is measured not by the complexity that each side sees from within their own viewpoint, but by the states that each side sees in the issues as made apparent to them by the other side.

I call the above arrangement the **mechanism of organisational adaptation**. Its diagrammatic representation can be seen in figure 7-6. It is a means to effectively bridge the information gap intrinsic to policy makers. This mechanism, if well designed, should permit to minimise the residual variety relevant to policy makers.

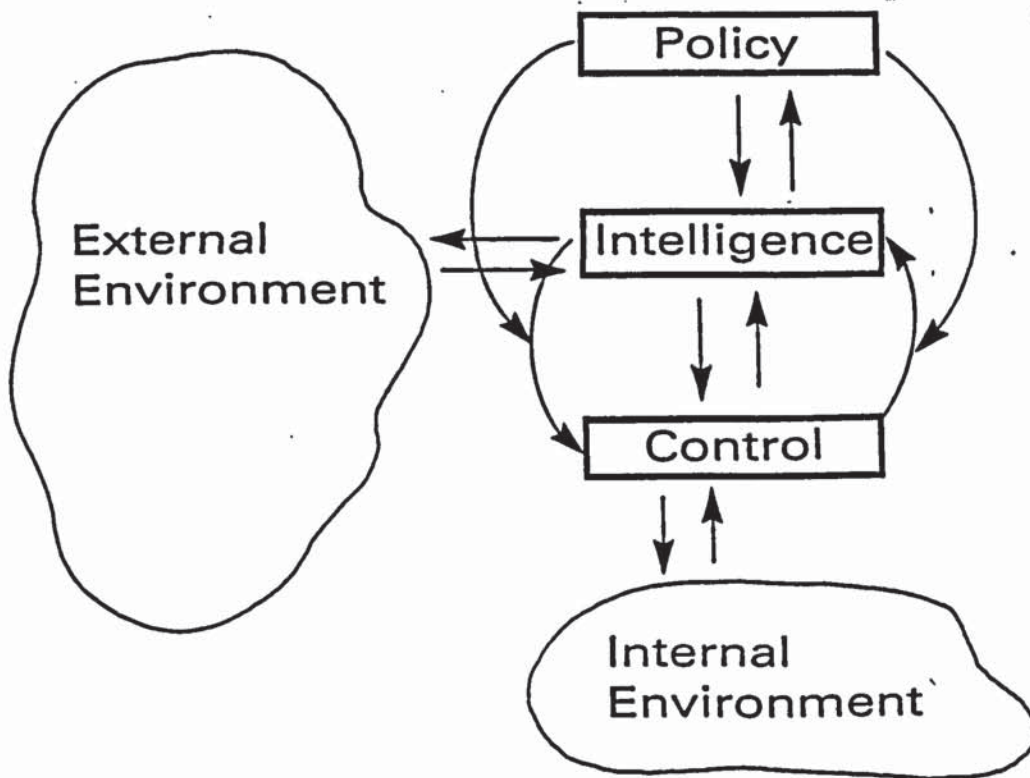
In general an imbalance between intelligence and control implies lost opportunities and unnecessary costs in the long run. As for policy makers they are likely to find themselves feeling that their information processing capacity is inadequate to cope with the uncertainties of the situations under their attention.

The discussion of this mechanism has made apparent the need for an overall balance between intelligence and control. However, the specific design of this balance will require paying attention to all the relevant issues impinging on the organisation's identity; in most cases the description or design of the mechanism will need to take into account a complex web of interactions, far removed from the deceptively simple diagram described in figure 7-6.

This model makes apparent, contrary to the widely held view that the main role of policy makers is to take decisions, that their key role is to monitor the interactions between the control and intelligence functions in order to amplify

Figure 7-6: Mechanism for Adaptation

## POLICY MAKING MECHANISM FOR ADAPTION



their functional capacity in policy making by making as much use of the organisational resources as permitted by the circumstances. Their responsibility is to ascertain that any policy issue either brought to their attention or initiated by them has been adequately cross examined by the two perspectives. To discharge well this responsibility they need not to be experts or even knowledgeable about the specific policy issues, but they do need to have a good model of how the organisation structure works with reference to the organisation's accepted identity. This model should help in particular to appreciate the need for communication channels to relate the relevant people. This is part of the residual variety that policy makers have to deal with.

Summing up, the following three points have been made to support an effective organisational adaptation:

**Firstly, it is necessary to minimise the information requirements of policy makers, and for this purpose,**

**Secondly, it is necessary to design control and intelligence functions of roughly similar complexities, and,**

**Thirdly, it is necessary to have highly interconnected control and intelligence functions, as a means to make effective the attenuation of the situational variety.**

Finally, the policy, intelligence and control functions correspond with systems 3, 4 and 5 in Beer's model of the



organisational structure of a viable system and the mechanism described is no more than an alternative discussion of his Third Axiom of Management (Beer 1979, page 298)

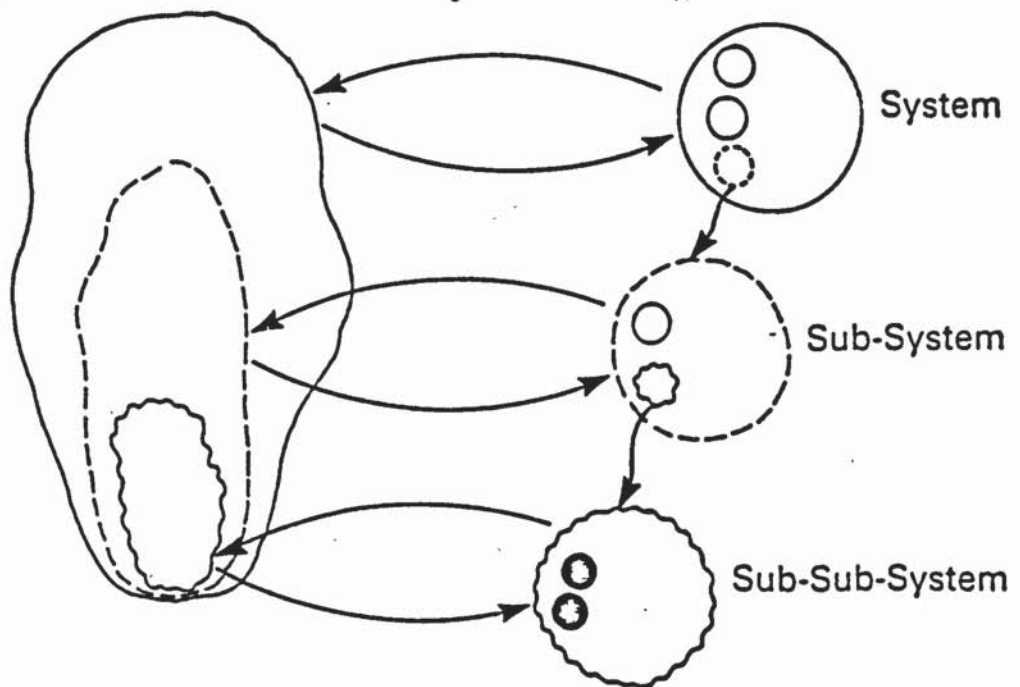
#### 7.4.2 Complexity Unfolding

By defining the identity of an organisation it becomes possible to define the primary activities of that organisation. In business terms these activities are the products or services implied by the company's "business areas". In general they are the the services or products offered by the organisation to its environment. Though defining these activities is the responsibility of policy makers, their implementation is not. What we witness is that, as an outcome of self organisation, a structure evolves to make possible the implementation of primary activities. Depending on their complexity, more or less structural levels with autonomy will emerge to make possible final implementation. At any stage, if the complexity of a primary activity overloads those responsible for its implementation, it will tend to be broken down into several primary activities at the next lower structural level, and their management passed (devolved) to managers operating at this new managerial level. Such an unfolding of complexity (figure 7-7) more often than not is the outcome of a natural, uncontrolled, process of self organisation.

Figure 7-7: Unfolding of Complexity

## UNFOLDING OF COMPLEXITY

The complexity of organisational tasks makes necessary autonomous systems within autonomous systems.



The modelling implied by figure 7-7 is focused only in the products or services implied by the organisation's identity.

It is not a modelling of any of the other activities, that though necessary to make possible the final tasks of the organisation, are only supporting or servicing them (i.e. are not producing the organisation's identity).

For example, in a university whose identity (from one viewpoint) might be described as "to produce and transmit knowledge", the implied products are the output by its academic staff in the class room or in publications. Of course to facilitate these results it helps to organise them in academic departments, faculties, research groups... All other units that are not directly producing these results, e.g. finance, computer services, registry, library, are support activities which facilitate the delivery of the universities "primary activities". Therefore, over-simplifying, the unfolding of complexity for a university would have the university itself at the first structural level, the faculties at the second level, the departments at the third and the lecturers at the fourth structural level. All of them, at different levels, constitute the primary activities of the organisation "university". This point is further elaborated in chapter 9.

Primary activities are the "objects" of management control; the "raison d'etre" of control. Lower level primary activities are doing what the higher structural levels found

they could not do by themselves. Each primary activity is responding by itself to chunks of environmental complexity, and moreover, in general, it is striving for its viability in the same way as the parent primary activity is doing at the more aggregated level. Indeed, if this were not the case, some primary activities of the overall task (i.e. those not responding to environmental challenges) would be endangering the overall viability of the organisation.

In this framework control and autonomy are not opposites (Espejo 1983). Viable sub systems with autonomy are necessary in order to implement the organisational tasks; in other words, it is necessary to have the "amplification" provided by viable (autonomous) sub systems in order to make possible the control of the organisation's tasks. The above discussion suggests that in any viable system there is, in one form or another, a complementarity between control and autonomy. Thus the problem is to find criteria to make the most out of this complementarity. This is what the discussion of the mechanism of monitoring control should help us to see.

#### **7.4.3 The Mechanism of Monitoring-Control**

##### **The Problem**

By definition, the control function needs to be in control of the organisation's primary activities in order to be an effective filter of the organisation's internal variety.

If there is something that the control function can contribute to the policy debate is an accurate appreciation of the capabilities, potentialities and performance of the primary activities.

However, to understand the above proposition it is necessary to understand the meaning of "control". If managers understand control just as the power or authority to direct, order, or restrain the people under them, the likelihood is that those managers will suffer "control dilemmas".

Two facts underlie such control dilemmas. The first is the unfolding of complexity, unavoidable if the aim is to implement complex tasks. The second is the suggested poor understanding of the phenomenon of control. While the first fact is responsible for perceived imbalances in variety since managers cannot possibly know everything that is going on within the organisation; the second is responsible for an apparent inability to accept that such imbalances are an intrinsic aspect of organisational complexity.

Complexity unfolding does not mean managerial abdication of responsibility. It only means that despite the fact that managers cannot know everything that is going on inside the organisation they are still accountable for any loss of control. This is a hallmark of management. There is always the risk of managers losing touch with their primary activities, be it only temporarily. Unexpected breaks of control may happen in these periods, but even if no problems

emerge immediately, they may emerge at a later stage as a result of their uninformed contributions to policy processes (i.e. to the adaptation mechanism).

The inherent imbalance between the low variety of management and the high variety of the primary activities they control triggers all kinds of control games. These are interpersonal games where on the one hand senior managers control the allocation of resources and on the other junior managers control the information. It is inherent to management that managers operate with an information gap. If junior managers, for whatever reasons, withhold relevant information, the likelihood is that corporate managers will lose actual control of the situation. Most of the time these games may be the outcome not of intentional behaviour, but simply of poor interpersonal interactions. The situation can be exacerbated by a poor understanding of control processes. How can we minimise the damaging impact of these all too common situations?

The problem seems to be how to avoid losing control of primary activities despite the existence of unavoidable information gaps. In terms of requisite variety the problem is how to match, at minimum cost, the residual variety left unattended by the primary activities with the variety available to management.

The mechanism of monitoring-control gives pointers to achieve this balance effectively.

## **The mechanism**

Logically, complexity unfolding implies that an organisation's transformation is unfolded into two or more primary activities; they define its implementation function. Each of these primary activities is autonomous, has its own management and is embedded in its own relevant environment. In figure 7-8 the primary activities are called divisions A, B and C.

Depending on the nature of their tasks, the divisions will have stronger or weaker interdependences; any number of combinations of interactions may occur, though, for diagrammatic reasons, only some of them are represented in figure 7-8; thus divisions A and C may also be interdependent. They may interact operationally by one providing inputs to another, or through the environment by one affecting the residual environmental variety relevant to the others. But above all they have in common the fact that they belong to the same organisation and, for as long as there is an organisation, there is also a degree of cohesion among the parts. Achieving this cohesion is the role of the control function (figure 7-9).

If managers in the control function understand control as only commanding or directing, then they are bound to be faced, as time goes by, with further control problems. It is important to understand this dilemma.

Figure 7-8: The Implementation Function

## CONTROL OF ORGANISATIONAL TASKS

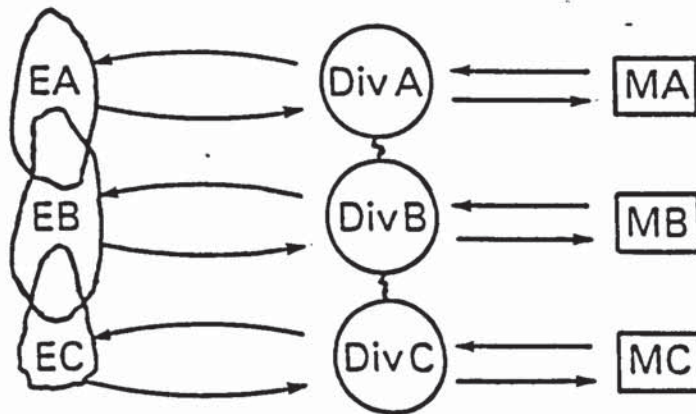
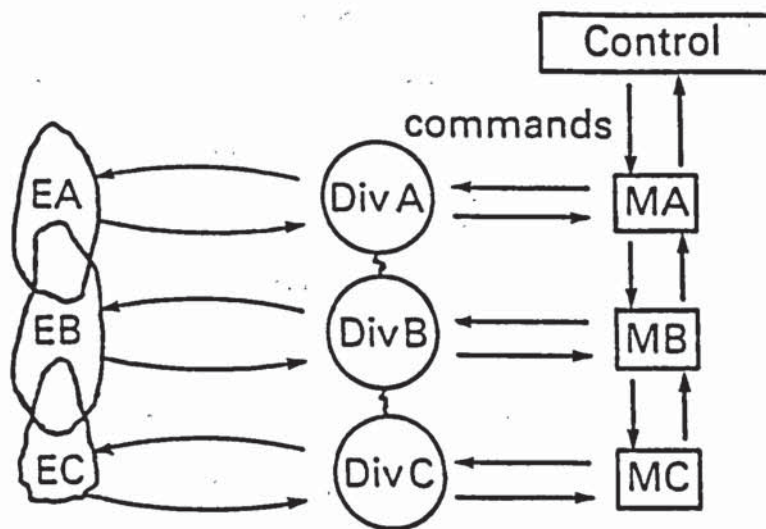




Figure 7-9: The Control Function

## CONTROL OF ORGANISATIONAL TASKS



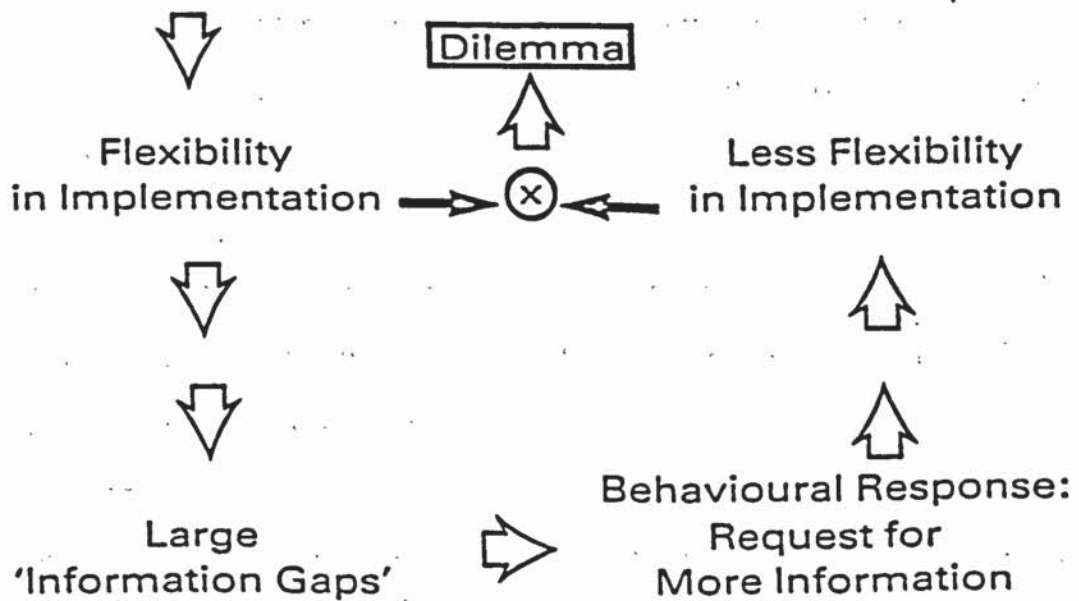
Managers often make the assumption that complexity is skewed towards higher structural levels; this is the legacy of a positivistic way of thinking where the only relevant complexity was taken to be that impinging in those with authority. If, on the other hand, we accept that complexity is not only the manifest complexity at higher structural levels but something that emerges at all levels from the interaction of people with a situation, then, naturally, the complexity of the environment will be seen to be distributed (as people are) and therefore all primary activities at all structural levels will be seen to operate in complex, if not turbulent, environments (figure 7-10).

The need to see complexity at all levels has been prompted by increased competition and sophistication in the products and services offered by modern organisations; it is now necessary "to see" a complexity that was previously easily ignored. The greater the complexity perceived in the environment, the more flexibility is necessary at all structural levels; managers have no option but to accept larger information gaps. However, if these gaps are interpreted by them, as they often are, as lack of control, and hence more commands are issued or more information is requested, the likely outcome is that lower level managers (e.g. divisional managers) will perceive more constraints, less room for autonomous action, less flexibility. Such a managerial response is in turn responsible for a control dilemma (figure 7-10). While structurally the outcome of

Figure 7-10: The Control Dilemma

## CONTROL DILEMMA

A Complex Environment



this managerial approach is likely to be a larger bureaucracy controlling more and more "dimensions of control", behaviourally lower level managers may become increasingly frustrated, fearful and inflexible, precisely when the need for flexibility is more acute. A proliferation of control games is likely.

Because the imbalance in the varieties of the control and implementation functions is natural, it makes no sense to try to force a balance by increasing the variety of the control function (as it is implied by the above suggested behavioural response). What is necessary is to reduce as far as possible the residual variety that the control function needs to take account of in the primary activities. This strategy would permit us to simultaneously increase both the autonomy of the primary activities and the cohesion of the organisation.

However, minimising residual variety is not enough, it is also necessary to ensure that this residual variety is properly communicated to the control function. However small the variety might be there is always the possibility of corruption in its transmission, and therefore the risk of losing control. Thus the need to validate the information used in transmitting such variety.

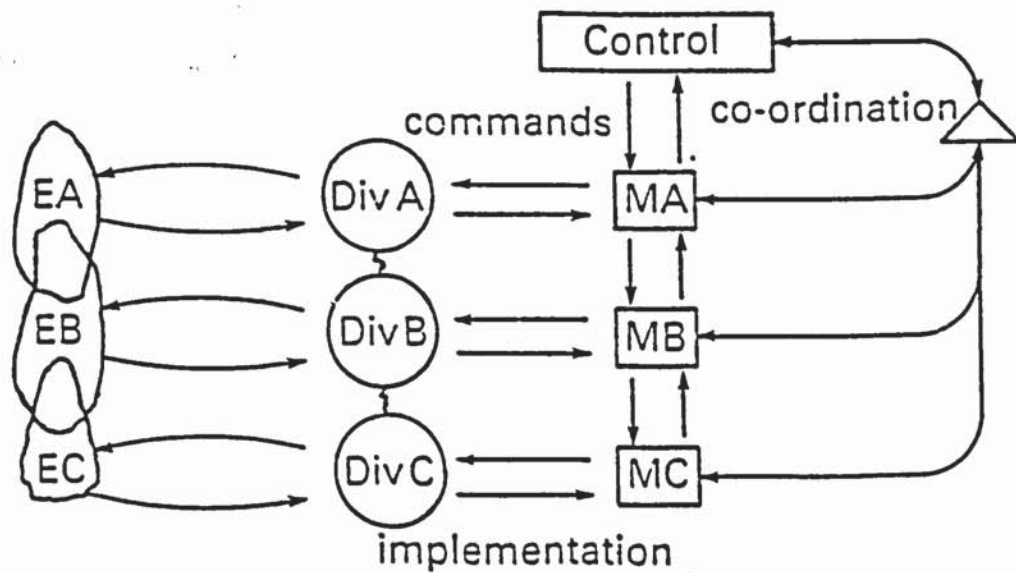
From earlier discussions it should be apparent that in order to minimise the residual variety relevant to the control function it is necessary to increase the autonomy of the

primary activities. The problem is to find the maximum "degree of autonomy" that still permits organisational cohesion. While the autonomy of the primary activities adds a huge flexibility to the organisation, permitting local responses to environmental demands, it also increases the likelihood of inconsistent responses. This is a natural outcome of the freedom of the primary activities in deciding responses. The options to counteract this drawback are twofold: either to achieve consistency of responses from above, i.e. co-ordination by direct supervision; or to let the primary activities do that by themselves i.e. co-ordination by self adjustment. The first option is attractive because it permits a comprehensive view of the primary activities in the context of the whole organisation. However, in practice it implies not only a potential overload of the control function, but a strategy that is based on an undesirable increase in control variety.

The second option, in which the parts find consistency of responses by themselves, creates the logical necessity of a powerful co-ordination function (see figure 7-11). The contention is that better interactions between primary activities is more likely to produce consistent responses; this is a natural outcome of a context more supportive of self regulation. Co-ordination systems, like those named in exhibit 7-1, help to damp oscillations among the primary activities, thus reducing the demands on the control function. Thus engineering damping of machine variances not only facilitates communications between primary activities

Figure 7-11: Co-Ordination Function

## CONTROL OF ORGANISATIONAL TASKS



## Exhibit 7-1: Examples of Co-Ordination

### **CO-ORDINATION FUNCTION**

#### *Examples:*

- Engineering damping of machine variences
- Quality control of major raw materials
- Damping systems to regulate debtors/creditors/stocks
- Damping of idiosyncratic accounting methods
- Work procedures
- Wages damping across divisions
- Production scheduling

but also permits easier maintenance and support of such machines. More problems are coped with at the local level permitting a larger acceptable variety (information) gap. Co-Ordination is in any case a very high variety function; the stronger it is, the smaller will be the residual variety needing the attention of the control function. Indeed, the more it is developed the more autonomy is possible at lower structural levels.

However, if management is going to be supported effectively by this "reduced" residual variety, then it needs a capacity to recognise the true states of the primary activities. Quite naturally, the information transmitted by primary activity managers through their accountability lines (the flows upwards in the command channels) reflects their own biases and communication problems (control games). To depend only on those reports in order to ascertain the state of the primary activities is potentially very risky; there is a need to cross check this information with an alternative source. This extra communication line is achieved through the development of a monitoring channel with those reporting to the management of the primary activities.

Monitoring is a means to avoid breakdowns in the communications between management operating at successive structural levels in the organisation. The control function needs an assurance that the autonomy of the primary activities remains consistent with global policies, that is that the residual variety transmitted by the accountability



reports is an adequate reflection of the primary activities variety. There is a need to maintain the integrity of the information flowing between levels. Among other factors, changes in the context of action and the natural changes of people do increase the uncertainty about the meaning of accepted information procedures, as well as of specific information reports .

The control function needs, by exception and sporadically, a high variety understanding of those lower level aspects that are relevant to global cohesion, i.e of those that the management of primary activities is accountable for. Monitoring is a low variety channel that carries high variety only about a few, specific issues.

Summing up, the following three points have been made to support an effective control of primary activities:

Firstly, it is necessary for the control function to minimise the issuing of commands or directives to the primary activities,

Secondly, it is necessary to develop as much as possible co-ordination by mutual adjustment among the primary activities, and,

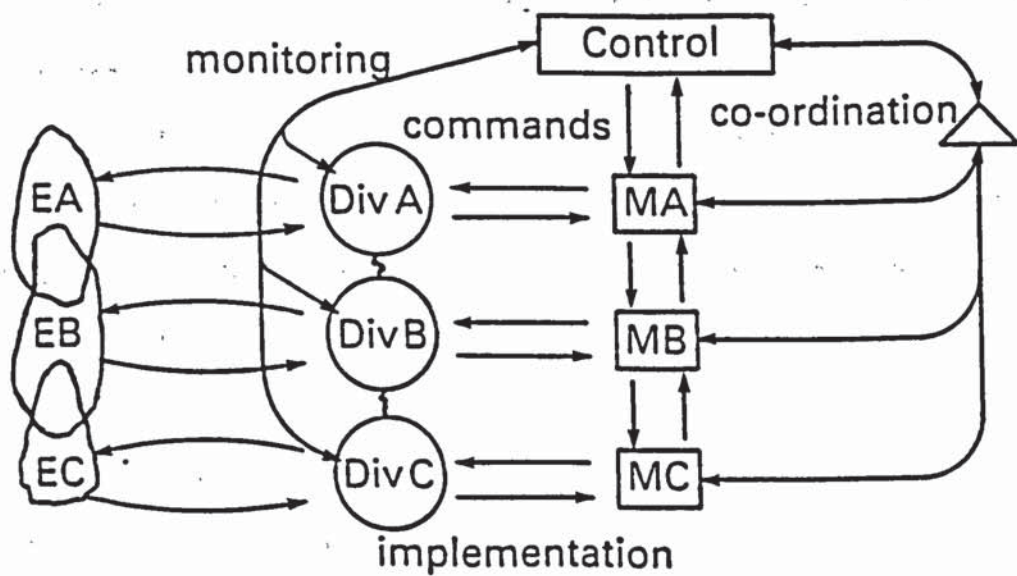
Thirdly, the control function needs to develop a capacity to monitor the primary activities in order to minimise breakdowns in their communications.

A better developed co-ordination function permits to achieve cohesion with fewer commands and to function with more general policies. However, if cohesion is going to be achieved, an adequate monitoring of primary activities is necessary as well. Thus quite contrary to the widely held theory-in-use that the communications between two successive structural levels take place mainly through a command channel, the above conclusions suggest that there are two other available channels for this purpose; these are the co-ordination and monitoring channels (figure 7-12). While the co-ordination channel can be used to induce self regulation, the monitoring channel helps to guard against communication breakdowns.

From the viewpoint of information processing, the capacity of managers carrying out the control function needs to be in balance with the actual information flowing through the three incoming channels. If the information reaching control managers is beyond their capacity, one of the options is to design a stronger co-ordination function in order to induce autonomy, reduce residual variety, and thus reduce the amount of information aiming for their attention. Provided it is backed by a parallel strengthening of monitoring this approach permits, a larger information gap without a loss of contact with implementation activities.

Figure 7-12: Mechanism of Monitoring-Control

**CONTROL OF ORGANISATIONAL  
TASKS**  
*MECHANISM OF MONITORING-CONTROL*



The links provided by the three channels among the control, co-ordination and implementation functions define the mechanism of monitoring-control (figure 7-12). These three functions correspond with systems 3, 2 and 1 of Beer's model of the organisational structure of a viable system.

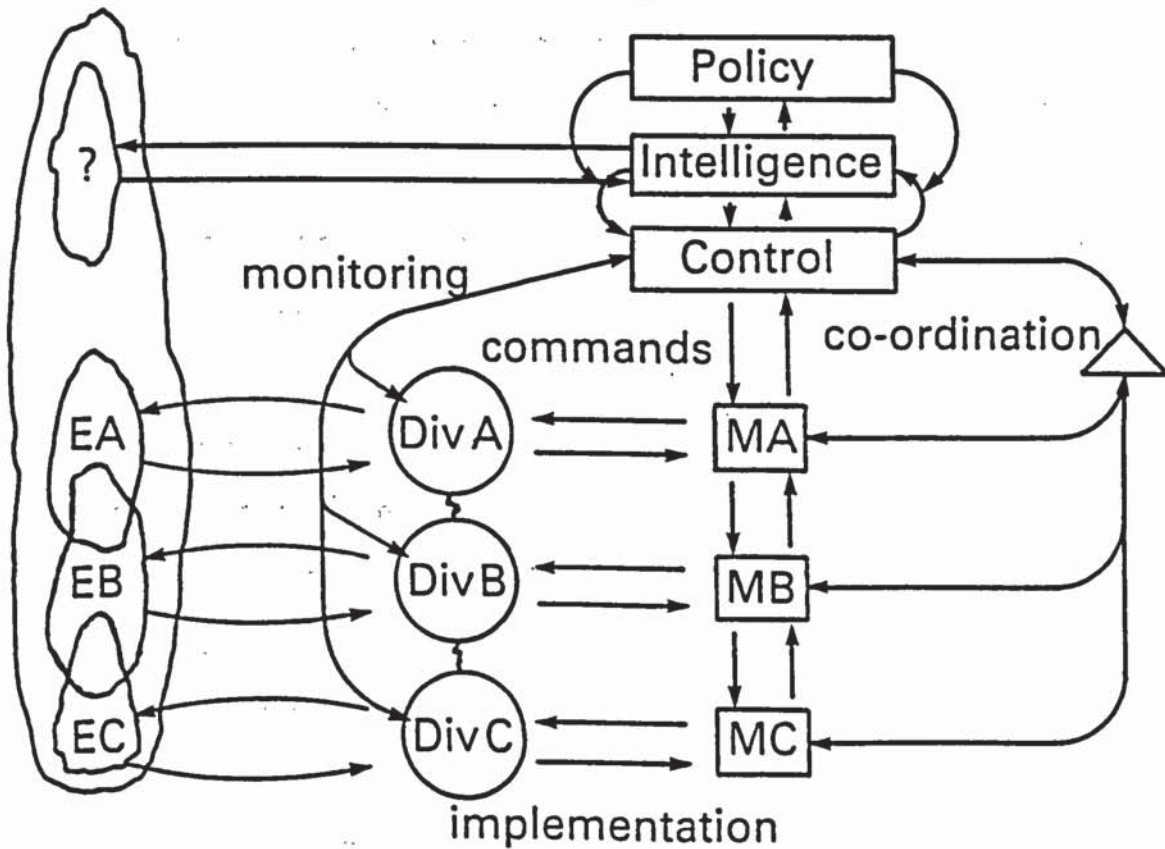
#### **7.5 Model of the Organisation Structure of any Viable System**

The discussion of the above two sections led us to the discovery of two mechanisms inherent to the management of complexity. In fact these mechanisms are extremely general. For instance the mechanism of monitoring control is applicable to any organisational entity with structural levels, whether it is a primary activity or not. However the focus of the discussion has been in primary activities and their capacity to remain viable. Together, the adaptation and monitoring-control mechanisms define the set of functions and relations necessary for effective viability. According to our earlier definition of structure, these are the mechanisms defining the organisation structure of a viable system (figure 7-13).

However, perhaps the most powerful insight into the management of complexity is made apparent when the mechanisms of adaptation and monitoring control are related to complexity unfolding. Since, in general all primary activities, at all structural level, have problems of viability, the same two mechanisms are valid for all of them. The same model of the organisation structure at the

Figure 7-13: The Two Mechanisms

### MODEL OF THE ORGANISATION STRUCTURE OF VIABLE SYSTEMS



global level is repeated in each of the primary activities at all structural levels; this is Beer's principle of structural recursion (Beer 1979, page 118). The diagram of figure 7-14 permits to appreciate the idea of structural recursion.

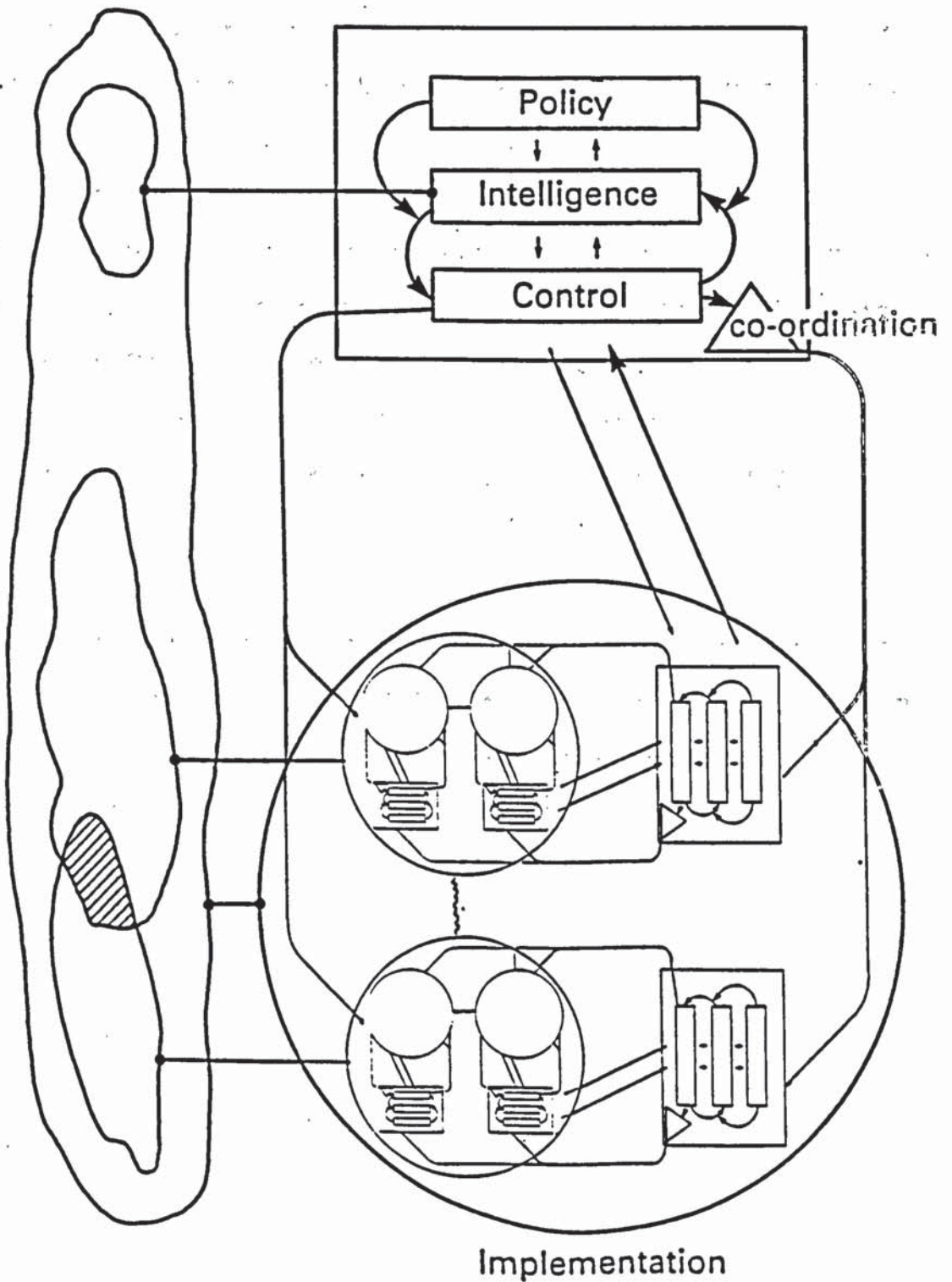
Then, the same criteria of effectiveness as discussed above apply to the sub systems within a viable system, and to the sub sub systems within a sub system and so forth. This proposition has deep consequences. It is saying that in truly effective organisations policy, intelligence, control, co-ordination and implementation are distributed at all levels. Autonomy should exist at all levels. Contrary to the established knowledge all structural levels, from the higher to the lower, should be concerned with the short, medium and long term. This proposition is making apparent that reducing people working at lower structural levels to the status of operators alone, not only is unnecessarily reducing their individual freedom, but also is reducing the effectiveness of the organisation as a whole.

## 7.6 Conclusion

The Viable System Model offers a paradigm for problem solving. Its understanding gives mental tools as to how to approach the creation and designing of effective contexts for the participation of people in human activities.

Figure 7-14: The Viable System Model

**V.S.M**  
*Principle of Recursion*



ADAPTED FROM  
S. BEER 1985

The mechanisms of adaptation and monitoring control are particular instances of the general mechanism developed in the Chapters 4 and 6 to study the interactions between high and low variety parts. In either case the problem was to find effective means to attenuate the variety of the high variety side, in order to reduce the residual variety relevant to the low variety side and to amplify the variety of this side to improve performance. The lower this residual variety is the more feasible it is for the low variety side to control the situation. Beer's model gave us the direction to discuss these mechanisms. As suggested in the introduction this chapter has worked out in detail, from the viewpoint of the law of requisite variety, the mechanisms invoked by Beer when he develops his model. The original idea behind the discussions of this chapter is "residual variety", which highlights the heuristic value of Ashby's law.

The next three chapters of this thesis will show how to make a practical use of this model. In this work I'm offering not only a theoretical approach but also the methods to make possible its use.



## **8. P.M. Manufacturers: The Viable System Model as a Diagnostic Tool**

### **8.1 Introduction**

The purpose of this Chapter is to illustrate the use of the Viable System Model (VSM) as a diagnostic tool. The model is applied to a small British company. The emphasis of the discussion is in general problems like "how apt is the organisation in reflecting and deciding about its policy" or "how likely is that people in the organisation will discover imaginative answers to cope with environmental threats and opportunities" or "how likely is that management will keep the organisational activities under control". Indeed these are effectiveness questions and the contention of this chapter is, along with the methodology discussed in Part I, that organisations with "good cybernetics" are more likely to score higher in answering them.

Good cybernetics suggests effective mechanisms both to pin-point problem situations and regulate relevant organisational tasks. A detailed study of these mechanisms and related criteria of effectiveness was done in the previous chapter.

The chapter will unfold as follows: firstly, the company subject of this study, P.M. Manufacturers, is described; secondly, the problems the company was facing at the time of this study (1978) are discussed; thirdly, the question

about the company's ability to discover "by itself" solutions to its apparent problems is raised. The study of the cybernetics of the organisation makes apparent several weaknesses directly impinging upon the company's ability to formulate effective policies. This study is at the core of the chapter. Finally some conclusions are drawn for the company.

## **8.2 The Company: P.M. Manufacturers**

P.M. is a small company in the electrical engineering sector. Its main business is the manufacturing, or rather the assembly, of engine driven electrical generating sets. However the company has also, for the past two years, been in the business of "procuring spares" for third parties and "servicing generators" on site. These two activities are referred to in the company as "non-manufacturing activities".

The company has around 40 employees and an estimated sales turnover of 2 million pounds for the current financial year (i.e., 1978). It is part of a larger engineering group with two more operating companies, one related to "Land Development" and the other to "Civil Engineering". The operating companies enjoy a fair amount of discretion. The Group's corporate structure is formed by a Chief Executive, supported by a Finance Department and a Secretariat with

planning and administrative responsibilities. Altogether the group has about 600 employees.

P.M. Manufacturers sell standard and non-standard generating sets to order. It is not their policy to stock products. Their market is mainly abroad, in particular Nigeria and the Middle East.

The company's organisation chart is shown in figure 8-1

#### **Production Department**

The "resources manager" is responsible for the production department. He controls the "buying manager", responsible for all procurement, with the exception of engines, and the "senior foreman", who is responsible for the day to day running of the plant.

All the manufacturing activities take place in the plant. A flowchart of these activities is presented in figure 8-2. Manufacturing are chiefly responsible for the assembly of the generators. At present only four of the five operations implied by the flowchart are active, these are:

- fabrication - manufactures bed frames for generators;
- building - mechanical assembly of engines and alternators (the two major components of a generator);

Figure 8-1: PM Organisation Chart

*P.M. Manufacturers  
Organisation Chart*

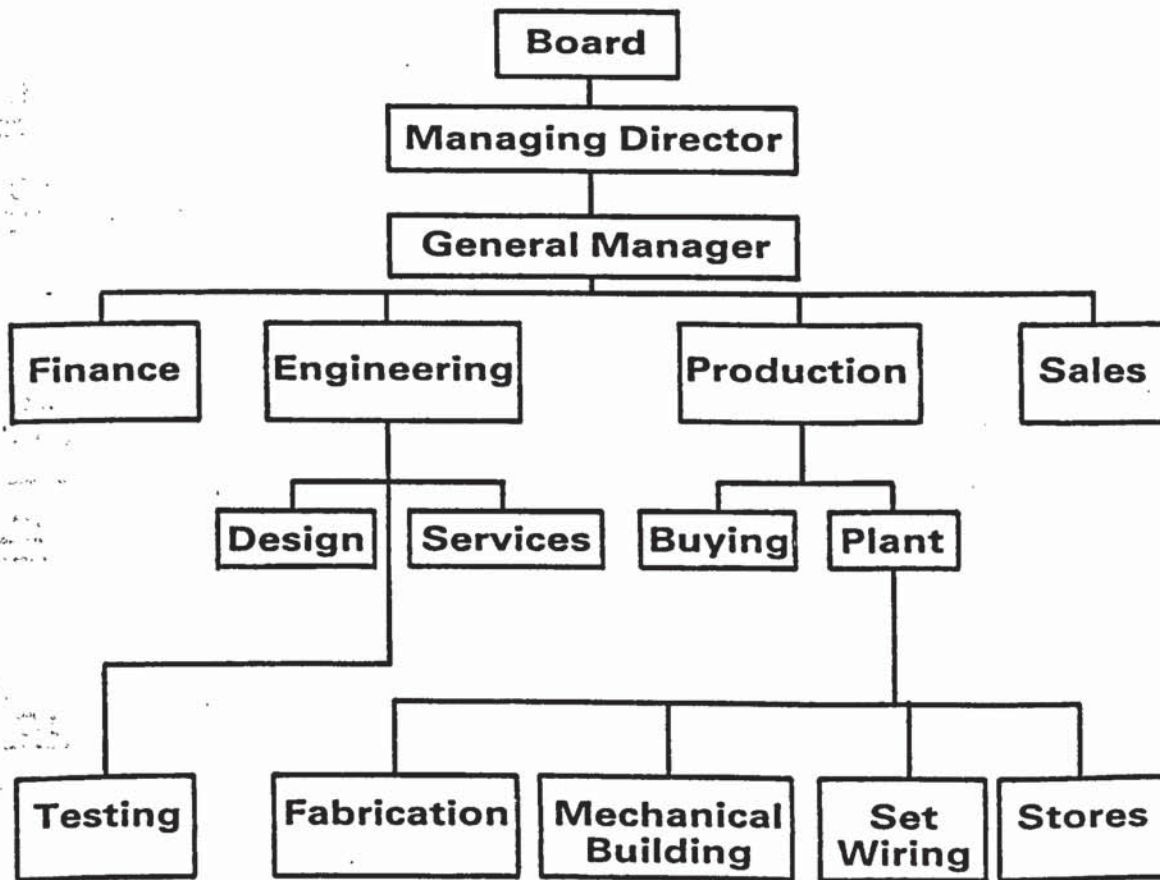
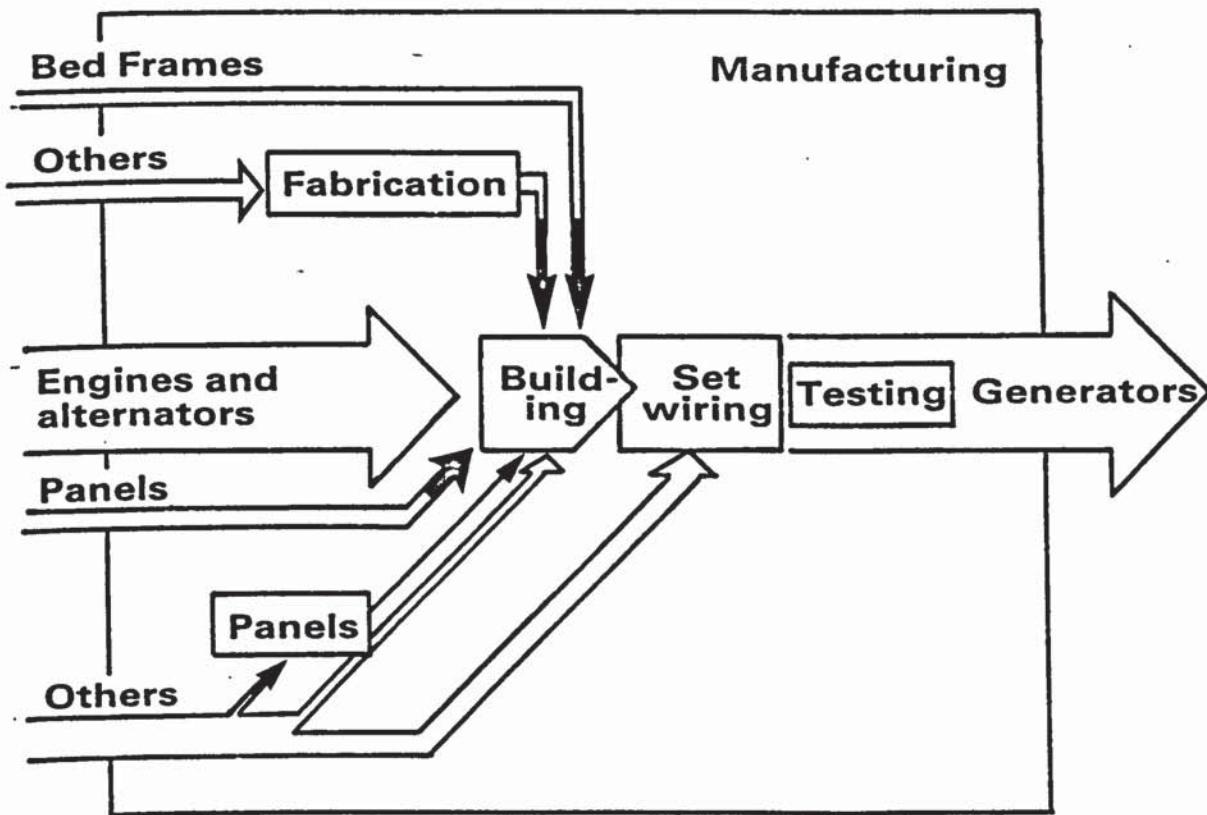


Figure 8-2: Manufacturing Flowchart

*P.M. Manufacturers  
Manufacturing Flowchart*



- set wiring - installing electrical system for the generator (this includes an electronic control panel);
- testing - generators are finished and tested under several loading conditions.

Although the factory has capacity to produce control panels, their production is at present subcontracted.

In the formal organisation structure the testing unit, manned by the "testing engineer", is under the control of the "chief engineer". Each of the other activities is under the control of a "leading hand"; the three leading hands formally report to the senior foreman.

The senior foreman also supervises the "stores manager". The store is physically in the shopfloor itself.

### **Engineering Department**

Most of production is standard sets, but the company also offers non-standard sets on request. Over time production is becoming more and more restricted to standards. In this trend the design unit of the engineering department has a major role.

Historically the company has evolved from producing a large variety of models in small quantities to larger quantities of a few standard sets. Today standard sets are responsible for 70 per cent of the company's turnover. This has simplified not only manufacturing but also sales and financial activities. For instance, the production of standard sets permits a "price list" that simplifies the interactions with customers. Quotations are done only for non-standard sets which represent 20 per cent of the company's turnover.

In addition to design, the chief engineer is also responsible for services and testing. The former is emerging as an important off-shoot of manufacturing activities; maintenance and servicing of generators in site is offered for all brands of generators, not only for those produced by P.M. Manufacturers. Testing was mentioned before in the context of Manufacturing. This activity is performed by a "testing engineer", who has two functions: first the testing of generators, and second the quality control of manufacturing operations.

#### **Sales Department**

The sales department plays an important role in P.M. Manufacturers. Customer's requests may fall either in the list of "standards" or imply purpose built "non-standard" sets. If the latter is the case a sales engineer, supported by the design unit, will prepare a quotation. This activity

consumes most of the time of the sales engineers, though only one in ten of the quotations is likely to be successful. Manufacturing orders are accepted by the sales manager after consultations with the general manager and managing director. The resources manager, in fact, is not consulted; he receives manufacturing orders in a way that practically implies that production scheduling is done by the "sales manager".

The company also sells its procurement capabilities, mainly to foreign customers. One of the sales engineers is full time co-ordinating procurement, storing and dispatching of spares and parts. He also oversees the "services" in site performed by the service engineers.

#### **Finance Department**

The finance department discharges both accounting and administrative duties. It is headed by a "chief accountant". There is limited financial discretion at this level since the group controls this business dimension. Cost accounting of manufacturing orders and company accounts are the main outputs of this department. Cost analysis is done for each manufacturing order, both periodically and after completion. There is no cost analysis for product lines, thus company finance reports are fairly detailed in nature. Wages, salaries, overtime and other administrative duties are also the responsibility of this department.



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Figure 8-4: Liquidity Indices

**P.M. Manufacturers  
Net Assets & Liquidity Ratios**

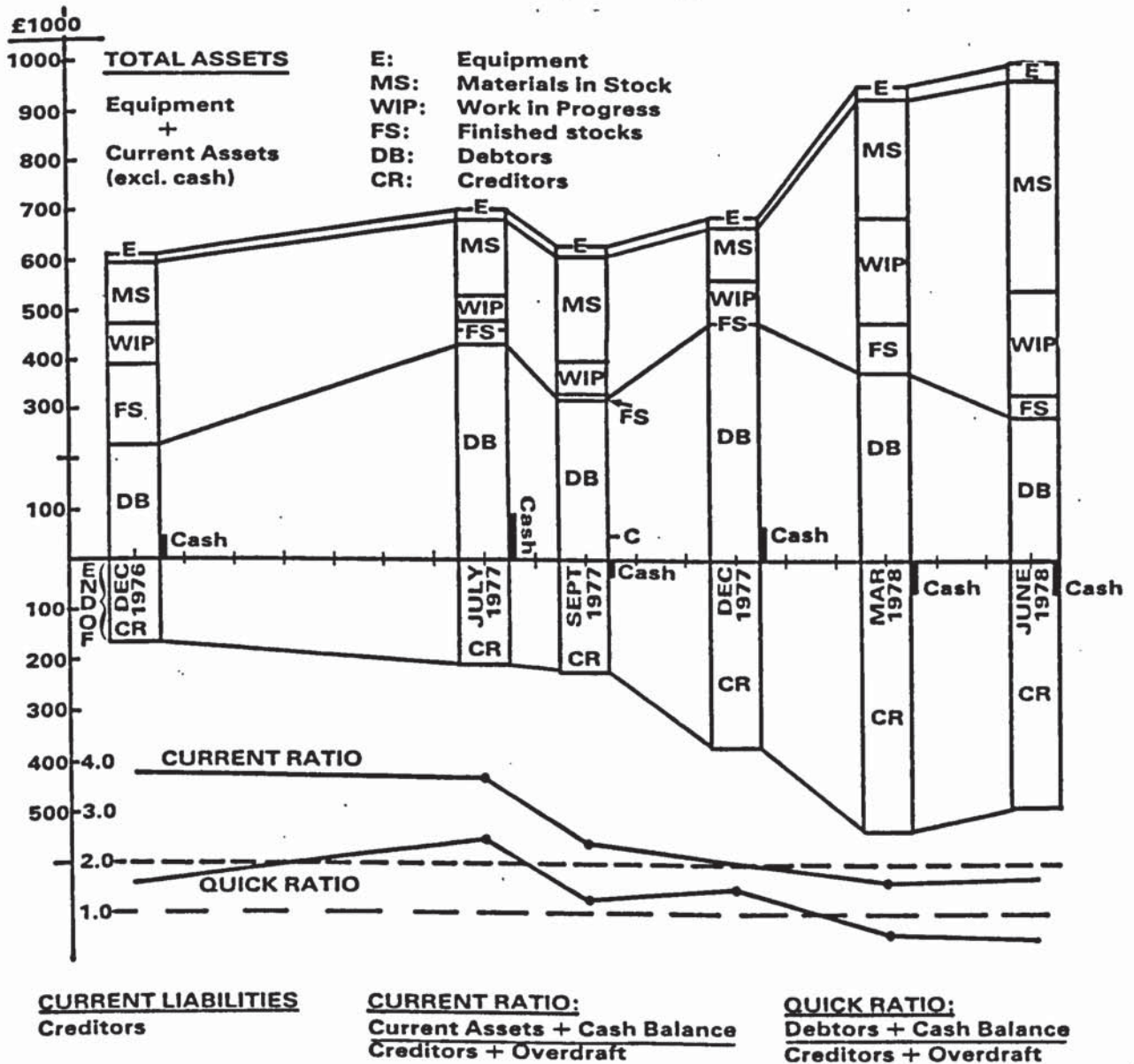


Figure 8-3 gives information about manufacturing and sales performance. Even using fairly conservative labour productivity figures it is possible to appreciate important slacks on the shopfloor; in some months more than 40 per cent of the available productive capacity was not used in manufacturing. The sales order index implies that at any given time the firm orders for the next six months do not exceed 50 per cent of the production capability for that period of time and moreover that in the last three months the situation has deteriorated even further. At present the order book only covers 40 per cent of the production capability for the next six months. The company is finding difficulty in having its products accepted in the market. An inquiry on "sales" makes even more apparent the company's fragility. P.M. is extremely dependent on the orders of only one foreign customer. Around 60 per cent of the company's turnover comes from a major distributor in Nigeria. Everyone is conscious that he is holding the company's future in his hands. Just three months ago the Nigerian Government decided on new imports restrictions. The distributor had to readjust his order programme with drastic effects in the company. All the efforts to increase sales in the U.K. market have failed so far, suggesting that P.M.'s competitive position is not good enough.

These problems are compounded by a worsening liquidity situation. This can be appreciated in figure 8-4. In an effort to keep production cost down the company accepted

deals which have increased both the money they owe to creditors, and, the materials they keep in stocks and work in progress. At the same time, in order to improve sales P.M. is giving more generous credit. Not surprisingly the company is in an acute cash problem. However this recent problem appears only to confirm the trend of the last eighteen months (figure 8-4).

On a more positive side, for the past two years P.M. has been selling its procurement expertise to foreign customers, making high profits. However, while the perceived significance of this activity is high, the company has failed to increase its contribution to the sales turnover; it is still under 10 per cent. Additionally, in an effort to reduce costs and achieve a competitive position in the U.K. markets, P.M. is trying new technology, namely the incorporation of microprocessors to their control panels.

#### **8.4 The cybernetics of P.M. Manufacturers**

Are the above problems the outcome of hard luck or perhaps the natural outcomes of an organisation that permits nothing better? If so, how can the situation be improved?

An answer to these questions is the aim of studying the cybernetics of an organisation. It has already been said that the essence of this analysis is to elucidate the "actual" mechanisms regulating organisational activities. The study will be done in two stages:

First we shall discuss the way in which autonomy and discretion appear to be allocated at different levels in the organisation. The outcome is a model of the necessary structural recursion for more effective organisational responses to environmental demands, and,

Second we shall study the effectiveness of regulation for two structural levels, that is the divisions within P.M. Manufacturers and the company itself.

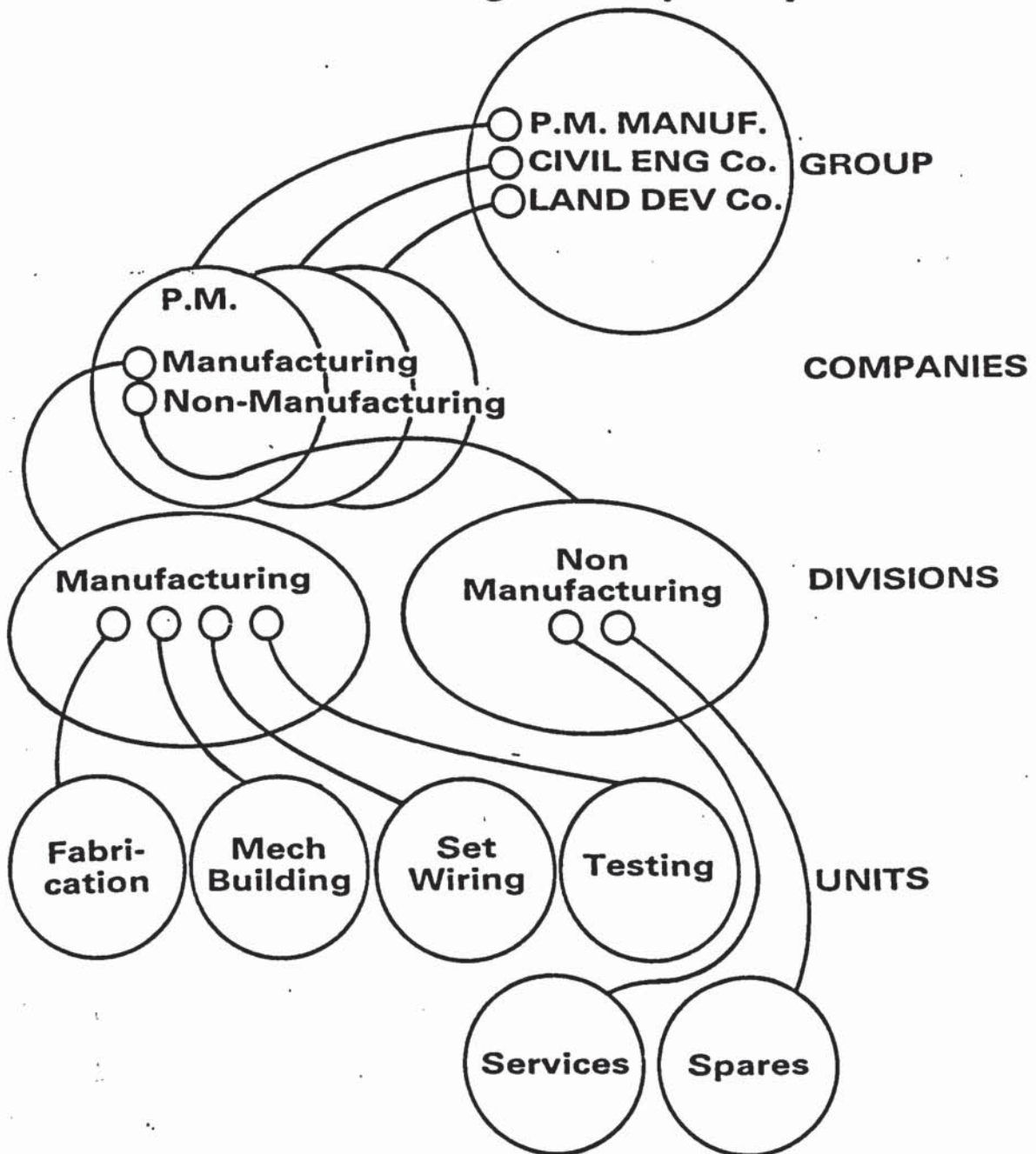
#### **8.4.1 Structural recursion**

Figure 8-5 postulates the structural levels which appear necessary to implement the Group's policies.

While in the context of the Group, P.M. is clearly one of three implementation sub-systems with responsibility over a particular policy area, within P.M. the situation is less clear. Only Manufacturing activities respond to the image that the company has of itself. Non-manufacturing activities have no identity of their own, but are perceived as by-products of Manufacturing. However, as explained below, both are business areas which imply complex activities demanding managerial autonomy.

Figure 8-5: P.M. Structural Recursion

*P.M. Manufacturers  
Structural Recursion;  
actual unfolding of complexity*



First structural level within P.M.

The view that each of these two business areas should have structural recognition, in the form of autonomous divisions or sub-systems, is a cybernetic conclusion that is not apparent from studying the company's formal organisation structure. While manufacturing activities are clearly the responsibility of the resources manager, the management of "non-manufacturing" is disseminated in several organisational parts (i.e. "services", "buying", "sales", "stores"). There is no structural recognition of the contribution of non-manufacturing activities to the company's viability. Yet, these are activities currently producing the company.

This assertion derives from the fact that services and procurement are activities that the company want and need to make viable. Their 10 per cent contribution to sales turnover disguises the fact that their contribution to the company's profits is much higher. While the production department (i.e. manufacturing) add little to the value of the final product, and also have negligible control over its price (because of their uncompetitive position), the value added by non-manufacturing activities is indeed larger mainly because the company control their prices. In the end, their contribution to the company's profits is substantially larger than that suggested by their small size.

To make of non-manufacturing activities a viable division it is necessary to give them the internal capacity to respond to the demands of a complex environment, that is, it is necessary to structure them as a unit with discretion and autonomy.

While this lack of formal recognition of the structural need to give autonomy to non-manufacturing activities may hinder the effectiveness of the related activities, it has not completely suppressed the natural self-organising forces which give these activities the degree of viability that they manifest in their two years of profitable existence.

Thus, the conclusion is, that in spite the lack of formal recognition of the non-manufacturing as a sub-system, P.M. Manufacturers has "de facto" two sub-systems in its implementation function.

#### Second structural level

Within each sub-system we find "sub-systems" with autonomy and therefore with the ability to amplify the complexity of the sub-systems they belong to. In manufacturing there are four sub-sub-systems:

- Fabrication
- Mechanical Building
- Set Wiring and
- Testing



In non-manufacturing it is possible to distinguish two separate activities

- Engineering Services and
- Spares procurement.

Overall the analysis of structural recursion in P.M. Manufacturers identifies two anomalies: firstly, and most importantly, there is a mismatch between P.M.'s formal structure, as implied by its organisation chart, and the structure necessary to make viable non-manufacturing activities; secondly, it makes apparent that the testing activity is within production and not within engineering. These mismatches are further explored below while discussing regulatory problems in the company.

#### Discretion at each structural level

Each unit, at its own structural level, is in interaction with a relevant complex environment. By definition these environments are encapsulated in the environment relevant to the higher structural level. Hence, the Group's environment encapsulates the environments relevant to the three operating companies. Particular to the Group is an overall financial discretion; in particular the Group controls investment decisions. While P.M. corporate management retains discretion in sales, engineering, costs and the procurement of engines, the divisions have discretion in

product development and procurement. Indeed, technological and operational discretion are seen as necessary to make possible the activities on the shopfloor.

#### **8.4.2 Effectiveness of regulation**

We shall study the effectiveness of regulation with reference to figure 8-6. This figure focuses attention on the mechanisms for monitoring control and adaptation in both P.M. Manufacturers and each of its two divisions, that is manufacturing and non-manufacturing. We shall start the analysis in the divisions and then discuss in general the Company.

#### **Effectiveness of regulation in the divisions**

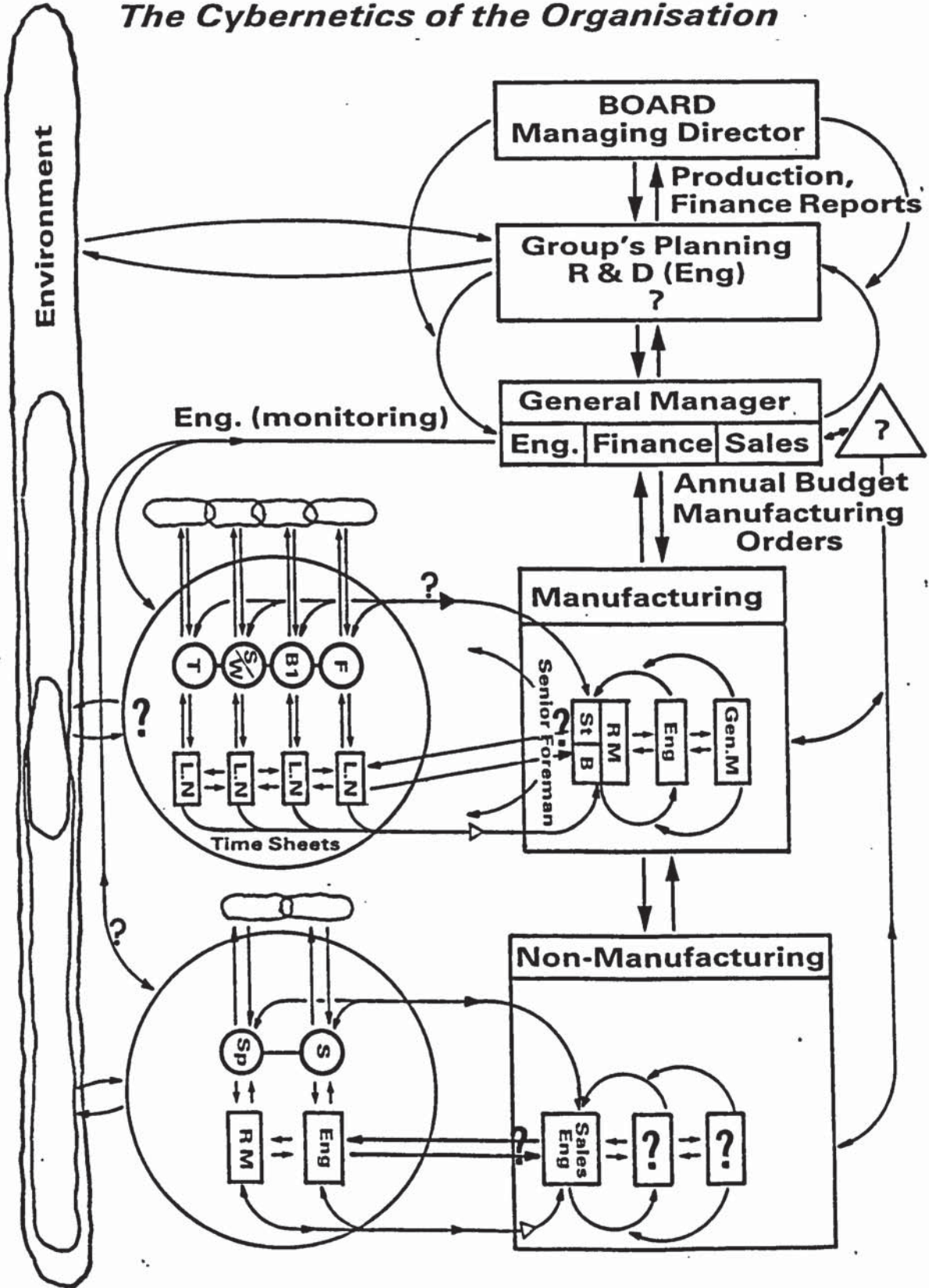
##### **Manufacturing**

The resources manager is responsible for the control of manufacturing activities, and in this task he is supported by the senior foreman and the buying and stores managers. Control in this case means to produce good quality generators, on time (note that cost is not a concern at this level of management, therefore, even if costs are comparatively high, production could still be under control!).

However, the formal structure creates problems in the effective performance of the control function. The

Figure 8-6: VSM for the Company

**P.M. Manufacturers:  
The Cybernetics of the Organisation**



organisation chart does not recognise the nature of the interactions between buying and stores. These are two closely interdependent activities. The effective supply of materials and parts in the shopfloor suggests a high variety interaction between those procuring these materials and parts and those using them. However the formal structure in manufacturing puts the senior foreman in between these two groups, a position in which he becomes an unnecessarily narrow communication channel which "stores" has been de facto forced to by-pass. This situation has been fuelling unnecessary frictions within manufacturing.

The monitoring of manufacturing operations (i.e. fabrication, mechanical building, set wiring and testing) is fairly hazy at present. There is a perception that this auditing has to be done by someone outside manufacturing. Therefore this activity has been allocated to the testing engineer, who works under the control of the chief engineer. This poses two problems in cybernetic terms: first, the testing engineer is not outside manufacturing, indeed he is part of the manufacturing process, and second he is auditing operations **within** manufacturing and not manufacturing as a whole; monitoring these operations surely should be the role of the senior foreman. This obviously creates problems. It seems the problem is the confusion between two levels of recursion. While manufacturing has to monitor its own operations, the company has to monitor manufacturing. Therefore, at the higher level, the concern should be

sub-systems, and not sub-sub-systems; this seems to be an intrusion in their autonomy.

In fact, the testing engineer is reporting directly to the chief engineer problems in manufacturing operations (e.g. difficulties in the welding of bed frames), before they are reported to the resources manager. This fact is creating ill feeling between these two managers; quite naturally the resources manager feels the chief engineer is intruding in his territory.

Despite the above difficulties, manufacturing is achieving output as necessary, but this situation might change if the present slack resources are removed by a tighter production programme. The analysis of regulation in the division says nothing about the control of "production costs"; this is not an aspect under the discretion of the Resources Manager.

The discussion of Manufacturing adaptation to changing environmental conditions is limited to those dimensions "that are not discretionary of higher structural levels", that is, to the space left for its autonomous behaviour. Indeed, at this level it is unlikely to have any questions of whether it is operating in the right markets, or whether it is producing the right products. Quite naturally the focus is on adaptation to changes in technology, production procedures and procurement. In fact it is possible to appreciate an ongoing interaction between manufacturing and engineering, with useful outcomes. New types of generators

are all the time in development and efforts to introduce a new technology are in progress (i.e. microprocessor in the control panel of generators). In this form Engineering is providing "intelligence" capacity to Manufacturing. The management of the interactions between these two departments is a continuous concern of the General Manager, who therefore is performing the policy function at this structural level.

#### Non-Manufacturing

This sub-system is not formally recognised by the present structure. In other words, there is no unifying managerial capacity related to this task. As suggested before, this may imply the non-viability of the task in the long-run. In figure 8-6 we can see that while "services" and "spares", the two sub-systems of non-manufacturing have their instances of control in engineering and production, their overall co-ordination is in sales. This co-ordination occupies one of the sales engineers full time. He does all the administration and is not actively in sales. Moreover, and most importantly, he is not operating within a policy framework, something which would be necessary to give him discretion to exercise control. The fact that monitoring control in this sub-system is not performed effectively is reflected by the number of operational problems that regularly require the attention of senior managers. Indeed the sales engineer cannot take operational decisions freely; he feels the need to involve senior managers in these

problems. The result is that senior managers are overloaded by trivial operational problems.

The adaptation of this sub-system to market threats and opportunities may be related to the hazy concern of the company's senior management to developing this line of activities. This is limiting its viable expansion.

The absence of a viable organisation for non-manufacturing strongly suggests that corporate management is itself absorbing a good deal of its implied complexity. In practice they are overloaded with the details of an activity which important as it is represents no more than 10 per cent of the company's turnover.

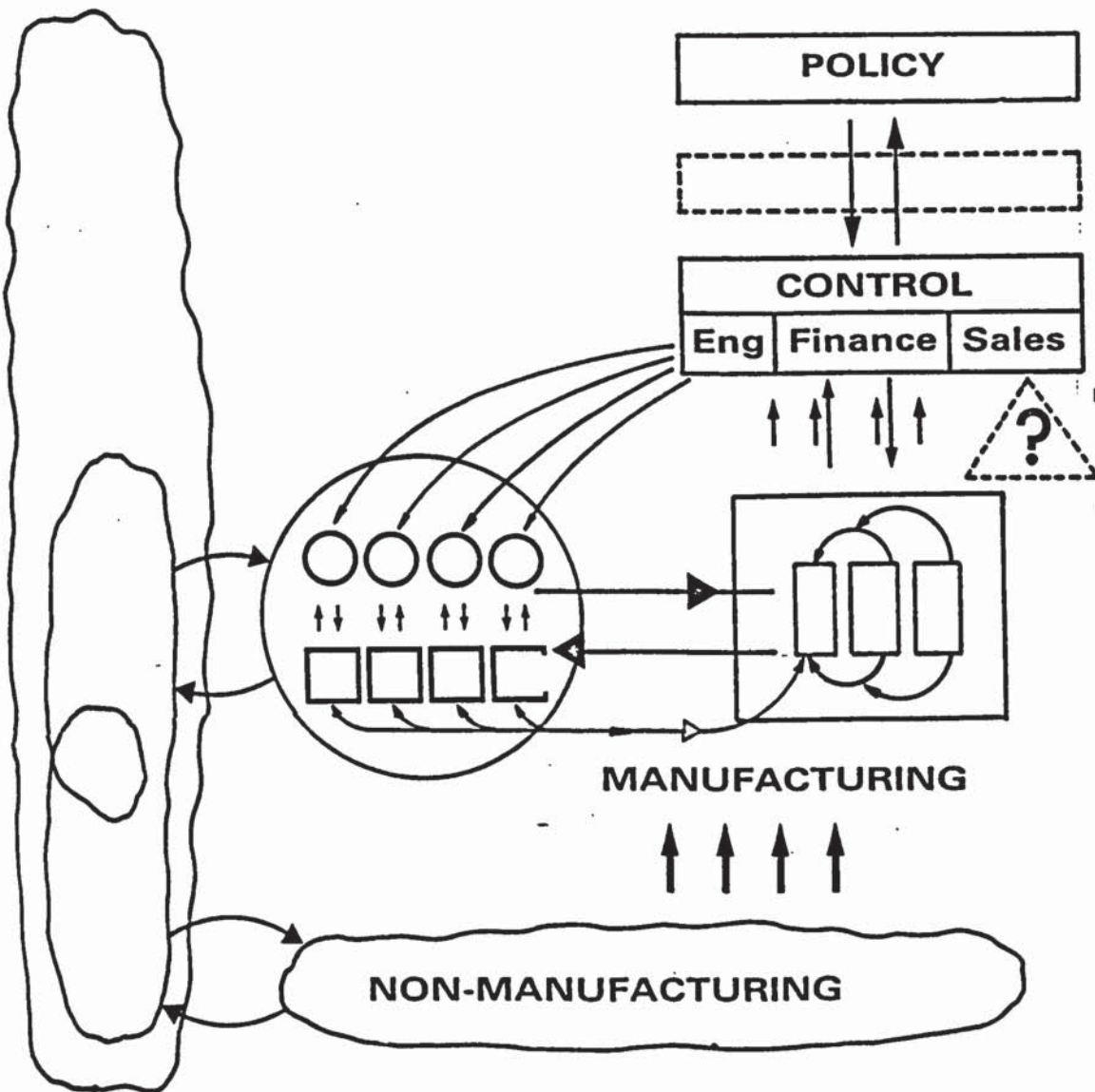
#### **Effectiveness of regulation in P.M. Manufacturers**

Not surprisingly the weaknesses of the two sub-systems have implications in the overall organisational structure of P.M. Figure 8-7 is perhaps a more accurate description of the way P.M. is actually absorbing the complexity of its activities.

Corporate management in P.M. is responsible mainly for selling the company's products at a financially viable price. While discharging this task the main parameters for production are set. In this the General Managers operate with the support of the Sales, Finance and Engineering Departments. In particular sales performance defines the

Figure 8-7: P.M. Theory in-use

*P.M. Manufacturers  
PM Organisation; Theory in Use*





level of activities in the divisions. However this performance is not independent of production costs, a dimension under corporate control. In fact most of the references used in the company to assess performance are in money terms, in particular attention is paid to sales turnover targets and gross margins in manufacturing and non-manufacturing activities. These references are the only explicit recognition of non-manufacturing as an activity in its own right.

In practice the control of sub-systemic activities is hindered by the lack of recognition of the non-manufacturing sub-system. On the one hand there is no effective organisational sponge with discretion to absorb the complexity of the multiple non-manufacturing transactions, thus increasing unnecessarily the demands upon corporate management. On the other, as explained below, it is limiting the opportunities for self-regulation in the implementation function as well as blurring the monitoring of manufacturing activities.

In the context of P.M. Manufacturers, there is a risk of confusing the need for co-ordination between the Engineering, Sales and Finance Departments, and the co-ordination between the two sub-systemic operations, that is, manufacturing and non-manufacturing. In systemic terms there is a difference between these two co-ordinations. While inter-departmental co-ordination is a mechanism to increase, and amplify the variety of the control function,

the self regulation of sub-systems is a mechanism to decrease, filter the variety reaching that function. Because the variety of the implementation function is far larger than that of the control function, the latter mechanism has a far more relevant systemic meaning.

Because they fail to recognise non-manufacturing as a sub-system, P.M. Manufacturers is not benefiting from this damping mechanism, and this is another way of understanding why senior managers are operating at too detailed a level, something which is limiting their capacity to deal with more strategic issues. This is reducing their effectiveness.

Monitoring the implementation function is necessary for effective regulation and indeed there is a perception of this need in the company. However it is perhaps because there is no recognition of two operational sub-systems that Engineering is confusing two levels of recursion and is monitoring at the wrong level. This point was explained before and the suggestion was made that the formal position of the testing engineers was creating frictions and misunderstanding. Monitoring the "right" level would imply, for instance, the assessment over time of whether the level of manufacturing activities is well matched to the factory capabilities, or whether the resources allocated to the non-manufacturing operations are reasonable for the magnitude of the task. Neither of them is performed by the control function.

Overall the way control is carried out in P.M. appears to be fairly ineffective and no doubt it is an important contributor to the present level of uneasiness in the company.

This situation is made worse by the lack of an effective mechanism for adaptation.

The need for functional capacity "to create" the company's future is just the recognition for a mechanism to make less painful its learning and adaptation processes.

Unfortunately P.M. Manufacturers, at its corporate level, appears not to be aware of this.

Planning the long term is indeed a very limited activity in this company. Its corporate plan is produced once a year by a planning team in the Group's secretariat, with a limited participation of P.M.'s senior management. In this scenario what in cybernetic terms is seen as the most important pay-off of planning, that is the process itself, is happening outside the boundaries of the company (i.e. in the Group). To be effective planning has to be done continuously by the whole organisation not just by a few of its members, let alone by people outside its boundaries.

In the final analysis, the balance between the intelligence and control functions which is necessary for effective adaptation, is strongly dominated by the latter function. This view is supported by considering the information

normally prepared for Board meetings. By and large, this information concerns manufacturing orders, production problems and financial details.

Thus the policy function is continuously plunged into operational details, far removed from the normative role that is suggested by our cybernetic model. This is a typical case in which policy making is hindered by a structural bias towards the control function at the expense of the intelligence function.

This weakness in the policy function is reflected by lack of a well defined, and insightful, identity for P.M. Manufacturers. Discussions about the company's identity are simply not perceived as relevant. The directors, as a corporate team, have not recognised that, whether they like it or not, the company's identity has been changing over the past two years from the original manufacturing identity towards a "service oriented" identity.

## **8.5 Conclusions**

Perhaps, one of the most important conclusions of this study is to identify the effect that P.M.'s weak identity is having on its ability to respond to unexpected changes in the market. While we could observe some efforts to make the manufacturing division viable, albeit with very limited resources, we could not perceive similar efforts at the

corporate level. The development of non-manufacturing activities - the result of a free opportunity in the market - has not been embedded in a cybernetically coherent structure. In general, we do not perceive organisational capacity to take further the several good ideas mooted. All this helps to account for the present fragility of the company dangerously dependent on the demand of only one customer. In cybernetic terms this situation could be explained by the lack of both adaptive and control capabilities at the corporate level. Both problems, very likely, being the consequence of the company's hazy identity.

Apparently corporate managers have not absorbed the implications of a changed environment and the structure is lagging behind events.

A number of diagnostic points were produced by the cybernetic analysis of the company. These points are summarised in what follows from the perspective of the manufacturing and non-manufacturing sub-systems and of the company as a whole.

From the viewpoint of the Manufacturing Division:

-The testing engineer is systemically within manufacturing, and not within engineering as suggested by the organisation chart.

-The monitoring of the manufacturing primary activities is done by the corporate control function and not by its own control function.

-The buying and stores units are linked by a too narrow communication channel (the senior foreman).

-Despite the above problems manufacturing is well under control; it is producing good quality generators, on time.

From the viewpoint of the Non-manufacturing Division:

-Non-manufacturing activities are not recognised as a "business area": this is limiting its viable expansion.

-There are signs that a "division" is emerging as an outcome of self organising forces.

-However, this is hindered by the fact that the sales engineer responsible for co-ordinating these activities is operating without a policy framework.

From the viewpoint of the company as a whole (i.e. the corporate level):

-The lack of a viable organisation structure for non manufacturing leads to overloading managers with trivia.

-The inadequate monitoring of manufacturing implies overloading the chief engineer with unnecessary detail.

-The non recognition of non manufacturing as a viable system hinders the development of effective co-ordination and monitoring mechanisms.

-There is no "intelligence" capacity within this level; this is limiting the viable development of the whole company.

-The company has a weak identity.

Summing up, in terms of the organisation chart, the study supports the need first, to move the testing engineer from the engineering department to the production department, second, to have buying and stores operating one within the other or at least at the same structural level, and third, and most importantly, to hive off non-manufacturing activities in one sub-system with discretion and autonomy. Decisions in this direction should have threefold consequences:

First, they should improve the control mechanisms at two levels of recursion, and in particular, should permit to make the monitoring of manufacturing activities more clear.

Second, the creation of a non manufacturing division should not only permit furthering the viability of the related activities, but also, it should have spin-offs that help to improve the effectiveness of the company's control and co-ordination functions.

Third, corporate managers should find that they have more time and opportunities to discover problems and carry out debates about the development and adaptation of the company to its market. This is the recommended approach to achieve a balance between the control and intelligence functions at this level.

Studying the cybernetics of P.M. Manufacturers has deepened an appreciation of the company's weaknesses. While no attempt has been made to find specific policies to overcome the present fall in sales and liquidity, the point is made that the structure of the company does not help people in the organisation itself to find solutions for their problems. Indeed structural factors actively hinder the emergence of such solutions.



## **9. The Viable System Model: a Method to Study Organisations**

### **9.1 Introduction**

Following the discussion of the Viable System Model (VSM) in chapter 7 and its application to P.M. Manufacturers in chapter 8, this chapter intends to offer a general method to facilitate its use in the diagnosis and design of organisational structures. Its methodological context is given by the discussions of chapters 2 to 6. The method facilitates the production of viable system models as required, for whatever purpose, in situational debates.

An important methodological problem encountered in using the VSM derives from difficulties in seeing that there are many equally valid "viable system models" for any particular organisation. Organisations can be described in a range of different forms by different viewpoints. Organisations are defined as multisystems rather than single systems. Organisations are an outcome of the negotiations of multiple viewpoints; therefore, any attempt to approach their study from a single viewpoint is bound to fail; it lacks in requisite variety.

Moreover, before undertaking a study it is necessary to establish not only the purposes that relevant viewpoints ascribe to the organisation, but also the purposes of the study itself: diagnosis and design are offered as two alternative modes of study.

The method is rooted in the ideas of naming systems (chapter 3) and the management of complexity (chapter 4). Both are seen as major requirements to facilitate the use of Beer's model. While naming systems is used to work out the identities ascribed by viewpoints to the organisation, the ideas of variety and complexity are used to discuss the partitioning of organisational tasks. I argue that, in any application, it is only after these two aspects have been taken into account that the power of the principles and laws of viability, as developed by Beer, become more apparent.

## 9.2 Activities of the Method

The followings activities constitute the method:

-Establishing the organisational identity.

The application of the VSM to social situations needs to assume the possibility of several viable systems in the apparently unquestionable "reality" of one social institution. While establishing the system in focus is not a straight forward task, any attempt to apply the VSM without a proper clarification of this point is bound to produce inadequate results.

-Modelling Structural Levels

A problem in using the VSM is to establish the structural levels that contribute to the implementation of the organisation's tasks. In Beer's terms, the problem is to define the levels of recursion for the system in focus. In general, it is inadequate to approach this problem by mapping the formal structure of the organisation (i.e. its organisation chart) onto the VSM; it is necessary to use more subtle criteria in establishing recursion levels.

-Modelling the distribution of discretion in the organisation.

Depending among other factors, on the type of organisation, the technologies it uses, the availability of human and other resources, alternative arrangements for the distribution of discretion in the organisation might be desirable. According to the discussions of chapter 7, the guideline for this modelling is to distribute as much discretion to lower structural levels, as it is consistent with corporate cohesion; the more dimensions of control are retained at higher structural levels the more constrained are the people in that organisation. The challenge is to hit an appropriate balance between control and autonomy.

-Modelling the organisational regulatory mechanisms; the mechanism of monitoring control and the mechanism of adaptation.

The modelling of the distribution of discretion provides the platform to study and/or design of mechanisms of monitoring control and adaptation, at different structural levels. The number of mechanisms that might be necessary to discuss could rapidly grow as the number of structural levels and primary activities grow. This part of the method makes use of Beer's work as explained in his book "Diagnosing the System for Organisations" (Beer 1985)

The method is discussed in two different modes:

- Mode I relates to existing organisations and is diagnostic in character. Its outcome is, in general, structural adjustments aimed at improving control and communications processes in the organisation.
  
- Mode II relates to organisations undergoing a fundamental change in identity or simply to new enterprises. Its outcome is a prescriptive definition of the control and communication processes likely to support an effective implementation of the organisation's agreed missions. Thus, its aim is organisational design.

In the diagnostic mode many of the difficulties in applying the Viable System Model stem from confusions about the purpose of the study; is its purpose to model the organisation as it actually works in the eyes of the analyst, or, is its purpose to model how the organisation should work based on VSM criteria? Are the discussions in

either case done with reference to what the organisation is currently doing (in the eyes of the analyst), or with reference to the espoused views of particular managers about what the organisation should be doing? Alternatively, are these discussions being done with reference to what the business plan might suggest the organisation will be all about in the future? Indeed, if the study is done with reference to new missions the mode may not be any longer mode I but mode II.

All these distinctions are subtle but important. If they are not worked out correctly, from the outset, the study is likely to confuse different forms of description and make very difficult a useful comparison between "reality" and the "VSM model". To a large extent success in using this method depends on establishing clearly the purposes of the study. It is only when these purposes are clear that the relevant "organisational identity" can be established.

The four parts of the method, though strongly focused in the modelling of a situation, need to be understood as parts of an iterative process, inserted in "real world" organisational debates (as discussed in chapter 6).

### **9.3 Organisational Identity**

What are the purposes ascribed by the stakeholders to their organisations. Which are the organisational activities that

they want to make viable. Answers to these questions permit to establish the organisation's identity.

However in practice the stakeholders have hazy ideas about the identity of their organisation. For instance, in many cases people in manufacturing companies are not clear whether their purposes are just manufacturing or are both manufacturing and distribution. The structural implications of one or the other identities are, as it was made apparent in chapter 8, and will become even more clear later on, significant. Haziness makes it more difficult to state uncontroversial criteria of effectiveness for particular organisations. Indeed, the effectiveness of an organisation depends upon its ability to make viable its organisationally agreed identity, but, the very problem may be that the stakeholders want to keep their options open, avoiding commitment to any specific identity.

Then, how do we establish an organisation's identity?

The main methodological tool for this purpose is to name the organisation of concern, that is, to name the primary transformation(s) of the organisation. Indeed, as it was implied earlier, depending on both the purposes of the study and the purposes ascribed to the organisation, a number of names are possible in any particular situation. Debates about these names may be "forced" at an early stage of the study, or may be left to later stages, after the application of the VSM has produced new insights. Most likely, in any

serious study, these debates will take place several times, at different stages of the study.

If there is evidence that there are important differences between the identities ascribed to the organisation by different people, then it might be useful to force an early discussion about these identities. This was the case in Parker Ltd. where there were two camps, each supporting very different identities for the company:

Name 1      A traditional owner-managed engineering company which manufactures fully assembled switchgear for supply to industrial end-users at the lowest cost consistent with high product quality (this is the name supported by the Parker-centred camp, it emphasises the manufacturing tradition of the company)

Name 2      A company which uses its expertise to advise users of electrical switchgear about the best equipment for a particular application and to provide that equipment either as a manufacturer or supplier (this is the name supported by the Market centred camp, it emphasises the marketing problems of the company and the need to develop synergistic interactions with other producers).

In general, the study of the organisation's structure is facilitated by a coherent definition of its business policy, including an agreed definition of its identity. However, if such agreements were not possible, then studying the structural implications of alternative viewpoints might help in the discussions.

Each identity implies a particular organisation structure if the organisation is to perform effectively.

In the above example, not dissimilar to P.M. Manufacturers, while the first name implies only the need to make viable the company's manufacturing, the second name implies the need to make viable both the company's manufacturing and services to clients.

Another instance to appreciate this proposition is given by the likely evolution of a "Management School" in a University under different identities. This evolution is likely to be very different depending on whether the School's identity is perceived as that of achieving academic excellence in specific management subjects, or as that of achieving excellence in the global subjects of "management and organisation". While consistency with the former identity is likely to lead the School to a "departmental" structure with marketing, finance, economics... departments, consistency with the latter is likely to lead it to a "business school" concerned with the viability of multidisciplinary teaching and research programmes.



Criteria for organisational effectiveness are very different in either case.

Another form of haziness is the case where the espoused view of the organisation's identity is in conflict with the "theory in use". For instance, if the espoused identity of a company were that of a manufacturing company but in practice, the analyst had established that it was operating in the manufacturing and non-manufacturing businesses, then it might be convenient to establish at least two names for the company's identity, one focused only in manufacturing and the other in both primary transformations. In the study of P.M. Manufacturers while managers perceived its identity as that of "a company to manufacture standard and non standard electrical generators for foreign and local markets", the investigator could observe a different identity for the company. For him it was clear that the company was also striving for the viability of its non manufacturing services (i.e. engineering services and spares procurement), and therefore, that any structural improvement would have to be based on the agreement of an identity like "company to produce comprehensive power generation services for local and foreign markets".

How does it help to establish the identity of an organisation?

In Mode I -the diagnostic mode- analysis is done with reference to the tacit missions of the organisation (as

perceived by the analyst). In general, analysts should aim at making apparent how the organisation actually works. They should hypothesise, as a platform for debate, their views about what the organisation appears to do. But also the study could be based on what managers claim the organisation is doing.

In this mode it is accepted that there is a reference organisation, and therefore that the study is based both in description and in criteria of effectiveness for the organisation's 'tacit' and/or espoused purposes.

It is only in a mode I study that analysts can make apparent mismatches between an "actual" structure and the "effective" structure as suggested by cybernetic principles. Figures 9-1 and 9-2 (the same as figures 8-7 and 8-6) help to appreciate the meaning of this mismatch. Figure 9-1 is a description of how P.M. Manufacturers works, as perceived by the investigator. Figure 9-2 would be a description of the same organisation if its current business areas, as defined by its tacit purposes, were effectively organised (according to the VSM). On the other hand, had the analysis been made with reference to the company's espoused view of its identity, that is, of a "manufacturing" enterprise, then the non manufacturing activities would have had to be considered as anomalous. Discontinuing these activities

Figure 9-1: Organisational Study: Theory in-use

*P.M. Manufacturers  
PM Organisation; Theory in Use*

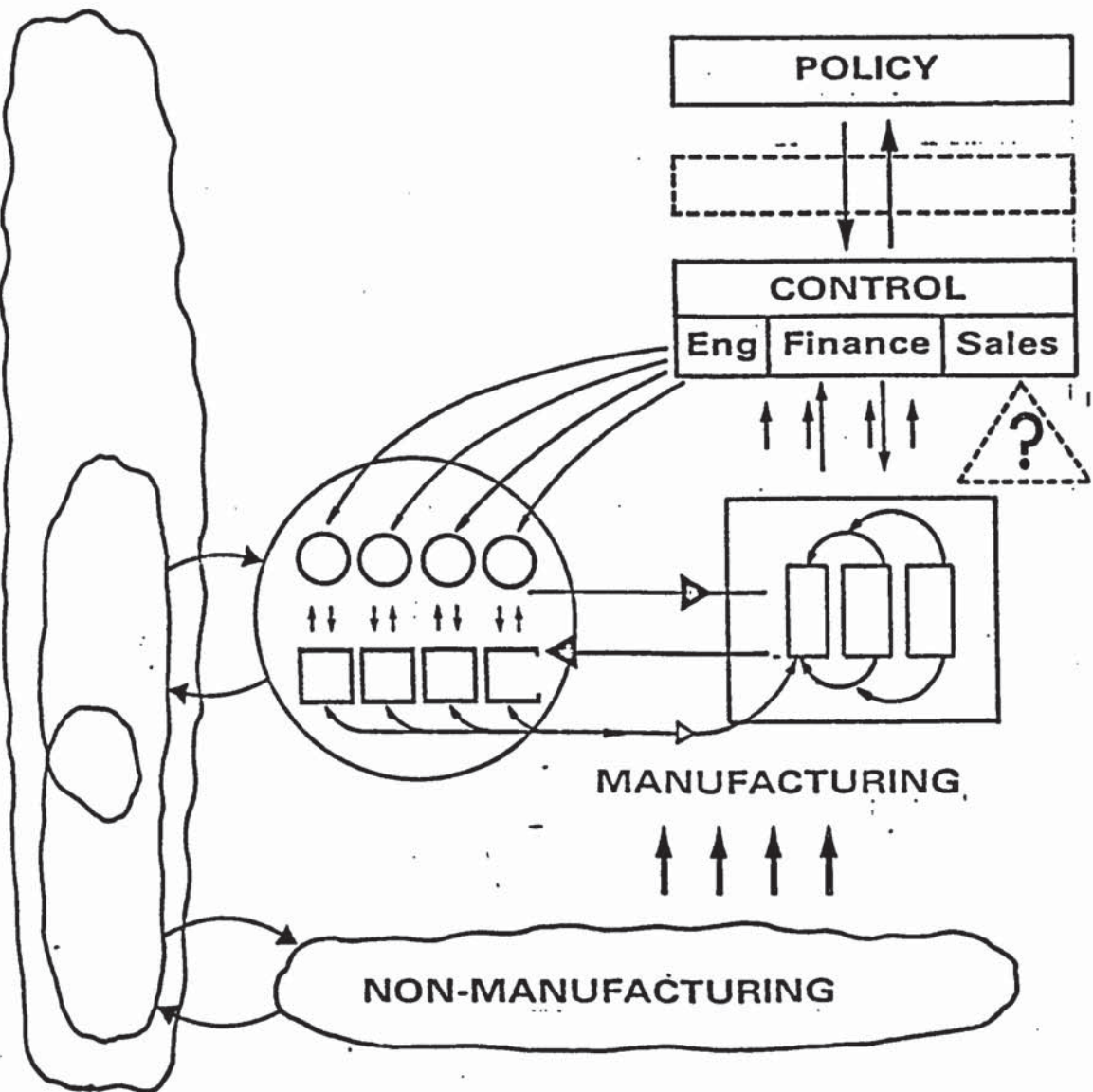
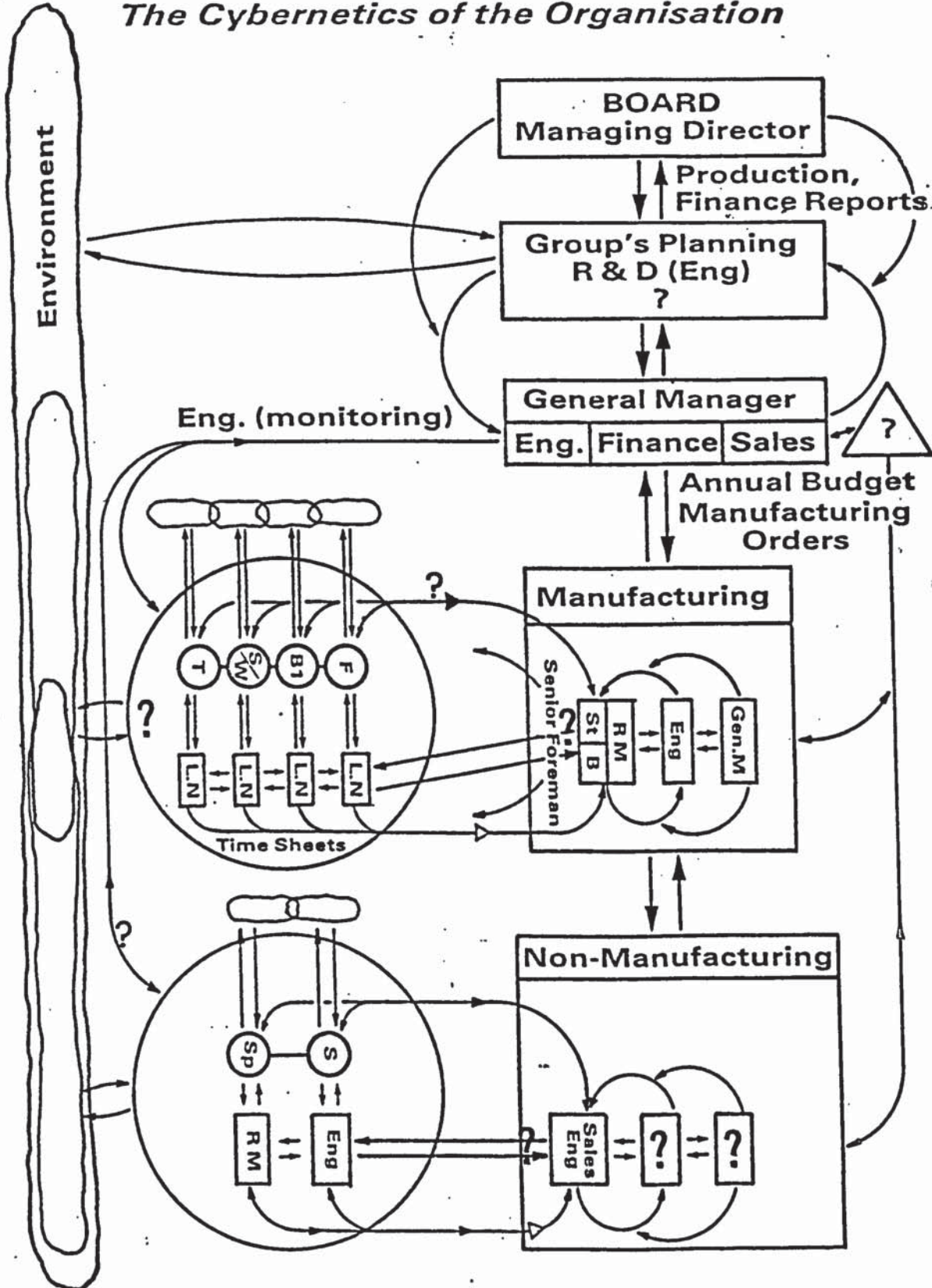


Figure 9-2: Organisational Study: Criteria of Effectiveness

*P.M. Manufacturers:  
The Cybernetics of the Organisation*



would be equivalent to collapsing the whole organisation onto the manufacturing division of Figure 9-2.

In mode II -the design mode- studies are done with reference to one or more statements of identity as defined by relevant actors. This mode is prescriptive and applies when the purpose (of the analysis) is to design an effective organisational structure consistent with the identity agreed by relevant actors.

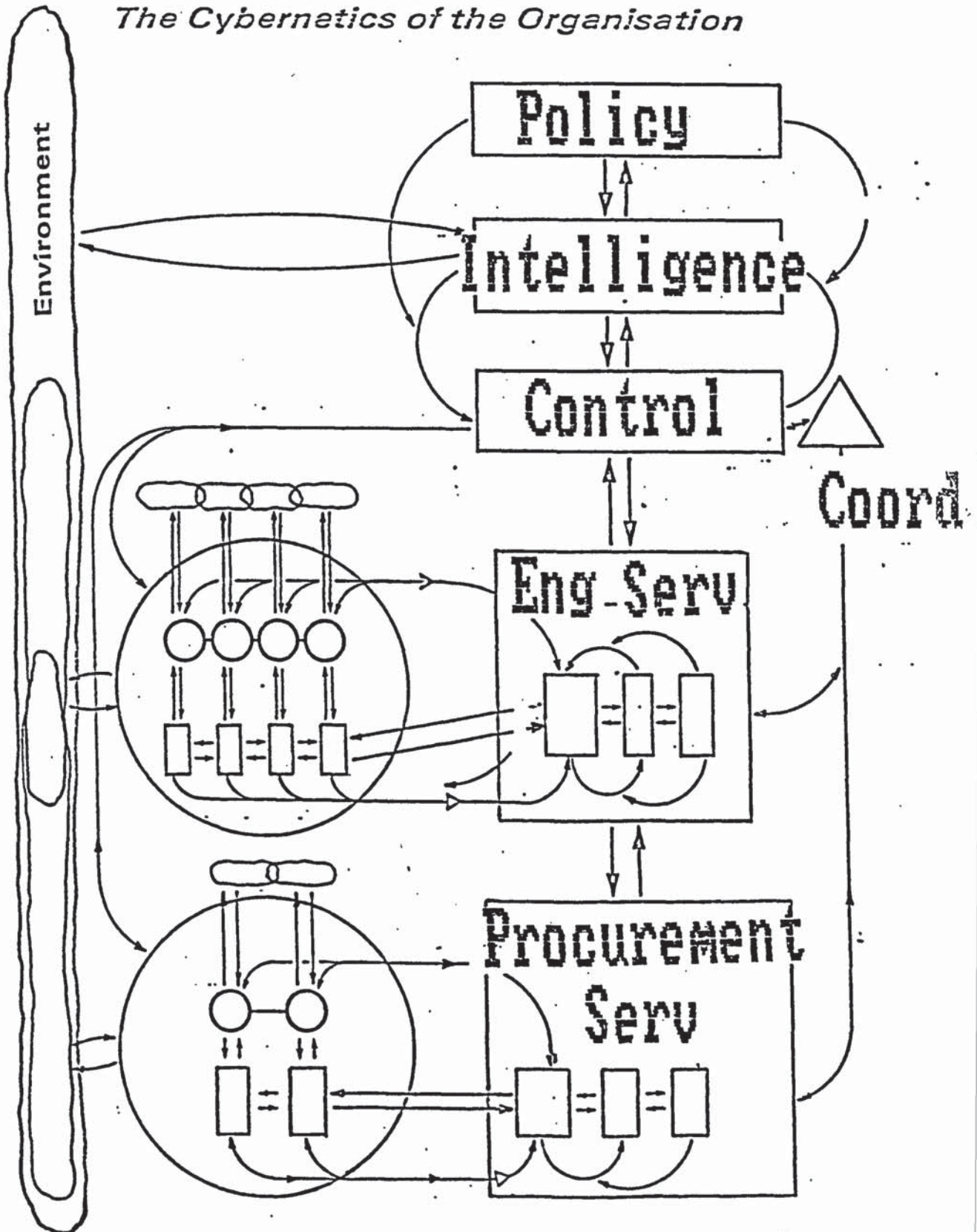
While the same criteria of effectiveness applies when the study is done in mode II, in practice, if the explicit purposes ascribed to an organisation are significantly different to those currently ascribed, then, naturally, the implied VSM for that organisation will have to be different. Figure 9-3 is an instance of a "possible" model for PM Manufacturers, given that the relevant managers agree in a shift of the company's identity from its current hazy manufacturing and services identity to a new identity only related to its non manufacturing services. The new structure implied by this identity would need to be designed.

While it helps to distinguish between modes I and II, in some cases, it might not be clear whether the analysis is being done in one or the other mode: indeed, it may not be straight forward to see how the current organisational weaknesses relate either to a hazy identity or to a new, yet unexplored, opportunity. For instance, for P.M. Manufacturers, non- manufacturing activities can be

Figure 9-3: Organisational Study: Structure for Service.

Company

*The Cybernetics of the Organisation*



perceived either as already having a degree of self organisation and therefore already defining the tacit identity of the company, or, as a new opportunity which lends itself to a Mode II analysis.

#### 9.4 Modelling Structural levels

Naming the system is a first step towards modelling the complexity of organisational tasks. However, in this process, it is also necessary the partition of the named primary transformations into activities that fall within the regulatory capacity of particular managerial levels. Establishing activities and their structural levels is one of the key strategies used by organisations to cope with the complexity of their tasks.

The complexity that managers see in their day to day activities is strongly influenced by this partition. However, in any organisation, that is, in any multisystem, different viewpoints will see different partitions. But, not all partitions are equally effective; the connectivity of activities in the real world suggests that, from the viewpoint of the management of complexity, there are partitions that are more effective than other. This is something that the VSM permits to appreciate.

However, it makes no sense to impose any such partition on the concerned managers. Methodologically, the problem is to separate different forms of description from the outset; is

the analyst modelling the complexity that individual managers should see, or is he modelling the complexity that they actually appear to see? Conflating these viewpoints is a typical pitfall in the application of the VSM. Analysts have to pay due attention to the views of the organisational clients! Indeed, it is by comparing the views of individual managers and the criteria of effectiveness as provided by the VSM, that useful improvements should become apparent.

In what follows I offer considerations to study how to partition tasks.

#### **9.4.1 Modelling technological activities**

The activities necessary to produce the named primary transformations are called technological activities. In this sense a model of "technological activities" is either a conceptual model of the activities necessary to produce the named transformations, or, a descriptive model of the activities producing the named transformations. The activities of concern are only those producing the transformations; any other activity, facilitating, servicing or, in general, regulating them, are not part of the model.

The boundaries of an organisation are defined, in the diagnostic mode, by those technological activities that the organisation actually performs, or, in the design mode, by those technological activities that it should perform. Those technological activities that are actually performed,



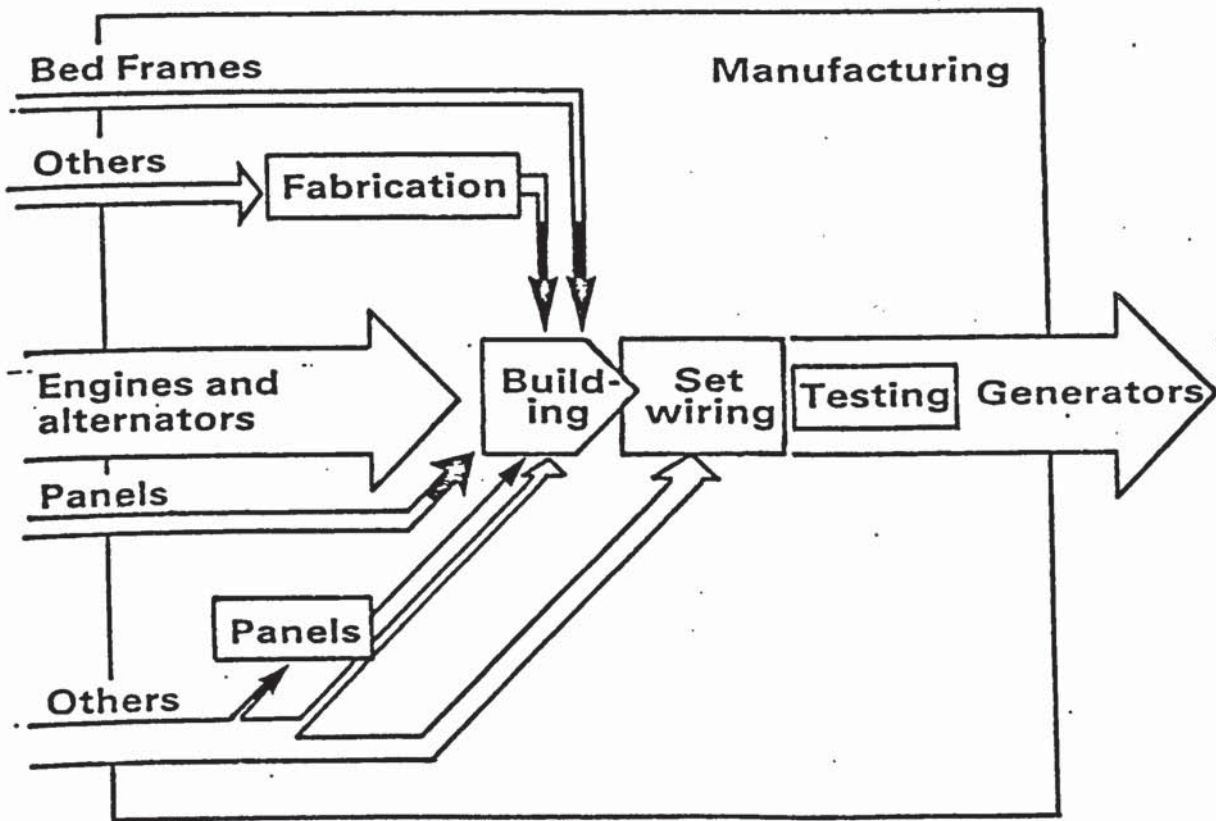
or are intended to be performed within the organisation, are its primary activities.

Indeed, there are a wide range of "technologies" possible to produce any transformation. In the manufacturing industry this range may vary from full "vertical integration" to almost no manufacturing in the case of an "assembly" plant. In the former case, the organisation's strategy is to produce within itself almost everything, starting from the "nuts and bolts", in the latter case the emphasis is in the very last stage of manufacturing. Thus, the same identity may imply different levels of task complexity. While the extreme cases may be easy to recognise, (names like "company to assemble electrical generators" or "company to fully manufacture electrical generators" are clearly different), the cases in between may only be distinguished with reference to their technological models.

Figure 9-4 (the same as figure 8-2) is one possible technological model for the "manufacturing of electrical generators". A number of alternative models could have been produced. In this example the model takes the form of a "quantified flowchart" (Beer 1975). The purpose of this quantification is to measure the complexity of the activities. In practice, most of the time, only proxy measurements like assigning money values to inputs and outputs and to the value added by each activity, are used to do this quantification. The purpose of the quantification is

Figure 9-4: P.M. Technological Model

*P.M. Manufacturers  
Manufacturing Flowchart*



to model, at any one level of resolution, activities of a complexity roughly within the same order of magnitude.

In a number of cases it may make sense to "open" each of these activities to produce a technological model at the next level of resolution (see figures 9-5, 9-6 and 9-7, relating to "Glass Ltd.") Producing these models is a form of variety engineering.

If information about inputs and outputs is not available, or if the interactions between activities is too complex to be described properly by a simple flowchart, then this type of modelling can be done, partially, by using boxes of different sizes, and boxes within boxes as described in figure 9-8.

In a mode I study, these models can be produced with reference to the "technology-in-use" in the organisation. By simple observation it should be possible to produce a descriptive model of the organisation's transformations. Whether or not these models, and the aggregations of activities implied by them, are a good example of variety engineering, is a judgement that should be left to experts in the transformations. In general, technological models in a mode I study are likely to be useful, simply because they are a summary of the organisation's expertise in managing complexity. But, they can also be dangerous; they may be the blinkers that constrain seeing other possible, and

Figure 9-5: Glass Ltd. -Quantified Flowchart Level 1

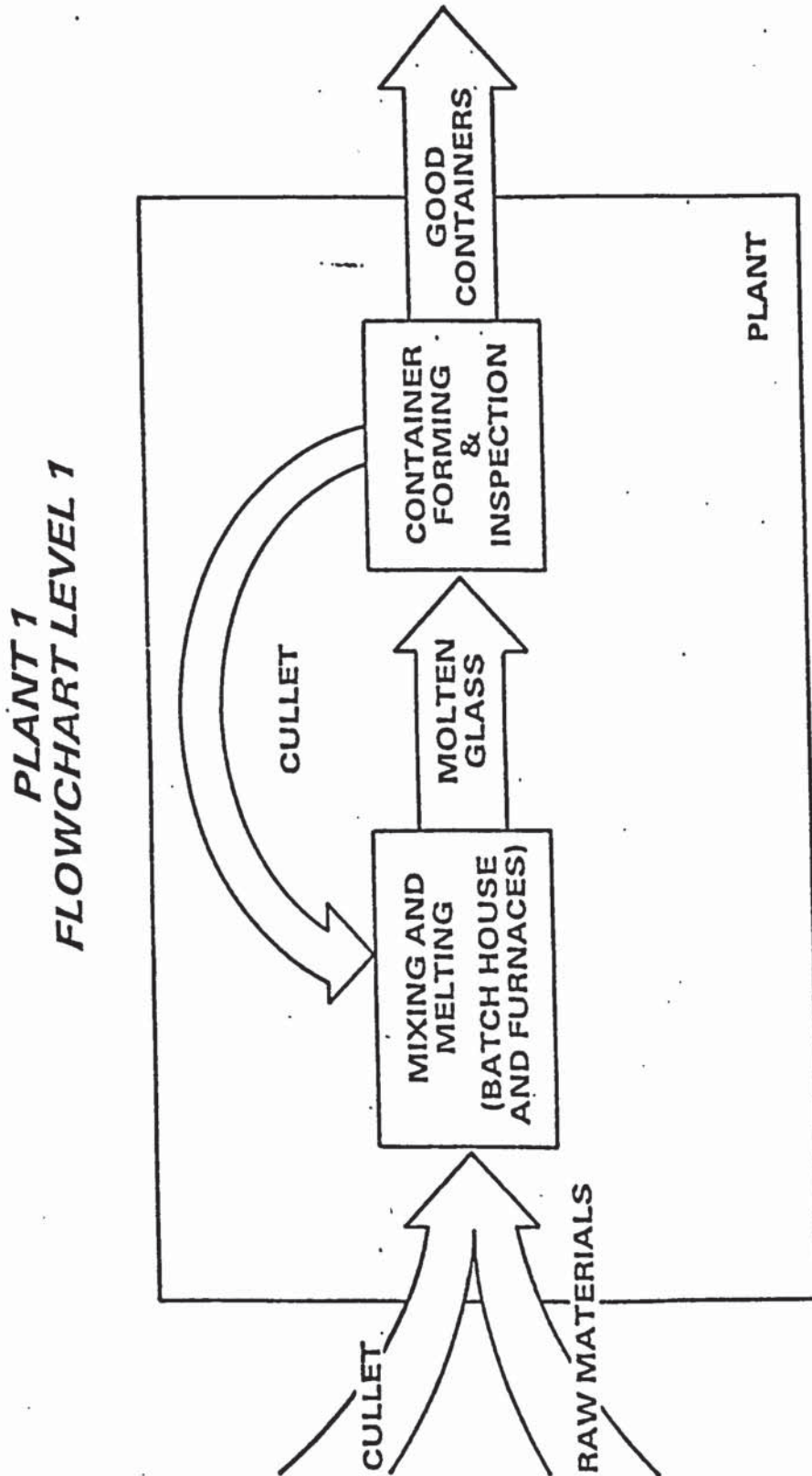


Figure 9-6: Glass Ltd. - Quantified Flowchart Level 2

**CONTAINER FORMING  
FLOWCHART LEVEL 2**

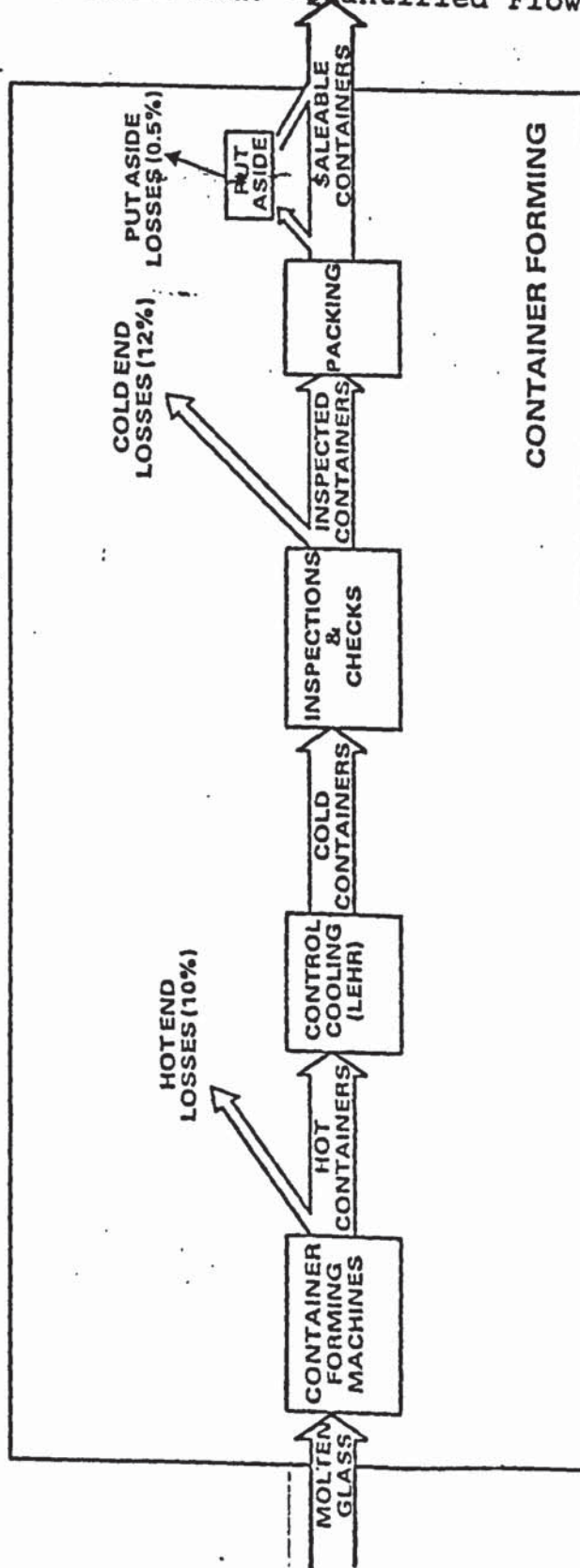


Figure 9-7: Glass Ltd. -Quantified Flowchart Level 3

**CONTAINER FORMING: INDIVIDUAL LINES  
FLOWCHART LEVEL 3**

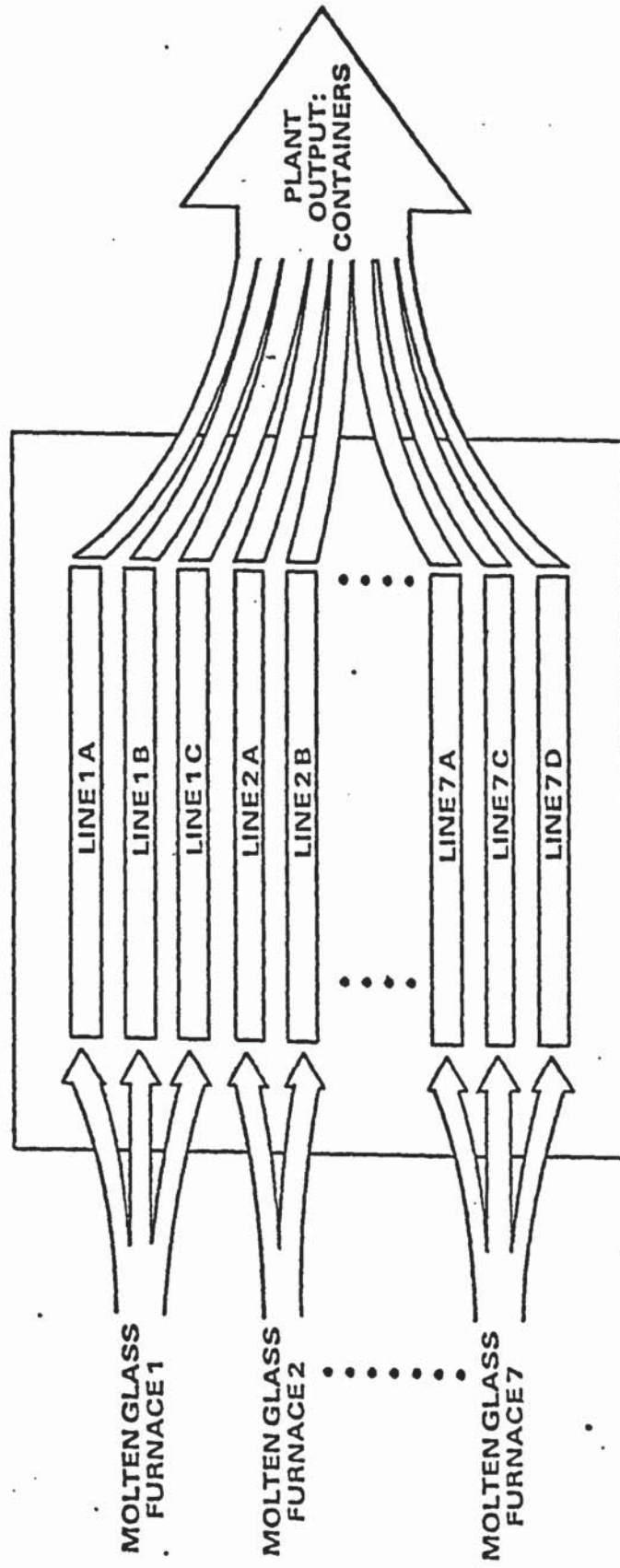
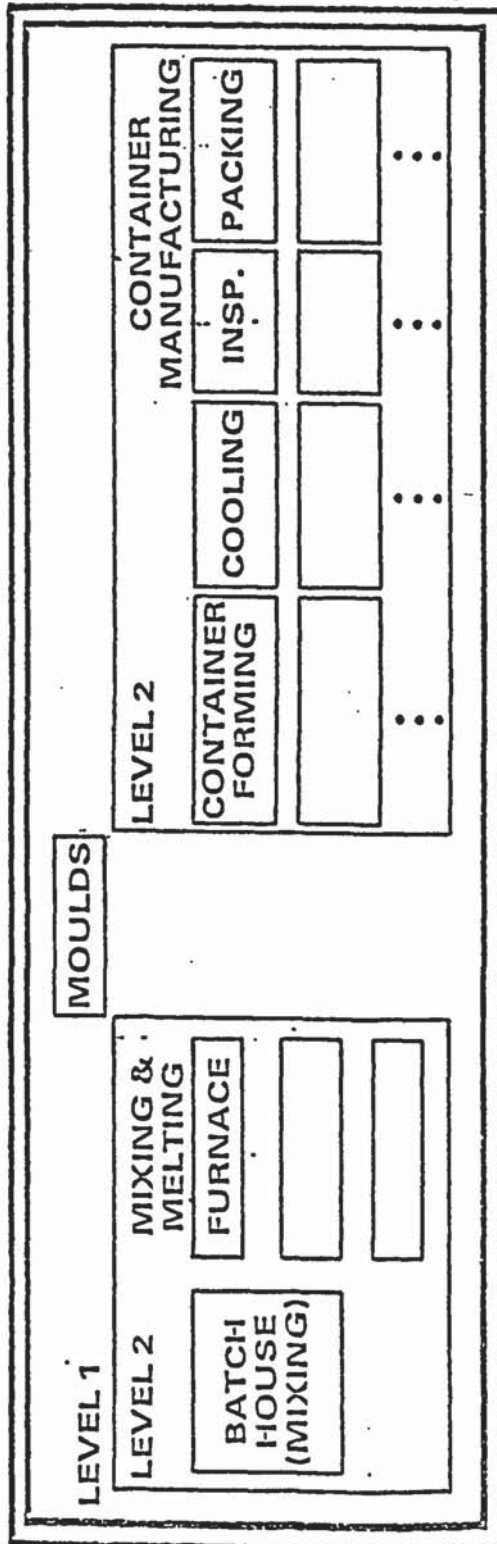


Figure 9-8: Glass Ltd. Technological Model

MODELLING 'TECHNOLOGICAL ACTIVITIES'



perhaps more effective, ways of handling complexity.

In a mode II study these models can only be produced with reference to expert knowledge. In this case good technological models are essential for an effective organisational design. In this mode the partition of activities is done with reference to expert knowledge.

#### **9.4.2 Modelling primary activities**

If a technological activity does not have, or is not intended to have, related regulatory capacity, then, it is not an organisational (primary) activity. It simply cannot happen in the context of that particular organisation. In other words technological activities become organisational activities (i.e. primary activities), if they have regulatory capacity attached to them.

This subtle distinction becomes particularly important in relation to technological activities that are perceived by managers as peripheral to the organisation's main missions. There is a risk that they may allocate no or inadequate regulatory capacity to them, creating awkward situations; for instance, the missing mile of road in between two plants, or, the missing vital services in a motorway, or, the many, all too common, similar situations in all organisations.



The regulatory capacity is given by **regulatory activities**, that is, by activities managing or servicing the technological activities.

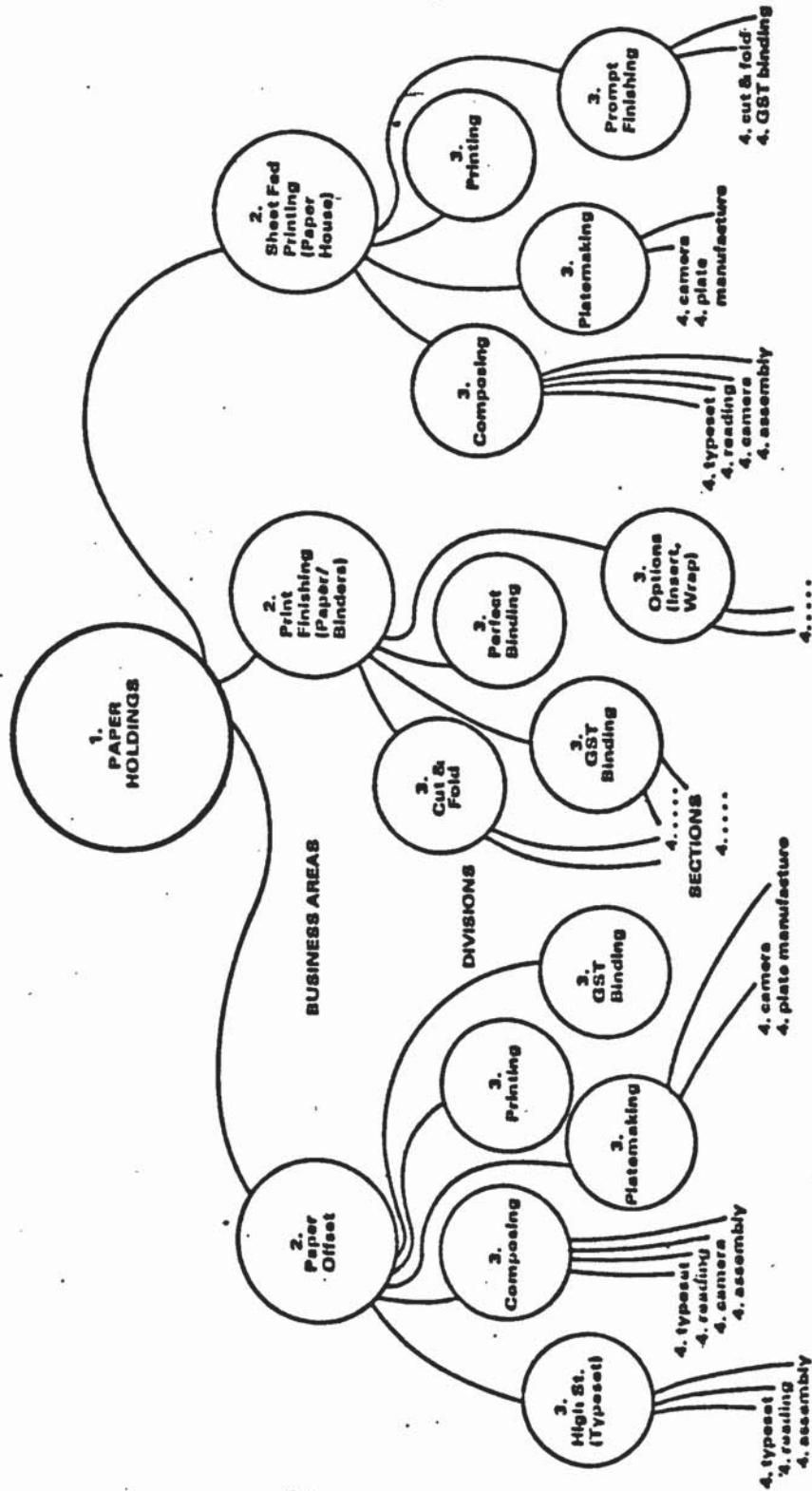
#### **9.4.3 How to recognise primary activities?**

In any enterprise, at the most general level the **enterprise itself** is a primary activity with reference to its primary transformations (i.e. missions). At the next level the "divisions" responsible for the products or services on which its viability depends, are the primary activities. Within these divisions the "sections" producing them are the primary activities, and so forth (see figure 9-9). In other terms, primary activities are all those activities which, in the framework of the currently agreed identity for the enterprise, have a transformation of their own. If hived off they would not lose the content of their transformations.

For instance, in a "manufacturing" company it may be possible to hive off parts of the production process (like "fabrication" in Figure 9-4) but it may not be possible to hive off activities like accounting, personnel... which do not perform primary transformations (i.e. technological activities). In a "manufacturing" company, in contrast to an "accountancy" firm, accounting is not a transformation producing the company, its purpose is to produce the company accounts as required to control the manufacturing activities.

Figure 9-9: Paper Holdings: Primary Activities

Exhibit 2: Unfolding of Complexity in 'Paper' Holdings



#### 9.4.4 How to establish structural levels?

Establishing the structural levels of an organisation is one of the key decisions in its design. Though in the long run the development of any organisation is more likely to be the outcome of self organisation than of blue prints by experts, design is likely to make this process less painful. Indeed, if the structure is just the outcome of trial and error, as it often is, the cost of developing the organisation may be too high, as proved by the often expensive swings from centralisation to decentralisation in large corporations: indeed self organisation can be facilitated by effective design, hence the relevance of having an approach to discuss the modelling of primary activities.

While the complexity that can be absorbed by any management level is limited to its information processing capacity, the complexity of the demands on that level increases as it pays attention to a larger set of regulatory variables.

Over-Simplifying, the need for another structural level will emerge when the latter complexity (i.e. the residual variety of the task) is perceived as larger than the former (i.e. the management complexity). In this event the complexity of the related primary activity becomes blurred to management and effective implementation will necessitate of another structural level. In general no single managerial level can penetrate in full the complexity of primary activities. Hence the need to partition these activities. Each of these

parts may need another structural level to make possible the production of primary transformations, and so forth. The complexity of the organisational tasks unfolds into several structural levels.

In a Mode I study, the partition of the organisation's tasks into primary activities is based on the organisation's strategies-in-use in producing the named transformations i.e. on its tacit technological model. In some cases it might be that there is a one to one mapping of technological onto primary activities. However, this overlap may be upset by organisational arrangements and decisions.

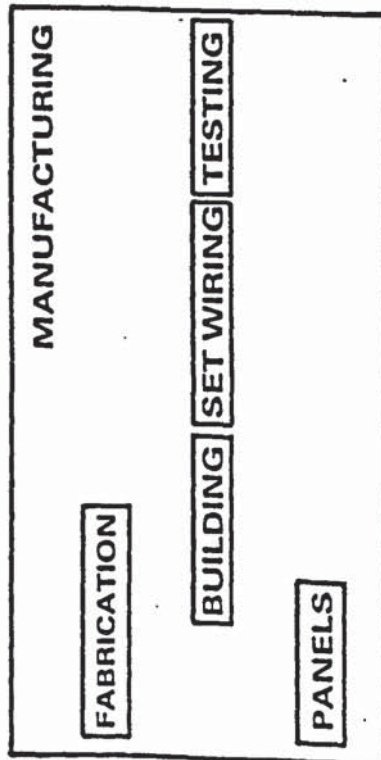
There are a number of factors, beyond the technological model, that may affect the unfolding of organisational complexity, for instance:

-management may think that it is more convenient to sub contract a particular technological activity outside the organisation, and therefore, by choice, decide not to have the related primary activity. For instance, the "division" related to the technological activity "manufacturing" in Figure 9-4 may or may not include within its primary activities the activity "control panels" (see figure 9-10). The latter case, in which the panels are sub- contracted outside the company implies not only different boundaries for the division but also a simpler manufacturing activity.

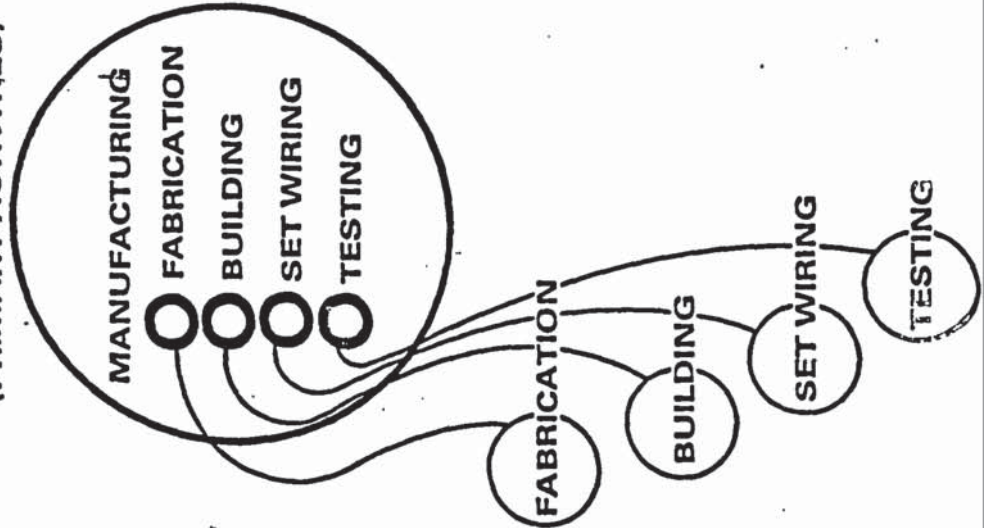
Figure 9-10: Technological Activities and Structural Levels

**TECHNOLOGICAL AND PRIMARY ACTIVITIES**

**TECHNOLOGICAL MODEL**  
(Technological Activities)



**UNFOLDING OF REGULATORY CAPACITY**  
(PRIMARY ACTIVITIES)



There is no regulatory capacity to do "panels". In fact the Company is sub contracting this activity outside the organisation:

Therefore, as can be appreciated in figure 9-10, while the technological model has five activities the primary activities model has only four.

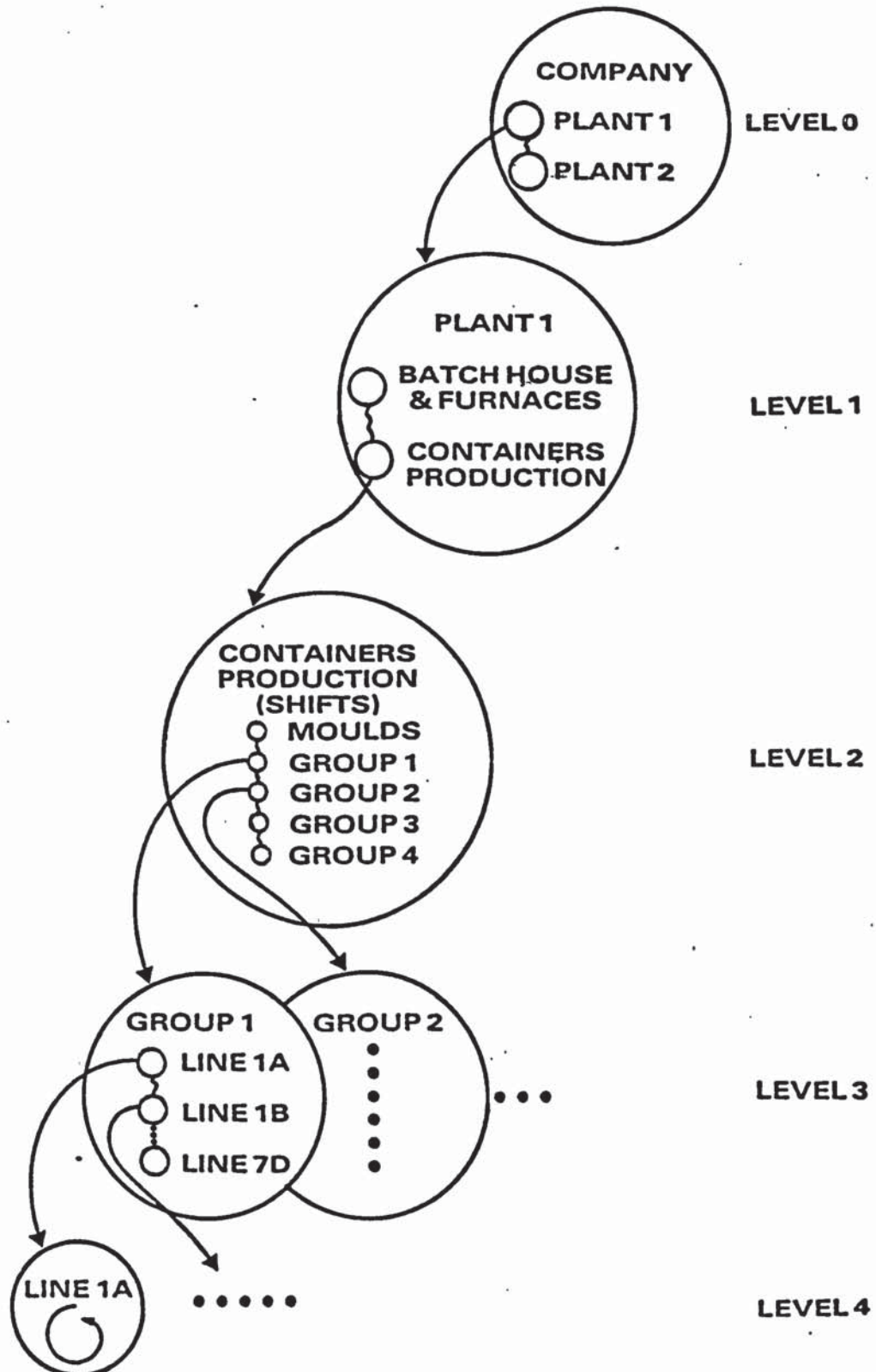
-it may be desirable to organise work in shifts or in different plants. In either case, from a regulatory point of view, there are one or more additional structural levels. This is the case in Glass Ltd. where the company's complexity is unfolded into two plants, and each plant's complexity is unfolded into four groups, each responsible for a shift. It is only within the shifts that the technological activities are made apparent (figure 9-11).

-management may consider that it is better to structure primary activities in forms that are different to those suggested by the technological models. For instance, a range of product lines could be manufactured either individually, under different management, or clustered under the same management. It is not difficult to appreciate that each option suggests different organisational arrangement for the same technological model. In this case a number of technological activities may be clustered under one level of management, collapsing two technological levels into one primary activity.

It is important to keep in mind that, in mode I, the actual decomposition of the organisation's tasks may not be apparent in the formal organisation structure. For instance in PM Manufacturers the "non manufacturing" primary activity

Figure 9-11: Glass Ltd. -Unfolding of Complexity

## GLASS LTD MODELLING PRIMARY ACTIVITIES



was not obvious from seeing the company's organisation chart. However, the fact that that transformation was taking place was made apparent by observing the company's outputs.

Indeed, the modelling of primary activities should be based on the model of the technological activities and not on the organisation chart. If a technological activity is taking place in the organisation, then, it is a primary activity and its structural position, de facto, is defined by its relationships with other primary activities, as implied by the technological model, and not by its position in the organisation chart. An instance of this situation was the case of "testing" in PM Manufacturers. While the organisation chart put it within engineering, the technological model made apparent that it was part of manufacturing.

In a mode II study, the modelling of primary activities should be done with the support of expert advice.

Alternative decompositions of the organisational tasks will depend upon both the technologies in use and the control strategies.

#### **9.4.5 Criteria to partition the organisational primary activities**

Regardless of whether a study is done in the diagnostic or design mode, it is useful to have criteria to discuss the aggregation or disaggregation of the organisational



missions. Are there criteria to establish whether the actual decomposition of these missions is adequate or not? To which extent should the technological model be replicated in the organisation structure? These questions are at the heart of the management of complexity. While good technological models (e.g. quantified flowcharts) are necessary for this purpose they are not sufficient.

The problem is to define the primary activities within primary activities and, as an outcome, the structural levels in the organisation. Primary activities, at any level, operate with a degree of autonomy.

In the partitioning of primary activities the following rule applies:

Partitioning of primary activities should aim at achieving a balanced distribution of complexity along each of the lines in which complexity unfolds.

A good example of this balanced partitioning of complexity is given by "Paper Holdings" (figure 9-9). Indeed, in this case while "High St." was an independent outfit and therefore could have been taken as a forth business area of the holding, the size of its activities was sufficiently small, compared with "Paper Offset", as to make sense its embedding in this latter business area. The implication of this decision was to reduce the complexity that corporate managers have to see in the second structural level; it is

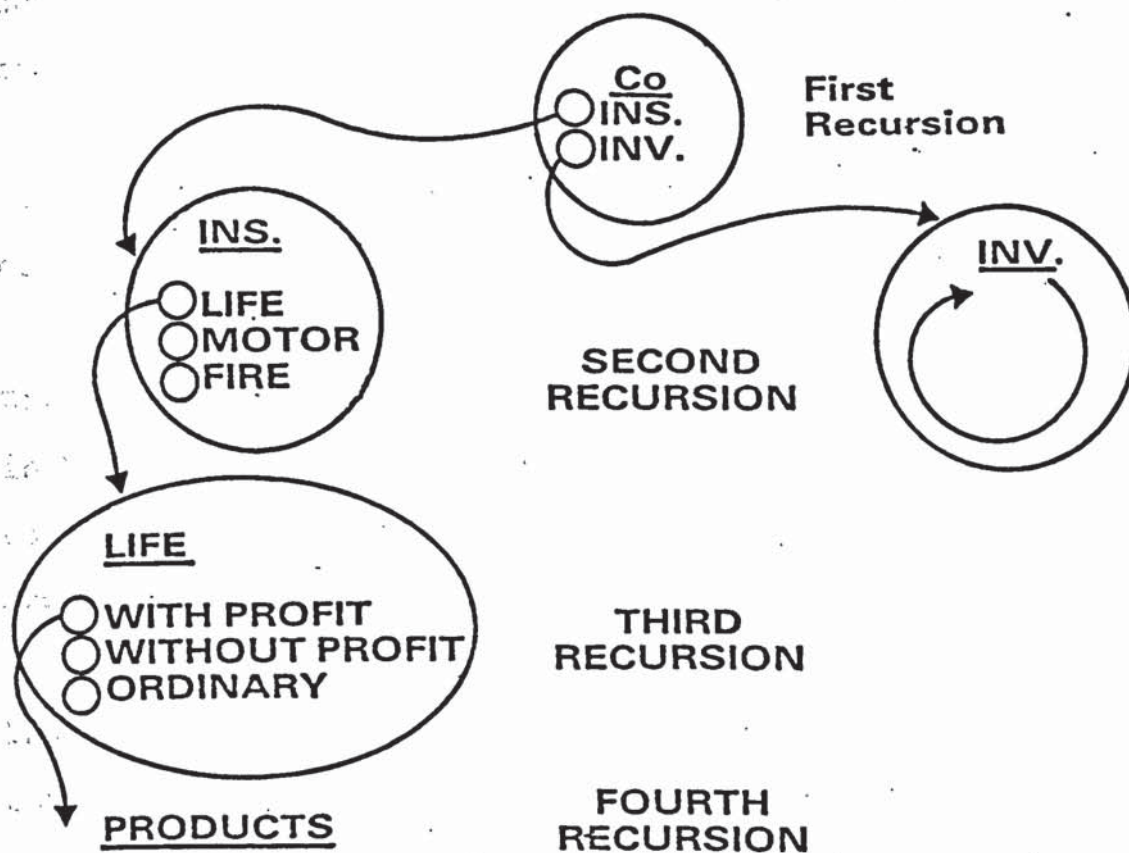
now the responsibility of "Paper Offset" management to see the complexity of High St.

Though this is a sound rule that reduces the demands on senior management, there are cases in which either the technological model or the strategic nature of a particular activity may require that it is managed at a higher structural level than that suggested by its complexity. This is the case, for instance, of the insurance company in figure 9-12, which has two primary activities at level one, the insurance and the investment activities. While the complexity of insurance is large enough as to require four structural levels to absorb in full its complexity, investment only requires of two levels to absorb in full its complexity. In this case, it should not be difficult to see that a technological model of the insurance activity would make apparent that investment is a global activity, independent of specific insurance types.

Another common case of imbalance in the distribution of complexity is provided by small new strategic units, hanging at the corporate level. Often they become problematic; on the one hand they should not be constrained by structural rigidities, -something likely to happen if they operate at a too low structural level- on the other they should not become a burden to senior managers -a clear possibility if they operate for too long at high structural levels. Changing the structural position of these units, as they grow and mature, is in itself a strategy that managers

Figure 9-12: Unfolding of Complexity in Insurance Company

**UNFOLDING OF COMPLEXITY FOR AN  
INSURANCE COMPANY**  
(Imbalance between two lines of complexity unfolding)



should be aware of in order to manage their complexity effectively.

Summing up, in mode I the modelling of primary activities is a description of the actual "unfolding of complexity" in the organisation (Figures 9-9, 9-11 and 9-12). In mode II this modelling is the modelling of the designed regulatory responses, design which, as suggested above, should be supported by expert advice and/or by any previous organisational experience.

#### 9.5 Modelling the Distribution of Discretion in the Organisation

Different structural arrangements imply different strategies in "matching" managerial regulatory complexity to task complexity. There are multiple possible structural forms to absorb the complexity of the same tasks.

The structural forms responsible for absorbing the complexity of tasks in an organisation, are defined by the regulatory mechanisms in use at and in between structural levels.

To perform a task, the more centralised is the organisation structure, the more likely is that additional structural levels will be necessary. The more centralised is the structure, the more functions are retained at higher structural levels. This means that higher structural levels

Figure 9-13: Table Recursion/Functions

Recursion - Function Table:  
Distribution of Discretion in 'Paper' Holding

FUNCTION		PRODUCTION		BUYING & STOCK CONTROL		MAINTENANCE		TRANSPORT / DESPATCH		SALES & PRICING	PER SONNEL	EDP	FINANCE			COSTING & ESTIMATING	
		Planning	Control	Paper	General	Routine	Repair	Own A/c	Contract					Cash Flow	Profits	Wages	
LEVEL OF RECURSION	High Street																
	Composing																
	Platemaking																
	Printing																
	Binding																
	Paper Web Offset																
	Cut & Fold																
	GST																
	Perfect																
	Insert & Wrap																
	Paper Binders																
	Composing																
	Platemaking																
	Printing																
	Prompt																
	Paper House Press																
	HOLDING																

each structural level, in mode II it permits to establish the desirable functional responses at each structural level.

In mode I at least two types of tables are possible; those recording the "actual" distribution of discretion, and those recording the "desirable" distribution of complexity after applying criteria of effectiveness. Therefore, in a diagnostic mode it should be possible to produce an overlay of actual against desirable distribution of discretion. Though the production of this overlay may not be possible until after the discussion of regulatory mechanisms, there are, as will be seen next, some general rules that emerge from the actuality table that permit to improve the management of complexity in the organisation.

In mode II only the second type of table is meaningful; indeed there is no actuality to use as a reference.

The table "recursion/functions" is used to establish the dimensions of control exercised at each level of recursion. By definition the name in front of a row is the name of an autonomous primary activity; the dots in it define the names of the functions that are discretionary to that primary activity. In other words, the dots in one row define the functional dimensions whose discretion is taken away, fully or in part, from the primary activities at lower levels of recursion.

If a column has only one dot, and this is at the highest level of recursion e.g. EDP in figure 9-13, then, the function is totally centralised. On the other hand a column like "production control" suggests the case of a decentralised function where discretion is distributed within the organisation.

Since, in general, primary activities are viable systems, the functions in a row (i.e. the dots) should include control and intelligence functions for the related primary activity. If "intelligence" functions are not present that would be a sign that capacity for adaptation is lacking. If control functions are not present that would indicate that there is no capacity to link together two successive recursion levels.

To make effective the complementarity control-autonomy, that is, to make possible both the autonomy of the parts and the cohesion of the whole, a global rule is to centralise the formulation of "co-ordination policies" for those functions common to a group of primary activities, and to decentralise their implementation. A fuller discussion of this rule will be done in the next section.

There are other rules: for instance, it is not advisable for a control activity to by pass recursion levels, that is, it is not advisable to have a dot at level 1 (highest level), a gap at the next, and again a dot at level 3. Cases like this would suggest that the first level is intruding in the

autonomy of level 2; level 1 might use the regulatory capacity implied by the dot at level 3, to monitor level 3 primary activities, that should be monitored by level 2. For example, if there is quality control at the corporate level, at the same time that there is no similar function at the plant level, but there is again quality control at the shopfloor level, then, the likelihood is that corporate managers -because their 'direct' link with the shopfloor- will be better informed about production quality than the plant managers, who happen to be the ones responsible for the control of shopfloor managers.

If a centralised unit performs a distributed function -which provides resources to primary activities at several structural levels- but there is no indication of a capacity to control the function in a distributed fashion, then, it should appear as a single dot in the table recursion-function. However, in the "effectiveness" overlay it should appear as a distributed function (i.e. with dots at all the appropriate levels and not at the higher level alone). For instance, though it may make sense to have one Central University Library, functionally it is bound to be decentralised; its role is to support lecturers and research groups. Hence, as a matter of fact, it functions at lower levels of recursion. In this case the "normative" table recursion/functions should have, as suggested above, dots at all the appropriate levels and not only at the higher level. Problems emerging from an inconsistency between the theory



in use, and the effectiveness criteria, are discussed in the next section.

At any particular structural level discretion relates to the specific functions that that level is accountable for, regardless of whether these functions are of a control, intelligence or co-ordination kind. These functions define, so to speak, the 'dimensions' for which the lower level primary activities have lost their autonomy. Autonomy, itself, does not have dimensions, it relates to the action/possibility space that is left open, at each level of recursion, after taking away the discretionary functions of higher structural levels. A particular level may have a larger or smaller degree of autonomy; this degree being defined by the functional discretion that higher structural levels take away from it.

It is important to realise that while the distribution of autonomy in an organisation is an outcome of 'complexity unfolding' -something that is made apparent by the modelling of primary activities-, the distribution of discretion is an outcome of the distribution, between recursion levels, of 'regulatory functional capacity' - something that is made apparent by the table recursion/functions.

## 9.6. Study and Design of Regulatory Mechanisms

The table recursion/functions gives the platform to diagnose and/or design the mechanisms of monitoring-control and adaptation. These are the two main regulatory mechanisms emerging from Beer's Viable System Model (see chapter 7).

The VSM makes apparent that primary activities at all structural level need both these mechanisms to remain viable. Capacity for adaptation is necessary not only to respond to unforeseen changes in the environment, but also to create the organisation's future. Control capacity is necessary to maintain cohesion and develop synergy.

In mode I, the diagnostic mode, the study is focused in the capacity of the actual communication channels within, and between, the control and implementation function. This study should permit to discuss the adequacy of the regulatory mechanisms in use.

In mode II, the design mode, the design is focused in designing structures with adequate complexity to perform the tasks implied by the organisation's identity, in particular, the design aims at establishing the necessary channel capacity to give requisite variety to the interactions among the entailed structural parts.

The diagnosis, and also the design, of these mechanisms is discussed by Beer in "Diagnosing the System for

Organisations" (Beer 1985). The discussion that follows makes only slight adjustments to Beer's work.

#### 9.6.1 The Mechanism of Monitoring-Control

When studying this mechanism the main concern is studying the relationships between recursion level X and primary activities at recursion level X+1.

In designing the interaction between structural levels the rule is, as discussed in chapter 7, to minimise the intervention of the higher levels. The smaller is their interference, the larger is the scope for the lower levels to develop their potentials. The clearer is made, in operational terms, whether a regulatory activity is of a "control" or "co-ordination" kind, the more likely is that lower levels will not perceive unnecessary interference in their own affairs. Organisations where this rule is upheld are those where management takes the view that its role is to service the organisation's primary activities and not to command them. Historically, the trend seems to be going from the 'old' organisations, strongly 'command' orientated (following taylorism and fayolism), to the 'modern' organisations, strongly 'co-ordination' orientated (Child 1987). For example, this appears to be the philosophy behind the recent establishment of science parks in the USA and UK (Department of Industry 1982), where almost all of the interactions between the parks' management and the park's

tenants (i.e. the entrepreneurs) are of a 'co-ordination' kind (i.e. of providing common services).

The detailed cybernetic implication of this rule are discussed in what follows.

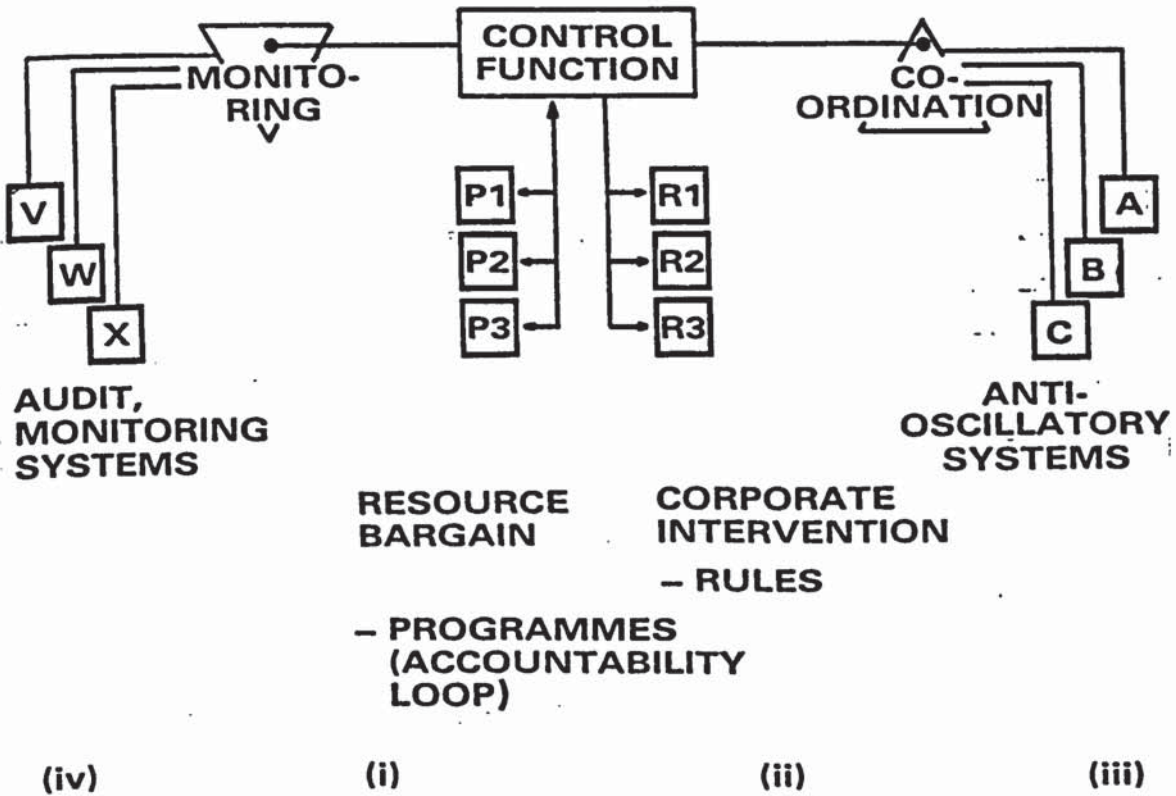
Four different types of communication channels link the control and implementation functions; these are the resources bargaining, the corporate intervention, the co-ordination and the monitoring channels (figure 9-14). We will discuss their meaning from the viewpoint of the management of complexity. Of the four channels, only the first two -resources bargaining and corporate intervention channels- are intended to constrain the variety of the implementation function, the third channel -co-ordination- is intended both, to amplify the control function's variety, and, to attenuate the variety that the control function needs to see in the implementation function, and, the fourth channel -monitoring- aims at amplifying the variety of the control function. Jointly, they contribute to the structuring of a control mechanisms that fulfils the criteria of effectiveness discussed in chapter 7.

### **Resources bargaining**

Resources bargaining is the process by which programmatic agreements are reached between the managements of two successive structural levels; X and X+1. In these negotiations the plans of the "global" primary activity

Figure 9-14: Design of Monitoring-Control Mechanism

**MONITORING – CONTROL**



From: S. Beer  
 Diagnosing the  
 System for Organisations  
 Wiley, 1985

(e.g. the company) are transformed into programmes for the "entailed" primary activities (e.g. the divisions). For instance, the expected financial results for the company should be consistent with the divisional programmes. Of course, as in any negotiation, both sides should adjust their positions to achieve consistency. These should be continuous negotiations, where plans and programmes are adjusted in the light of any additional information. The Viable System Model makes apparent that these negotiations do/should take place in between any two successive levels, that is, negotiations, planning and control are taking place in between all levels with autonomy. This makes apparent that negotiations, planning and control are distributed processes.

#### **Corporate intervention**

The need for "corporate" intervention varies from situation to situation. It is necessary to reduce the chances of costly errors, and increase the chances of co-ordinated action; rules are required in all cases where the perceived costs of breakdowns outweigh the benefits of freedom at lower structural levels. Instances of these rules are the application of legal and safety rules in a corporation. The structural level responsible for establishing and/or working out a "regulation", and for monitoring its implementation, is the "intervening" level: this level is constraining the freedom of lower structural levels. This channel is the one

most likely to be over-used, and misused, if co-ordination and monitoring do not ensure cohesion.

### **Monitoring**

Control managers should monitor only the activities of the immediate lower structural level. To intervene beyond this level is an intrusion in the autonomy of lower structural levels. This is a common diagnostic point. This was discussed above with reference to the recursion/functions table, when 'dots' appeared at levels of recursion 1 and 3, by-passing level 2.

In a mode I analysis it is common to find that managers fail to adhere to the monitoring rule.

In small companies, with highly centralised management, while it is easy to recognise an unfolding of task complexity into primary activities, it is not equally easy to recognise a parallel unfolding of managerial responsibility (perhaps, because senior managers do not appreciate that autonomy, at all structural levels, is a necessary strategy to give viability to primary activities). The result is senior managers monitoring activities two or three structural levels below the right level (Ben Ali 1986).

In larger organisations it is common for managers to have hazy views about the focus of their managerial attention

(i.e. about their system in focus). Therefore, unwittingly they cross the boundaries of structural levels simply because they are unaware of the "management of complexity" issue.

Different managerial styles are used in this monitoring activity; some managers, those with an analytical cognitive style, prefer to be close to the tasks, and therefore they tend to focus their complexity "lenses" at too high a resolution level. On the other hand other managers, those with an intuitive cognitive style, prefer to distance themselves from the tasks, and therefore tend to lose control of them, simply because they fail to monitor even the most immediate structural level (Ben Ali 1986).

The control function should monitor primary activities both globally and along each of the dimensions of control (i.e. along each of the functions for which it has functional capacity). The monitoring that managers at recursion level X make of level X+1, should be focused in information about the relationships between managers at level X+1 and people at level X+2.

### **Co-Ordination**

Co-Ordination is indeed a high variety activity, it relates to the detailed interactions between primary activities, and not to any form of global, aggregated, overview of these activities. Therefore, while periodic meetings among the



concerned managers may be useful, they can deal, as far as the complexity issue is all about, only with the tip of the iceberg. The co-ordination function is aimed at facilitating the ongoing interactions among primary activities.

In general the co-ordination of primary activities can be achieved either by direct supervision, mutual adjustment or, of course, by any combination of the two.

If the emphasis is in direct supervision, the 'control function' takes on its 'shoulders' the responsibility to work out, in detail, the implications of the interactions between the primary activities. This option would imply, in the extreme, to develop the "co-ordination function" within the control function. The control function is taking the option to match from within itself the vast complexity entailed by the interactions between primary activities. If building up this capacity proves an impossible task, then, its response vis-a-vis the operational demands of the primary activities, is bound to be inadequate.

If the emphasis is in mutual adjustment, the emphasis is in facilitating the direct interactions among primary activities. The responsibility for co-ordination is left in the hands of those who are directly affected by the interactions themselves, that is, the strategy is to distribute the co-ordination of activities. The variety that can be absorbed by this latter strategy is much higher than that of the former strategy. This strategy not only avoids

unnecessary bureaucracy, but enhances the chances of local autonomy. It constitutes a true co-ordination function in the cybernetic sense.

Perhaps, co-ordination is the key function that differentiates the well organised from the less well organised enterprise. While control, intelligence and policy are based on aggregations, and therefore their development can take place in a relatively short period of time, and at a relatively low cost, the development of an effective co-ordination function depends on the capacity to build up systems to cope with the huge complexity of primary activities, and this is something that takes time and large quantity of resources. This point highlights the difficulties and relevance of a proper design for the co-ordination function.

In general it makes sense to develop a mixed strategy for co-ordination, one that takes advantage of the control function's global stance, and, of the implementation function's much larger capacity for problem solving. In this context, it is possible to think in at least three alternative types of co-ordination systems. They offer pointers for design:

-It may be necessary to have systems to amplify the outcomes of the "resources bargaining" from within the control function. These outcomes, as explained earlier, are aggregated programmes establishing perhaps the commitments,

and expected results, agreed by primary activities. If these activities share common resources and facilities, or depend on others to perform their own activities, then, for as long as the complexity of these interactions is not too high, it may be advantageous to support co-ordination (i.e. to work out the detailed implications of the resources bargaining) from the corporate level. Timetables in a school, or production schedules in a plant are good examples of this kind of co-ordination. These are cases where one activity depends on the results of or decisions about other well defined activities or where the allocations of time and space are likely to be stable.

-It is also necessary to have systems to facilitate "local" communications among primary activities. These are systems aimed at producing a "common language" at the local level. This form of co-ordination is particularly relevant when there is an on going need for mutual adjustments among primary activities (i.e. two way interactions). In this case it makes sense to avoid the proliferation of local (accounting, control, planning...) dialects. Schemata for planning, accounting systems, costing standards, production control systems are but a few of the possible designs to facilitate these lateral, two way, interactions.

-Finally, it is also necessary to have systems that increase the likelihood that primary activities will behave in a co-ordinated fashion. These systems intend to reduce the need for "one to one" communications, in favour of "one to

many" communications. The use of newsletter, boards and the like are good examples of this form of co-ordination. But perhaps the most powerful way to attenuate idiosyncratic behaviours is by the development of common customs and traditions (social mores) in the organisation.

Whether any one, or any combination, of these forms of co-ordination is more effective will depend on the nature of the interactions between the parts. A rich on going, two ways, interaction is likely to require mutual adjustments, and therefore may need to use co-ordination systems of the second kind, on the other hand a more structured kind of interaction, which, additionally requires an overview of all the parts, may require or favour a co-ordination system of the first type.

Co-Ordination systems can be specific to particular structural levels or can be general to all people working in the organisation. A timetable, for instance, may be specific to a teaching programme. On the other hand, social mores affect all people at all levels. This latter form of co-ordination relates to the ethos of an organisation and is part of the "co-ordination function" at all structural levels.

Also, in other cases, like when establishing accounting systems for an organisation, or providing common services like "library services" in a university, they become part of

the mechanisms of monitoring control at all those levels which are affected by these functions or services.

A case like a Central University Library is of interest; systemically its services are distributed, it is affecting the interactions of lecturers with students and it is affecting the interaction of researchers with the environment. To establish the need for these services, and to allocate the available resources, it would be necessary either that the Library negotiates directly with the concerned lecturers and researchers, and therefore intrudes in the autonomy of faculties and departments, or, to avoid this problem, it would have to have the support -for this allocation and the related control- of faculties and departments. For this latter arrangement to be effective, it is necessary to support not only the resources bargaining but also the details of how to make any allocation of resources effective. The latter is a co-ordination activity. Hence, "library services" should be considered in the design of the co-ordination function for faculties and departments, as well as for the whole university.

Summing up, the four types of communication channels -for resources bargaining, for "corporate" intervention, for monitoring and for co-ordination- need to be considered in studying, and/or designing, the interactions between control and implementation functions. The rule is to minimise the use of the first two while developing as far as possible co-ordination. It is important to visualise that even in

simple cases like, for instance, the study of a company with three divisions, and each division with three sections, the number of mechanisms of monitoring control to consider, and design, would be beyond single figures.

#### 9.6.2 The mechanism of adaptation

The diagnosis and/or design of the mechanism of adaptation requires that we look at the interactions between the control, intelligence and policy functions.

##### The intelligence function

A form of measuring the magnitude of the adaptation problems of a primary activity it is to ascertain the perceived (by the relevant managers) opportunities and threats in the environment.

If the study is in mode I, this measuring requires to work out for each of the perceived issues the viewpoints (i.e. organisational units or individual people) dealing with them, the time frame in which the issues are being considered and their perceived priority.

For this purpose it is necessary to establish the 'outside and then' issues, or activities, significant to this structural level (i.e. to this named system). People mix activities belonging to different structural levels; they are not necessarily aware about structural levels, or, for

this matter, about criteria for an effective management of complexity. In a diagnostic mode the table recursion/functions may permit to cross check, and focus, the perceived 'outside and then' issues. Once named issues, or activities, have been accepted as genuinely belonging to the named system, for each of them, it should be possible to established the responsible viewpoints, the time horizon and priority (see figure 9-15).

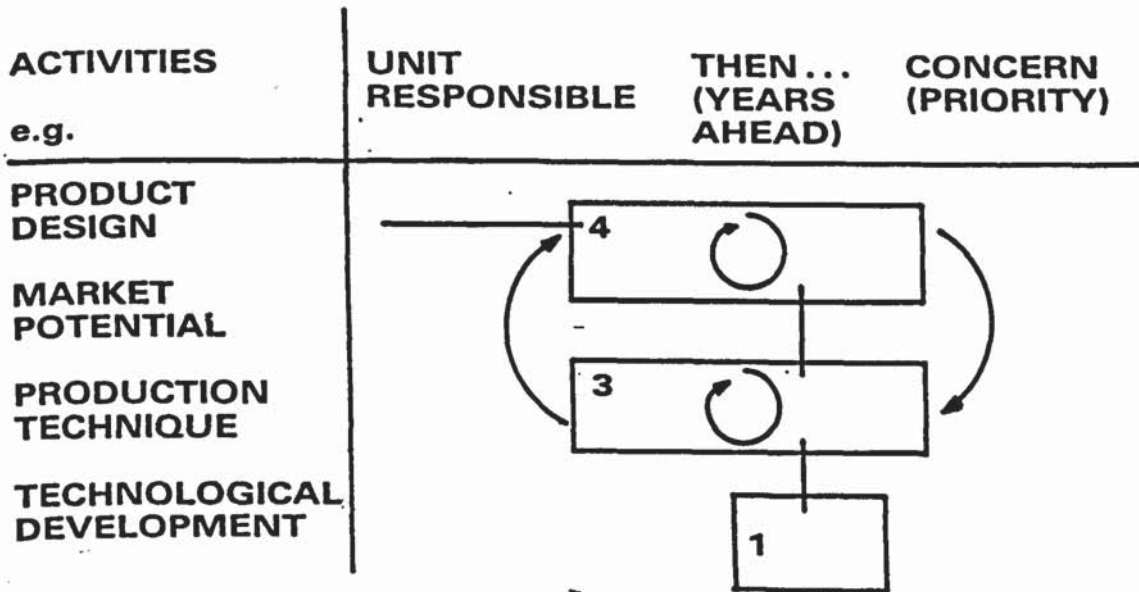
The next step in this study is to assess the "complexity" that the viewpoint is seeing in these issues, and also the capacity of the communication channels linking these units. This is a crucial step. A set of weakly interrelated units increases the likelihood of uncoordinated views about the future and reduces the chances of an integrated strategy for the primary activity as a whole. Also, a scattered arrangement is likely to produce unnecessary duplications and gaps in communications, particularly with the units and/or people performing control and policy activities (Manancourt 1988).

Indeed, there is a need for some kind of cohesion among all those units, or individuals, that are concerned with the future at the same structural level. As a whole they define, more or less effectively, the model that the primary activity has of itself. The reference to assess the effectiveness of this model is given by the agreed identity for the primary activity.

Figure 9-15: Intelligence Function

***Intelligence Function***  
**(ANTICIPATION, ADAPTATION)**

**LIST OF INTELLIGENCE ACTIVITIES  
 FOR EACH LEVEL OF RECURSION:**





In a Mode I study, the overlay of descriptive models of the communication mechanisms in use on top of related conceptual models, may permit to detect discrepancies, and the possibility for improvements. Of course, in a mode II study, conceptual models are all we have to design the intelligence function.

Without attempting to offer a comprehensive methodological discussion, in practice, the analysis of interactions can be done by establishing the capacity of the communication channels supporting the interactions of any two parts with reference to particular issues or named systems (see chapters 4 and 6).

#### **About the mechanism for adaptation**

This mechanism is defined by the articulation of the control, intelligence and policy functions. In studying this mechanism it is necessary to keep in mind the outcomes of our discussions in chapter 7; firstly, the control and intelligence functions should possess roughly similar complexities, secondly, these functions should be linked by adequate communication channels, to support their creative interaction, and thirdly, these balances and interactions should happen with reference to specific issues of policy concern. It is for these latter issues that the policy function can monitor the interactions between the other two functions.

Diagnostic points emerging at this stage are likely to be focused in mismatches between the perceived actual capacity of the 'control and intelligence' structural parts, and their communication channels, against the requirements entailed by the tasks, or issues, of policy concern. The perceptions of policy makers are important in defining these balances: do they think that they are being stretched by challenging, internally generated, policy issues?; do people in the organisation respond effectively to their requirements?; how often do they need to refer back, for further study, policy issues; how often do they need to set up sub committees, or other mechanisms, to work out more thoroughly the issues brought to their attention. These are some of the questions that may permit to measure, by proxy, imbalances in the complexities of the internal debates.

I think that much more needs to be researched in the future about this issue, in particular the measurement of complexity issue.

## **9.7 Conclusion**

This chapter has offered a method to facilitate the application Beer's Viable Systems Model to any kind of organisation.

The definitions of identity and structural levels offered an approach to interpret the model in practice.

The simple, but key idea, on which the use of the VSM is grounded is that organisations are multisystems and not single systems. Thus the relevance of having a tool to name systems. Different names permit to separate, for particular viewpoints, what is from what it should be. As these different forms of description and representation are made apparent it becomes possible to compare the actuality of an organisation, as interpreted by a viewpoint, with the criteria of effectiveness as provided by the VSM. This is the bases for diagnosis. Equally, the names articulated by relevant viewpoints for primary activities at different structural levels, give the platform to design the structures of those activities. These are the bases for design.

The other key idea used in this chapter -idea that was developed in chapter 4- is that complexity is not an objective property of a situation, but depends on viewpoints. The problem is thus reduced to finding the appropriate viewpoints for each situation. The appropriate viewpoints are those coping with the "complexity" of concern; the measurement produced by them is as significant and valid a measurement as it can possibly be produced. In a diagnostic mode, the method permits to make apparent mismatches between the complexity that particular managers appear "to see" and the complexity that they should see for an effective discharge of their organisational duties. In a design mode the method permits to focus the concerns of a

manager at the appropriate level of resolution in order to avoid unnecessary information overload.

Finally, once the relevant viewpoints have both named the systems of interest and developed an appreciation of their complexity, then, my contention is that Beer's ideas, as developed in *Diagnosing the System for Organisations*, offer a most powerful method to study and diagnose the regulatory mechanisms of an organisation. These ideas are complemented by those offered in the final part of this chapter.

The method discussed in the chapter is used in the next with the purpose of designing an organisation.

## 10. Design of an Organisation Structure

### 10.1 Introduction

This chapter makes use of the method developed in the previous chapter; it elaborates the method with a concrete application, and shows some of the problems entailed in the designing of an organisation structure. In particular, it illustrates how to overcome some of the problems in defining structural levels and designing mechanisms of monitoring-control and adaptation.

The organisation to be designed is a management school. Broadly, it is assumed that the School's identity is perceived as one where the purpose is to achieve excellence in the global subjects of 'management and organisation' and not in any specific functional discipline.

This kind of enterprise, in general, offers as products its teaching programmes and, also, the 'knowledge' that is taught in these programmes. It's as if in a manufacturing enterprise the products were not only those manifestly coming out of the factory but also the very technology used in this manufacturing. Hence, it would appear as if the management problem of such schools were to make viable, in an integrated whole, both their teaching programmes and the related research. Their viability appears to depend upon two, concurrent and interdependent, sets of products. If the teaching programmes and research activities are focused in

the same disciplines and issues, then, the likelihood is that their integration will not be perceived as a major problem (e.g. an economics degree within an economics department). However, if the teaching programmes are focused in 'enterprises', whether private or public, at the same time that the research activities are focused in specific disciplines or topics, then, the integration of teaching and research may become more difficult.

The intended identity for the school would suggest that this design will have to pay attention to the problem of integration.

But, no doubt, the meaning of integration will vary from situation to situation. Some management schools may de facto give priority to teaching, others to research, others to both, but with different degrees of integration, and so forth. An interesting challenge is to achieve an effective integration between the two dimensions. This is not a simple task; however, it may be expected that the excellence of a management school relates to the success in producing this integration.

In organisational theory, the design of matrix structures has been suggested as an effective approach to achieve this result (Galbraith 1978, Minzberg 1985). Hence, while on the one hand a management school may have a number of teaching programmes, on the other, each programme may need the concurrent participation of several disciplines. The

problem is to design the mechanism to achieve the required integration. A matrix structure aims at producing mechanism to provide, on the one hand, teaching programmes with specialised knowledge, and, on the other, the research activities with teaching outlets. Unfortunately, for those resting their hopes in a matrix structure, the co-ordination of the 'teaching' and 'research' dimensions is likely to create some practical problems. This chapter discusses them from the viewpoint of cybernetics.

I call the school to be designed, Deepend Management Centre, or in brief, DMC.

This design, no doubt, has been influenced by my work at Aston Management Centre (AMC), however it is not my intention to make a diagnosis of this Centre. Yet, I must accept that my views about the transformations taking place in management schools have been strongly influenced by this particular experience. Indeed it should be possible to think in a whole range of alternative designs based in different definitions of identity and "technology", however, the point of this design is to illustrate a consistent use of the cybernetic method from one viewpoint, and not to discuss the organisation of management education in general.

In line with the method discussed in chapter 9, the following is the plan for the rest of this chapter:

-discussion of the Centre's identity,

-discussion of the structural levels necessary to implement the chosen identity,

-a proposition about how to distribute regulatory capacity in the structure, and,

-the design of mechanisms of monitoring-control and adaptation for the Centre's corporate level.

## 10.2 The Identity of DMC

The following assumptions about DMC are made:

There is agreement that one of DMC's purposes is to contribute to the effective viability of social organisations, whether these are public, private or of any other kind. DMC is interested in public sector enterprises as well as in small, medium and large business enterprises of all kinds.

For this purpose DMC wants to acquire existing relevant knowledge, and develop new knowledge, about the organisation and management of any enterprise, and, wants to transmit this knowledge to as wide a community as it is feasible within the constraint of its resources.

DMC wants to operate in the local, national and international environments, that is, it is prepared to



undertake activities beyond its immediate geographical boundaries, however, its emphasis is on quality and not quantity.

Specifically, the focus of DMC's activities is on whole organisations and not on any specific individual functional activity. Its emphasis is on knowledge relevant to all enterprises, including aspects like corporate strategy, organisational development, innovation, information and operations management, and, strategic management. To maintain a current understanding of the environment of enterprises, DMC wants to maintain within itself an in depth understanding of current economic, social and technological changes and policies.

DMC wants to maintain a good balance between academic staff with expertise in strategic, long term issues, and academic staff with expertise in the operational, short term problems.

Structurally, DMC wants the formation of effective multi disciplinary "subject groups", rather than the formation of discipline based "subject groups". In this sense it prefers a subject group in "finance and accounting", with a strong emphasis in "strategic management", rather than a subject group in "finance and accounting" mainly concerned with the disciplines themselves.

The following two names may be offered to support debates about DMC's identity:

- 1) DMC wants to increase the quality of management and organisation in enterprises of all kinds, by providing to these enterprises newly trained human resources and by offering, to their existing managers, services to update their knowledge about management concepts, methods and tools.

TACO for this system would be as follows:

T: improved performance in those enterprises using DMC's graduates and services

A: all people working in DMC, some people in the University's central services, students and alumni

C: enterprises using DMC graduates and services

O: academic community

- 2) DMC produces, and communicates to all interested people, original knowledge about the effective organisation and management of social enterprises -private and public- in a context of rapid economic, social and technological change

The related TACO is as follows:

- T: to produce and transmit knowledge about the organisation and management of enterprises
- A: all people working at the DMC (including research students), and some people in the University's central services
- C: undergraduate, postgraduate and post experience students, as well as the people and enterprises directly affected by the the outcomes of its studies and research activities.
- O: the academic community at DMC

The first name is focused on the 'enterprises' themselves and appears to emphasise the Centre's role as a change agent. The second is focused on the students i.e. society at large. The structure implied for DMC by each one of the names is indeed very different. As suggested in chapter 9 decisions about identity are one of the major, on going, problems of the enterprise's policy function.

It seems useful to highlight the inclusion of students as actors in the first name. This inclusion would imply that 'students', while working in 'enterprises', are involved in producing DMC's transformation. This identity suggests that,

should DMC take this avenue for its development, it would be mainly concerned with students coming from 'industry', and not with undergraduate students, coming from secondary schools.

It is also worth noting that in both names some of the actors are people working in centralised services, like the University's Library and Information Services; indeed a researcher to do research needs the information services provided by the Library. This point was discussed in chapter 9 and will be discussed again later in this chapter.

Also, it seems useful to understand that in discussing its identity, DMC could have chosen to emphasise the need to achieve excellence in particular disciplines e.g. finance, economics, or to concentrate its efforts in particular types of enterprises e.g. small businesses, public sector enterprises, finance institutions..., or to emphasise any other kind of identity. Each identity would have implied the design of a different organisation structure.

In this case the organisational design will be done with reference to the second name.

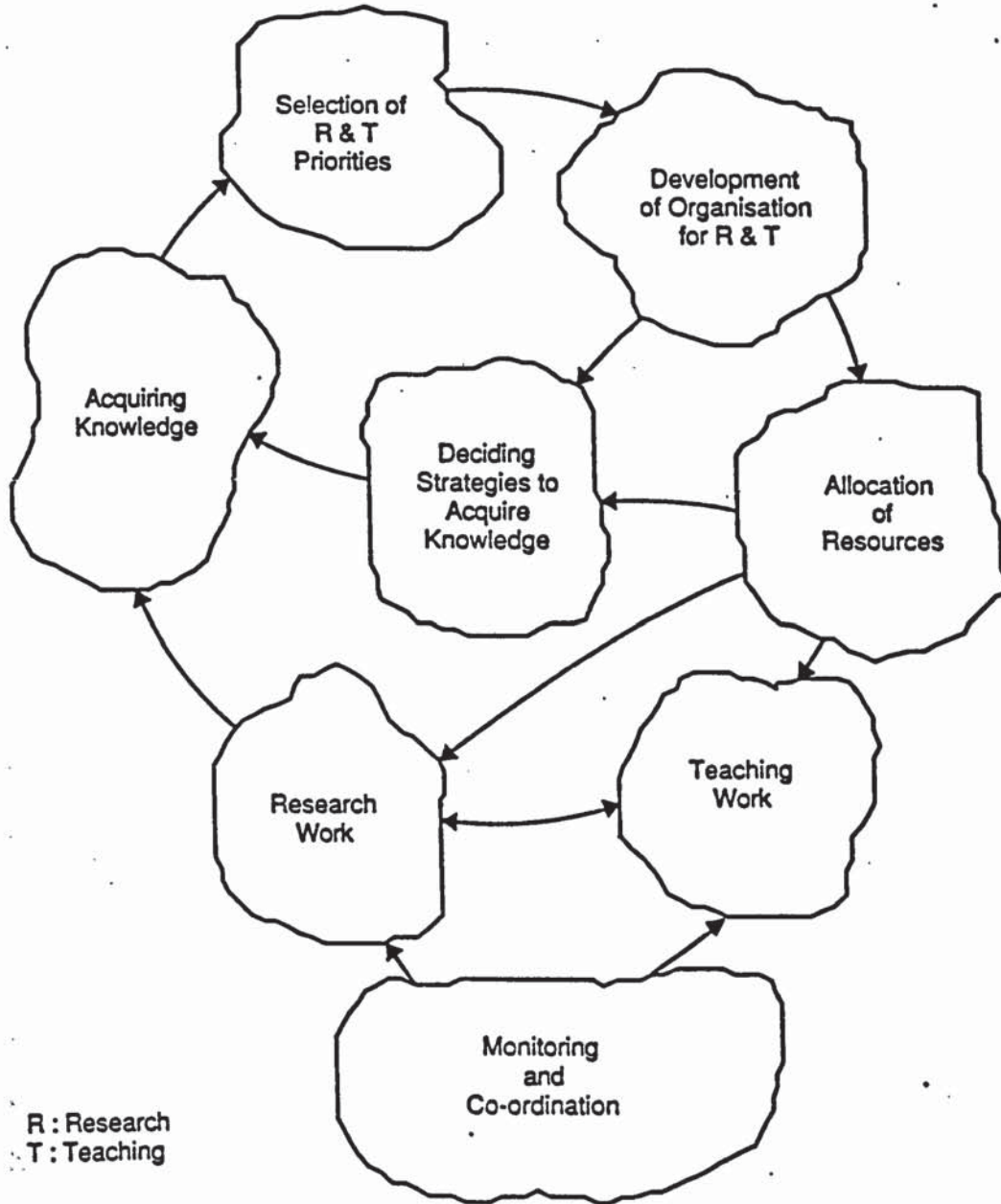
### 10.3 Defining DMC Structural Levels

#### 10.3.1 The Technological Model

A conceptual model for the transformation of Name 2 is as follows (see figure 10-1):

- on going definition of priority areas for 'knowledge creation' (i.e research) and 'knowledge communication' (i.e. teaching and diffusion, or in short 'teaching'),
- development of mechanisms to permit the implementation of the agreed policies, that is development of the organisation for teaching and research activities,
- acquire knowledge about potential knowledge to be acquired,
- decide, as an on going task, what knowledge to acquire, that is, what knowledge is relevant to the identity of the Centre,
- decide how to acquire this knowledge, that is, decide the strategies to be used e.g. the extent to which information and library services, attendance at conferences, recruitment of staff with specific knowledge, training and retraining of staff, participation in academic networks, sabbaticals and academic visits, will be used,

Figure 10-1: Conceptual Model for DMC's Second Name



-acquiring this knowledge, that is, implementation of decided strategies, in the context of the University's organisational structure.

-allocation of resources for research and teaching,

-research work, that is the work of research groups or individual researchers, and also,

-teaching work, that is, the definition of methods to transmit created knowledge as well as the on going teaching and diffusion activities.

-co-ordination of research and teaching activities

-monitoring of research and teaching output.

Underlying this conceptual model is the idea that the transformation, to take place in the real world, requires of policy, intelligence, control, co-ordination and implementation capabilities. This model will be unfolded more precisely later on; in fact it is the "organisational model" that we are interested in this design. At this stage, however, it is clear that DMC is undertaking two fundamental 'primary' transformations vis-a-vis its external environment, it is creating and transmitting knowledge. All the other activities of the conceptual model are necessary only to make possible the primary transformations.

The primary transformations can be performed in varied forms, using multiple alternative strategies. Each of them would suggest a different technological model. At this stage of the design process the concern should be to define a set of logically necessary activities to produce DMC's agreed primary transformations. Inevitably, this model will be influenced by the context of the designers, hence the relevance of having a range of backgrounds among the designers. Indeed, it is desirable to take into account alternative forms to produce the transformations.

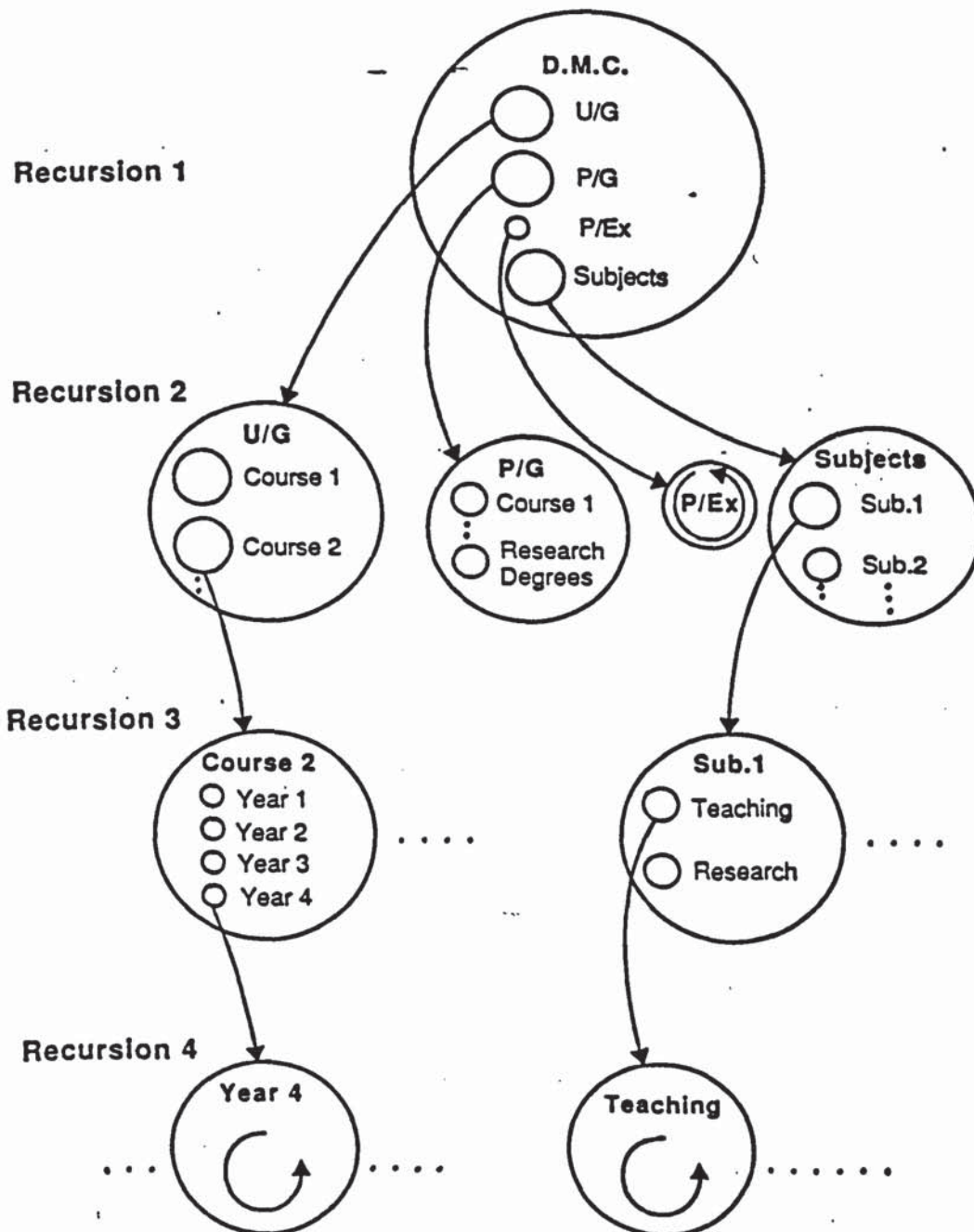
In this design, I'm the expert defining the technological model for DMC transformations (see figure 10-2); this model naturally is biased by my personal experience, and therefore, it incorporates the advantages of tested experience and the disadvantages of my tacit blinkers.

The model of figure 10-2, consistent with DMC's identity, suggests four global technological activities; one for knowledge creation and three for teaching. DMC aims at servicing a wide constituency; the teaching transformation is perceived to be different whether it refers to under graduate (u/g), post graduate (p/g) or post experience (p/ex) students, hence the need for three teaching programmes.

Subject groups are assumed to be both adequate to further research and to contribute to teaching. Of course an alternative could have been to separate teaching groups from



Figure 10-2: DMC's Technological Model



research groups. However, the proposed technological model is making the assumption that DMC's transformations depend on the 'full' development of all subjects, and that while in the short run the emphasis between teaching and research may vary from group to group, in the longer run all subjects need to achieve a balanced development between research and teaching. In a technological model subject groups should not be named for administrative convenience, but as a response to detecting synergistic opportunities.

For DMC, assuming that in a stable state it has about 80 academic staff, the number of subjects could vary from 8 to 15. To make possible the 'global' mission of DMC, these groups should cover a minimum number of subject, for instance: 'corporate strategy and policy', 'organisational innovation', 'organisational development', 'finance', 'marketing', 'operations management' and 'information management'. The absence of any of these subjects will hinder the global transformation of DMC. On the other hand, the development of other subjects, not directly focused in the management and organisation of an enterprise, could affect its defined identity beyond recognition. However, in a truly 'systemic' management centre, subjects like 'management of financial institutions', 'public sector management', 'project management', 'small businesses' and the like, would make sense as long as they make use of the specialised knowledge offered by the above named core subjects, that is, as long as they avoid developing this knowledge areas by themselves.

Subject groups do research and contribute to the teaching programmes to different degrees, and therefore have different mixes of teaching and research. While the research activity within a subject group is also responsible for the dissemination of its results, the teaching activities do the teaching through the teaching programmes.

An alternative technology to the three teaching programmes could have been the complete modularisation of the teaching. Had this been the case, the same module could have supported u/g and p/g programmes. However this is not the technology suggested for DMC.

As it is made apparent in figure 10-2 the u/g programme is formed by courses. For instance, there could be two courses, one concerned with business administration, the other with public sector administration. The courses are made up by taught modules and practical 'industrial' experience.

The p/g programme offers taught and research degrees. The taught part is made up of courses, within the courses there are modules and projects. In DMC there are two possible technologies to run the same course, say a Master in Business Administration, one is a university based course, the other is an industry based course. The former is the traditional course, taught in the Centre's premises, the latter is an instance of "distance education", based on tutored video instruction.

Finally, the p/ex programme is planned to have "themes" alone, and these themes may be based either in 'academic' activities within the Centre or outside it.

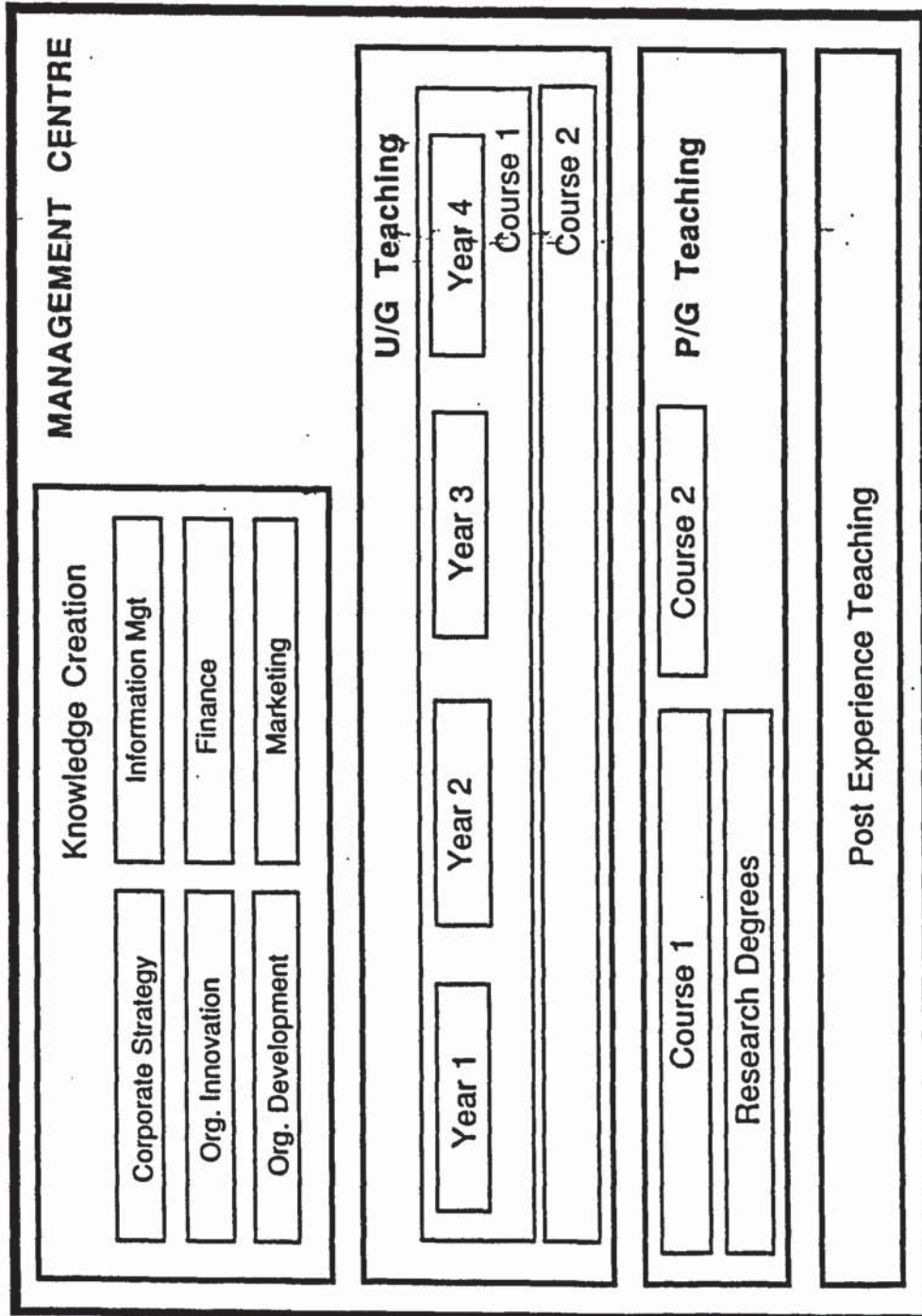
It is worth saying that the modules taught in the u/g and p/g courses can also be offered as modules for other courses outside DMC. This is the case, for instance, of modules contributing to Joint and Combined Honours degrees, run in collaboration with other departments in the University.

### **10.3.2 The Primary Activities Model**

In this section I'll discuss activities of DMC from the viewpoint of the unfolding of complexity. Which are the technological activities that DMC wants to make viable? The answer to this question should be consistent with the discussion of DMC identity. As discussed in chapter 9, to make viable an activity implies to support it with adequate regulatory capacity in order to perform, control and, when necessary, adjust its transformations. The discussion that follows is of great relevance to the design of the organisation. It can be followed with reference to figure 10-3.

Figure 10-3 makes apparent one possible design for the unfolding of complexity in DMC. This design implies that the complexity to be seen by the Centre's corporate level is, on the one hand, that of several teaching programmes and on the

Figure 10-3: DMC's Primary Activities Model



other, that of academic subjects. In general, the corporate level should avoid being involved either in specific courses or in particular subjects. The management of the teaching programmes is responsible for seeing the complexity of specific "courses", at the same time that the management of subjects development is responsible for seeing the complexity of specific subjects.

From the viewpoint of knowledge creation DMC's second level of recursion is the 'Subjects Development Directorate'. Without it the corporate structure would need to see the complexity of each of the teaching programmes and also of each of the individual subject. Should this 'seeing' be beyond its capacity, DMC would lack the capacity to produce the synergistic integration of subjects. If this were the case, there would be a strong argument in favour of a structure based on "discipline" oriented departments. This issue is discussed later while discussing the design of regulatory mechanisms.

The 'Subjects Development Directorate' is responsible for the aggregation or synthesis of management knowledge for the Centre. This directorate is responsible, in particular, for the viability of the research activity in DMC. Primary activities within it are the 'subjects', which are not necessarily discipline based.

It is assumed that subject groups want, and, by and large, are able to make viable their own teaching. Equally, subject

groups want to make viable their research, hence, the proposed design supports the viability of subject based "research groups" and not of individual researchers. Of course, this is not a rigid proposal, exceptional researchers may form a one person 'research group'. Also, this design supports the integration of multisubjects research in the context of the directorate. Hence, in addition to subjects, this directorate is responsible for supporting the development of non subject based 'research groups'.

It makes sense to support the synergistic interaction between teaching and research and therefore, it makes sense to have in the subjects a structural capacity "to see" both sides as a whole.

In this design, subject groups also have the purpose "to see" the global performance of their academic staff and in that sense they are concerned with the academic viability of individual members of staff. From this viewpoint, individual academic staff are 'primary activities' within the subject groups (this point is not made apparent by figure 10-3). There is the potential conflict of interest between individuals, who may be more interested in making viable their academic careers than that of their 'subject teaching' or 'research group'.

From the viewpoint of teaching, the u/g and p/g programmes plus a programme to run post experience courses constitute

DMC second level of recursion (see figure 10-3). They should co-ordinate their tasks in the context of DMC corporate structure.

DMC wants to make viable several post graduate and under graduate courses, in fact it wants to make viable 3 p/g and 2 u/g courses. The three p/g courses are two different versions of a Master in Business Administration and a Master in Public Sector Management, and, the two u/g courses are Honours degrees in Business Administration and Public Sector Management. There are a number of fundamental differences in the markets of, and teaching methods for, u/g and p/g courses, hence the need to have independent viable programmes to run them. If any of the programmes had only one course, then the management of the programme and the management of the course would be the same.

Only recursions 1 and 2 are fully described in figure 10-3. It should be clear that the unfolding of complexity of the p/g programme is similar to that shown for the u/g programme. The Research Higher Degrees Programme, the so called "doctoral programme", is, in this design at the same level as the other three p/g courses, hence the Director of p/g studies should "see" the complexity of 3 p/g courses as well as the complexity of Research Degrees. These courses are at recursion 3.



As for the p/ex programme; the design suggests that for the foreseeable future all its complexity will be absorbed at level 2; this means that there is no intention to make viable the specific themes taught in it. Therefore, this is the case of a relatively small programme, operating at a high level of recursion. If the view about its strategic relevance changed then either the programme would have to disappear or it would have to be absorbed for example by the Subject Development Directorate.

From the viewpoint of 'courses' the purpose is to make viable both the teaching of subjects and the 'placement' of students. Hence DMC wants to make viable, for example, the core teaching, the specialist themes and placement year of the BSc in Managerial and Administrative Studies. However, the courses themselves do not have the capacity to make viable the teaching of subjects; for this purpose they depend upon the contribution of the subjects. Indeed, this is one of the costs attached to the matrix structure; the viability of courses depends on their ability to regulate the teaching of subjects that are not accountable to them.

Subjects and courses are interrelated in more than one way. While the management of a subject should develop a comprehensive picture of the teaching of this subject in all teaching programmes, the management of a course should develop a comprehensive picture of all the subjects contributing to a course.

Subject groups want to make viable the teaching of their subjects in general, regardless of whether the teaching is based only in one of the teaching programmes or in all of them. However, teaching programmes may want to make viable the teaching of particular subjects, in the specific context of their own teaching. That is, there is a potential conflict between the view of subject groups, who want to make viable the teaching of subjects like marketing, finance, corporate strategy and policy, information management and others in general, but not, necessarily in the context of specific teaching programmes, and the view of teaching programmes who may need, for the viability of courses, the teaching of viable subjects in their own context.

Therefore the corporate structure of DMC has to develop the capacity to manage these interrelations. On the one hand it negotiates the allocation of resources to courses, on the other it negotiates the allocation of resources to subjects. However, these two negotiations are clearly intertwined as explained above. The design of a mechanism aimed at overcoming this problem is the concern of a later section.

Finally, DMC should not be concerned with the viability of, for instance, a Joint Honours in Management and Languages. In fact, the viability of such a degree should be the concern of the higher structural level e.g. the Faculty of Management and Languages of which DMC and Modern Languages are departments. Of course, individual lecturers, or even

subject groups, may succeed in making their teaching viable by making themselves relevant to these other courses, but the courses themselves are not primary activities in the context of DMC.

#### **10.4 Distribution of Discretion**

The next stage is concerned with designing the distribution of discretion among levels of recursion. The design of the table Recursion-Functions (figure 10-4) is the main tool for this purpose. Since this design is focused in DMC and not in the overall structure of Deepend University (DU), this latter structure is taken as a given parameter defining the context of our design. DU has a whole range of centralised functions; they include finance, personnel, registry, estates and buildings management, computer services, technical services and the library and information services. The key functions of departmental concern are the delivery of teaching services and research.

Experience has permitted to establish a list of regulatory functions that are perceived as necessary within DMC. The design problem is to work out the recursion level(s) at which they should be discharged. A particular design is proposed in figure 10-4. The names in the horizontal axis are the functions deemed necessary at each level of recursion to facilitate the delivery of DMC products. Of course each of the primary activities in the left side column of the table should have, by the very definition of



recursion, co-ordination, control, intelligence and policy functions, however the purpose of the table is to name the specific "control and intelligence functions" that each level needs for organisational cohesion. The design of regulatory mechanisms is going to make apparent the other two functions.

Criteria to build up this table are:

First, for as long as the perceived benefits of decentralisation are compensated by the advantages of higher standards in services, the idea is to push up (i.e. centralise) specialised services. Hence, it may make sense to centralise the technical and computing services of DMC, since this decision would permit to have highly specialised services for primary activities that otherwise would be unable to afford them. However, from the viewpoint of DMC's structure, the trade off is between making available specialised services, and, making more demands on its control procedures. There is an increased probability that the specialised services will go out of control as they are centralised. A centralised service, on the one hand offers services to decentralised units, on the other, it is only accountable to the corporate level. If DMC's control mechanisms are inadequate, that is, if they lack in requisite variety, then the problem might be either rocketing costs or a sub optimisation in the use of the specialised resources. An adequate design of control mechanisms is necessary; this is discussed below, however,

if the conclusion is that the cost of implementing these mechanisms is too high, then it will be necessary to alter the distribution of discretion (perhaps in favour of a distributed less sophisticated service).

Second, the idea is to push up functional capacity to work out the procedural systems necessary to implement policies common to several primary activities. At the same time the 'lower levels' are made responsible for the implementation of the policies themselves. This way of centralisation may permit to have co-ordinated action without hindering primary activities autonomy. For example, it makes sense to centralise the administration of examination procedures, or the administration of the students' tutoring system, however, naturally, it makes sense to leave in the hands of lecturers (i.e the lower level of recursion) the definition of exams' content, or the tutoring of students; it is at this level where requisite variety for these tasks is available.

Third, in cases like the Centre's "marketing" of its products, the design suggests that the marketing problems of u/g, p/g and p/ex courses are sufficiently different as to make necessary the development of this capacity within each programme, however the design also recognises the need to market DMC as a whole. Another possibility, not considered in this design, it to have a university wide marketing specialised, for instance, in u/g courses. This latter

option would pose the above suggested control problems related to the centralisation of specialised services.

Figure 10-4 suggests a clear differentiation between "programme" and "course" management; while course managers should be responsible for the development, planning and management of the course as a whole and the primary activities within it, programme managers should be responsible for the strategic development of the programme, the identification of new courses, and the control of the courses.

#### **10.5 Design of DMC Corporate Level**

So far the design has been concerned with the distribution of functional complexity in the organisation, nothing has been said about the concrete mechanisms to support the effective management of the Centre; this is the concern of this section. However, this section only offers an illustration of how to design regulatory mechanisms; it does not attempt to offer a comprehensive design for DMC.

Basically, a comprehensive design would entail the design of two mechanisms for each primary activity; the mechanisms of monitoring-control and adaptation. To assess the magnitude of this tasks it is enough to visualise that if DMC goes ahead with 3 programmes and one directorate for subjects development, while the programmes go ahead with 2 u/g courses and 4 p/g degrees and the directorate recognises 8

subject groups and the subject groups have on average, say, 10 lecturers; the number of mechanisms to design would be in excess of 45. Naturally, there is no space in the context of this thesis to develop a full design of DMC, covering all recursion levels. Only the first level of recursion will be discussed.

The design is focused on the structural mechanisms necessary to support the effective operation of the Centre as a whole; it is neither focused on the management of regulatory activities nor on the design of the roles of particular individuals.

Corporate management should be concerned both with its own adaptation and monitoring-control of the lower level primary activities. Figure 10-4 is particularly relevant to study the corporate structure.

From the viewpoint of corporate management, the design problem is to structure mechanisms to focus the discussions at the right level of recursion. While by exception corporate management may become involved in the state of affairs of particular courses or subjects, in general its attention should be focused at the more aggregated levels of the Centre and the programmes/directorate.

This design has to deal with the following functions:



1)Policy; DMC has to develop a capacity to maintain the relevance of its activities. Management at this level needs to maintain a model of the organisation in line with its ascribed identity. Without such a model management is likely to find very difficult to adapt to changes in the environment.

2)Intelligence; DMC has to maintain an adequate appreciation of environmental changes relevant to its future. For this purpose it is necessary to design the necessary channel capacity to permit DMC's interaction with the environment; the focus to define these channels is given by the identity ascribed to the organisation.

3)Control; DMC has to control the programmes/directorate. This implies the allocation of resources to, and the monitoring of, programmes/directorate and not of courses or subjects.

4)co-ordination: DMC has to offer appropriate mechanisms to support the interactions among programmes and subjects directorate.

A detailed analysis of the structural mechanisms necessary for the effective operation of these functions is done in what follows.

From the figure 10-4 it is apparent that the corporate structure at DMC has to cope with the following specific functions;

- academic planning
- recruitment
- secretarial and administrative services
- acquisitions
- examination procedures
- accounting
- building services
- technical services
- computer services
- external relations
- marketing

#### **10.5.1 The Mechanism of Monitoring-Control**

From the viewpoint of current organisational theory a matrix structure would be ideally suited to cater for the interactions between teaching programmes and 'specialised' academic subjects. In theory, this structure should permit to develop both, highly sophisticated teaching programmes, from the administrative point of view, and, viable subjects at the forefront of their specialised knowledge.

Should DMC wish to implement a matrix structure, the two dimensions of the matrix would be the "teaching" programmes and the "academic" subjects. In this structure neither the subjects can be embedded in the programmes nor the programmes in the subjects; either alternative would imply an undesirable restriction in the scope of the related primary activities. From the viewpoint of the mechanism of monitoring control this structure poses an interesting challenge; as explained before, the matrix suggests that the organisation wants to make viable the teaching of programmes that do not have within themselves the functional capacity for the teaching.

In this scenario it is only at the first level of recursion that management can secure the 'accountability' of subjects to courses. Moreover, it is only at the global level of the three programmes and one directorate that co-ordination between courses and subjects can be achieved. Beyond that global level courses and subjects do not cohere in a common viable system. This fact puts the emphasis of co-ordination in the 'co-ordination function' of the first level of recursion, where interactions are more abstract than at lower levels. This arrangement limits the possibilities for effective self regulation at the local level, and increases the need for multiple meetings to plan the interactions of courses and subjects. Should the capacity of the 'level one' co-ordination function be inadequate, the rest of the structure will suffer producing courses with 'weak' teaching support, and subjects with inadequate understanding of

teaching potentials. The support that the 'high variety' co-ordination function offers as the interactions move down in recursion levels is lost. The corporate level is the only level at which it is possible to have both, the co-ordination between programmes and subjects, and the control of the support offered by subjects to programmes. This is the only level at which the strategies and actions of subjects and courses can be made consistent with each other. The corporate control function has to achieve cohesive teaching programmes, and also cohesive academic subjects, and moreover it has to set up the conditions to make possible their detailed co-operation.

In this context the corporate level needs to develop adequate capacity for co-ordination between programmes and subjects. In theory, assuming a very competitive market and a genuine concern for the viability of the courses, programme directors would need to negotiate contributions, and revise results, with each subject group, all the time. Clearly, this is a very demanding task, even for a very well developed corporate structure. From the viewpoint of the management of complexity, if the matrix structure is to work, that is, if effective integration between the two dimensions of the matrix is to be achieved, the corporate level must have the support of a very large functional capacity. It needs the capacity to produce by itself the cohesion of teaching programmes and subject groups. The organisation cannot rely in the self regulation of courses and subjects to achieve this integration; courses and

subjects do not cohere in the same viable system. Without a large control and co-ordination capacity at the first level of recursion the matrix structure does not work. This capacity is the cost to pay for the advantage of having at the same time global teaching programmes and specialised subjects.

The directorate of subjects development is a response to this problem (hence making apparent that the modelling of primary activities is in itself a first step in the design of regulatory mechanisms) . Having this directorate is likely to reduce significantly the co-ordination problems of the directors of teaching programmes. In this arrangement they are able to see 'subjects' through the attenuation of one director, thus reducing the need to co-ordinate their plans and actions with a wide range of subject heads. Naturally, the success of this arrangement depends on the capacity of the director for subjects development to control the specific subjects. This mechanism, whereby the complexity of subjects is effectively attenuated by a director, while, at the same time, the co-ordination problems are simplified, is more likely to have requisite variety than the arrangement where directors and subject heads aim for cohesion through an endless series of co-ordination meetings. Indeed, this is the design suggested for DMC.

Figure 10-4 helps in the more detailed design of the Centre's monitoring-control mechanism (figure 10-5). This design has to take into account four aspects;

- 1) the resources bargain with 'primary activity' managers
- 2) the corporate intervention
- 3) the co-ordination needs of primary activities and
- 4) the auditing of the primary activities.

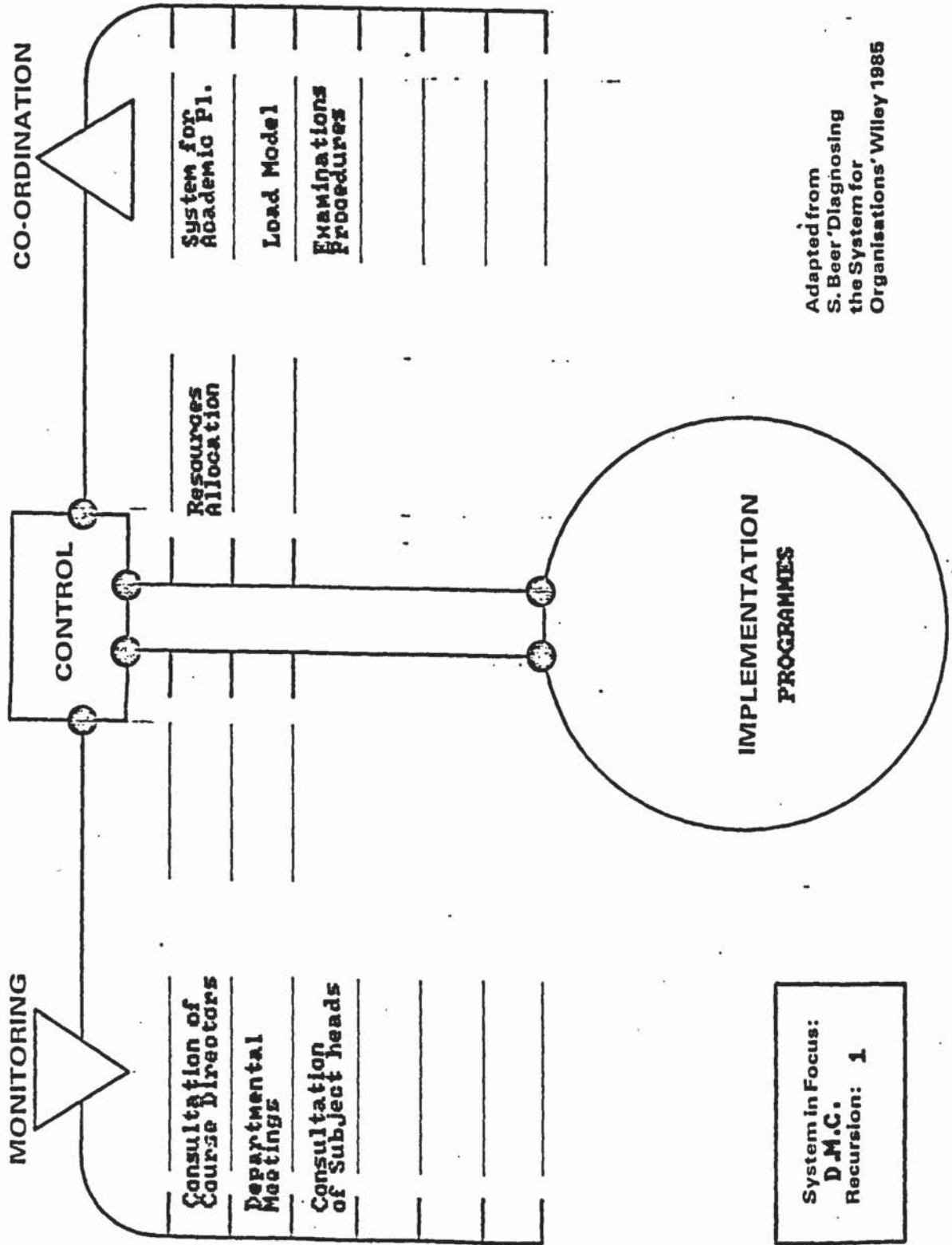
Each of these four aspects is discussed next:

1) As an on going activity the Head of the Centre, with the support of its administration, negotiates with directors both their commitment to the Centre's policies and the allocation of resources. How much of the resources available should go to each of the teaching programmes? which are the priorities regarding subjects development? how to distribute equipment resources? How to allocate non academic staff? are but a few questions to be resolved at this level.

To be effective the resources bargaining should be focused at the global level of programmes and not at the the more specific level of courses or subjects: this is necessary to make possible the matching of varieties between the Centre's Head (supported by a planning team) and the directors of primary activities (i.e. programmes and directorate). If the discussions drop to a lower level of recursion, either the control function will need to increase

# Mechanism of Monitoring Control

Figure 10-5: Design of Monitoring- Control Mechanism



its variety, in order to cope with the extra complexity of courses and subjects (making a nonsense of the programmes/directorate recursion level), or it will have to abdicate its role in the resources bargaining process (making impossible the synergistic use of resources, thus making DMC no more than the addition of, by and large, unrelated programmes).

The outcome of the resources bargaining at this recursion level is the budget of DMC; indeed this budget assumes that similar bargaining of resources takes place at all other levels of recursion.

2) Corporate intervention is limited to codes of practice regarding the teaching, research and consulting activities of staff members. In fact, being freedom one of the perceived strengths of working in an academic environment, the idea is to minimise the use of this channel.

3) The above discussions made apparent the importance of an effective co-ordination function. This need goes from systems to avoid an overload of idiosyncratic, uncoordinated, information to/from the programmes, to systems aimed at working out in detail the implications of the resources bargaining for each programme. While the design and maintenance of these systems should be a corporate concern -they are the only people with an overview of the programmes and directorate- their operation should be, as far as possible, distributed to the programmes and



directorates themselves. Figure 10-5 establishes the need to develop systems:

- for academic planning, in particular, for planning the teaching and research activities from within the programmes and directorate,

- to assess both the operational demands of teaching programmes and contribution of subjects to research and teaching activities. This is potentially a most important system to balance the Centre's activities. The system should permit balancing the Centre's teaching commitments with the research requirements to 'make viable' DMC. The system should provide information to programmes about supply and demand of services. This information should help in directing their negotiations .

- to permit the use of centralised administrative, computer and technical services. This design should also include designing systems to use university wide services like the library.

- to assess students performance: in this design DMC has a centralised system for examinations, though, naturally, the examinations themselves are decentralised. This system should permit to maintain similar standards of academic performance in all programmes.

4) Finally, it is necessary to design mechanisms to monitor the programmes and directorate. Corporate managers should audit the global performance of programmes and directorate. They should not audit at a level of resolution higher than that. This may imply the design of sporadic means for the Centre's Head to consult subject leaders and course directors. Indeed, as it was explained in chapter 9, the design of the auditing channel at this level should take into account only potential breakdowns in the interactions between the corporate and programme managers; the more unstable appear these interactions the more auditing would be required.

As explained in chapter 9, corporate intervention and co-ordination systems may penetrate the complexity of the organisation beyond the immediate structural level below. In this case they pose further control problems. For instance, to make effective the operations of a centralised 'examinations office' (i.e. one of the co-ordination systems) it is necessary to design control procedures to permit 'course' management to monitor the lecturers responsible for setting the exams, programme management to monitor the examination standards of courses, and, corporate level to monitor the examination standards of programmes. It is not good design to have a central office dealing only with lecturers at recursion 4, and therefore by passing programmes and courses; this design makes less likely a coherent, just and flexible examinations process. From the viewpoint of information flows, the centralised examinations

procedure has to make possible the closure of information loops at each of the structural levels above the lecturers. If that is not the case, the implication is that the central office in charge of examinations would be attempting to give closure by itself to the examinations activities of all the lecturers, activity for which it does not have requisite variety; it can only perform this activity at the cost of sub optimising the overall examinations process.

This will also be the case of technical services in DMC. These services affect directly the interaction (in the classroom) of lecturers and students, at recursion 4, yet it makes sense to centralise it. It should be, in the end, accountable to the corporate level. However, to make the service effective it is necessary that each intermediate recursion level monitors these services in order to avoid wasting resources and/or poor services.

The same argument applies to services like 'library' and 'computer' services. The accountability of these services to their customers is lost should there be no monitoring system to check the adequacy of their services.

#### **10.5.2 The Mechanism of Adaptation**

Since DMC is one of two departments in the Faculty of Management and Modern Languages, the faculty board is not the appropriate mechanism for policy making; its debates should be one level above those of DMC. An ad hoc board is

necessary for DMC, with representation of academic staff, managers (from private and public enterprises) and students (u/g and p/g students). This board should have about 10-15 members; it should be responsible for the definition of Centre's missions and identity. This identity should permit the members of the board to develop a model of the organisation itself. The board needs this model to engineer functional capacity and communications channels at the Centre's corporate level. Naturally, the board needs secretarial services to be in 'gear' with the rest of the organisation. This role should service the board not only in preparing its agenda and minuting its meetings, but also in providing the board with functional capacity to influence communications and debates in the organisation. This role should develop an understanding of communication and control systems.

Management activities, at any level, should have an emphasis in interpersonal communications. If academic planning is perceived as a data gathering exercise necessary to produce a plan then, its relevance as an intelligence activity is going to be negligible. To increase the profile of the planning activity it is necessary to articulate relevant conversations. While it may be necessary for administrative reasons to have academic plans incorporating details of DMC as a whole, as well as of programmes, courses and subjects, for managerial purposes their preparation should be the outcome of distributed debates at the right levels of recursion. The Centre's intelligence function should focus

its discussions in global issues relevant to the viability of DMC as a whole. A mechanism for this purpose could be the on going operation of a management team with the participation of the Head of the Centre, the three programme directors and the subjects development director. Just like in the case of the Centre's Board, to be effective this team has to have secretarial support (i.e. functional capacity), to co-ordinate the necessary actions emerging from their conversations.

The operation of this team may benefit of the fact that most academics maintain communications of one kind or another with the Centre's (global) environment. It is in the nature of their jobs to interact with other management centres, to visit other countries, to participate in ad hoc committees or policy debates elsewhere, and in general, to receive information about the environment. To make this information available for policy debates, it is necessary to engineer the communication channels between these academics and the management team. Each member of the management team should not only offer consciously this channel capacity, but the team should pro actively support the development of these academic channels with the environment.

A clear understanding of the Centre's identity and missions is the most important factor to focus the information gathering and the discussions of this team. Indeed any adaptation effort needs to make reference to a model of the organisation.

The control function should be strongly under the Head's control. Effectively he has to negotiate with directors the distribution of resources, hence it makes no sense to rely on the management team for this purpose. If the Centre's Head is going to control the allocation of resources, as he should, then he needs of a functional capacity. This capacity, perhaps based in the Centre's Secretariat, should be explicitly different to that supporting the programmes; otherwise there will be no capacity to cross check the interests of the control and implementation functions.

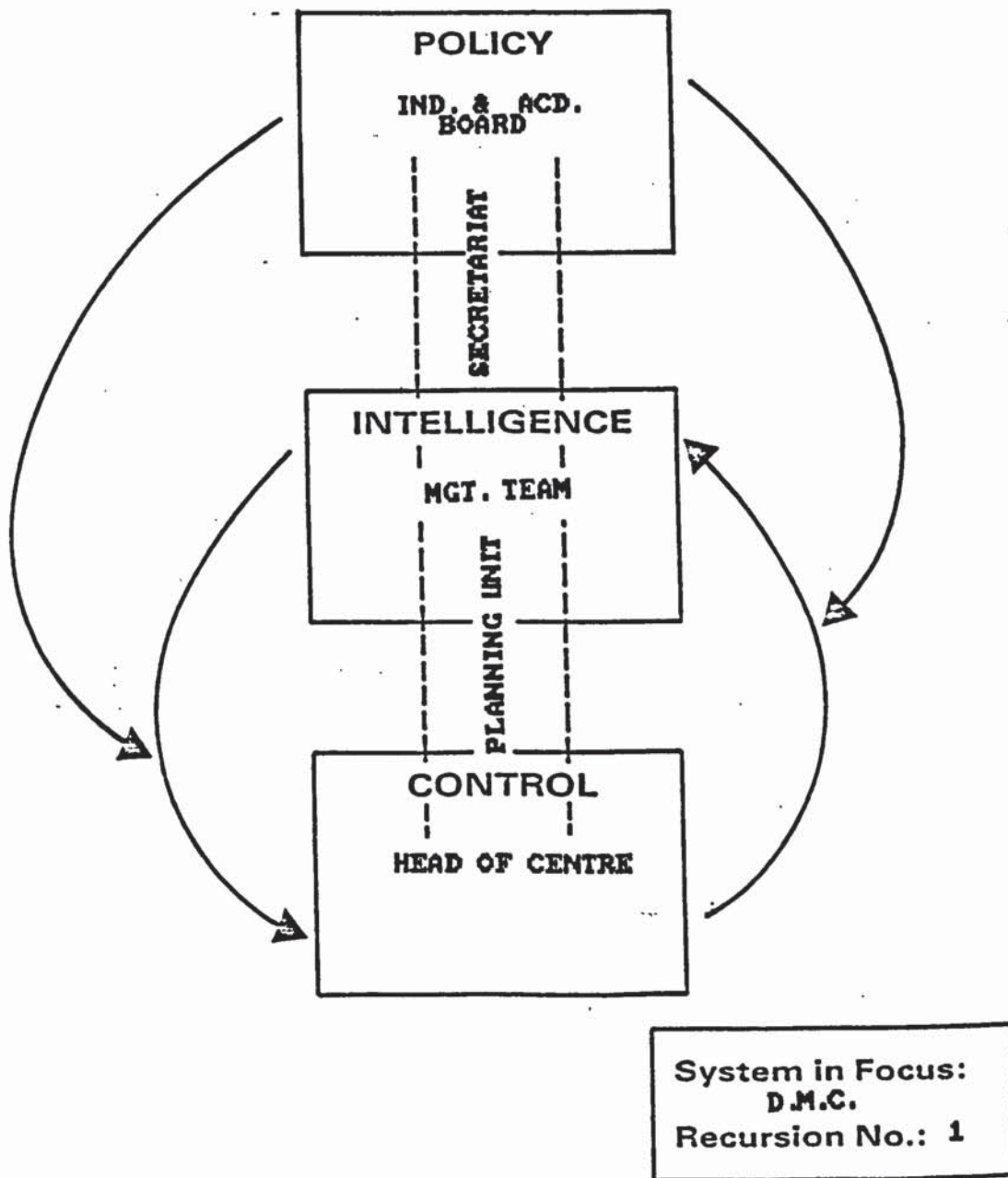
Finally, we can now see in full the mechanism of adaptation for DMC (figure 10-6); the Centre's Head and "planning group" define the organisational capacity to maintain a good appreciation of programmes and directorate; the Management Team, with the support of the information provided by academics and the capabilities for synthesis of the planning group, should elaborate its views of the organisation's future; the board, responsible for the definition of the Centre's identity and missions, should articulation the necessary interactions to support the formulation of feasible and desirable changes.

#### **10.6 Conclusion**

The purpose of this chapter has been to explain how to use the method developed in chapter 9. It should be apparent that the job of organisational design is exceedingly

Figure 10-6: DMC's Corporate Mechanism for Adaptation

*Mechanism for Adaptation*



complex; in fact after all this lengthy discussion we only have a very "incomplete" design. However, each of the steps in the method has been illustrated.

An adequate design of the mechanism of monitoring control for all recursion levels should be of particular interest. In an organisation like DMC where the 'products' are not always easy to assess, it is particularly important to maintain adequate communications in between structural levels. Measures of performance for teaching and research tend to be elusive, therefore it is unlikely that a management by objectives approach will work. This fact makes more necessary 'high variety' checks of results. Directors, course tutors, subject heads... need to maintain auditing communications to cross check their views about courses, subjects and lecturers, otherwise they risks losing touch with events at the lower levels. There is the risk of assessing performance of programmes, courses, subjects and individuals with hearsay, and not with well structured filtering devices. In this case the likely outcome is not only possible injustices, but also a loss of control. In a place like DMC it makes sense that this auditing should be designed taking into account the views of students, industrial clients and peers aware of the work by the affected groups or individuals. The design of these mechanisms should help to develop within DMC more accurate views of the impact and worth of its on going activities.



The implementation of a properly completed design should permit setting the platform for a centre of excellence. In its own right this design is a system that permits measuring performance even without quantification. Moreover it permits to understand how to distribute responsibilities throughout the organisation, avoiding as far as possible problems of lack accountability in the structure. Its implementation, with distributed responsibilities, should help to reduce the administrative load of people at the first level of recursion in the organisation; those who normally attempt to see more complexity than that that is advisable either for them or for the organisation. For the organisation because by seeing more than that that is required they interfere with the autonomy of other people in the organisation, for the individuals because by attempting to cope with a too large "chunk" of complexity they are overloading their limited information processing capabilities.

## **11. Conclusions**

### **11.1 About the thesis...**

This thesis has explored both epistemological and methodological issues.

From the epistemological viewpoint it has emphasised the role of the observer, and the so called cybernetics of the observing systems. The discussion of complexity was based on the idea that the 'known' properties of real world situations reside within the individual and not within the situations themselves. Since the observing systems (i.e. people) have a very limited capacity to see and deal with complexity, the 'black box' construct proved to be an essential aid to understand how they interact with the 'real world'. It was argued that people know about the world through black boxes, and that this was not a choice but a matter of fact.

These epistemological considerations were fundamental in establishing a methodology to deal with human activities. The paramount role of viewpoints emerged in this context. Viewpoints, by communicating with each other, and forming a multisystem, were responsible for the creation of reality. However, the effectiveness of these communications was a function, among other factors, of the multiple 'black boxes' underlying the viewpoints, that is, of multiple black boxes producing the viewpoints' knowledge of the world. Hence the

importance of considering the management of complexity within these black boxes; while good management may produce reliable knowledge, and therefore facilitate these communications, bad management may inhibit them to different degrees. Methodologically, this concern with the management of complexity was related to the cybernetic loop in problem solving.

An important aspect of this thesis was to make apparent that effective problem solving in human activities -that is effective 'learning loops'- depended on effective cybernetic loops, that is, on effective organisation structures.

To show how to improve the cybernetics of a situation the thesis offered a discussion of Beer's Viable System Model, that was based on an original discussion of the Law of Requisite Variety.

In my view, the discussion of requisite variety is perhaps the most important contribution of this work. It permits to make operational the ideas of variety engineering, and in particular it permits to design effective organisations.

### **11.2 About designing human activities...**

An understanding of the law of requisite variety opens wide possibilities for designing human activities. This is a major contribution of management cybernetics to the social

sciences. Unfortunately, so far, the meaning and implications of this law have not been understood, let alone used in social design.

The idea that by understanding and using an abstract law it might be possible to manipulate human activities towards the unilateral wishes of certain groups or individuals terrifies many. For these people social design is reminiscent of the worst forms of exploitation. A free society is one where this kind of social engineering is not accepted; people ought to have the freedom to express their values and beliefs with no restrictions whatsoever. Any attempt to design information flows and structures with reference to an abstract law must be by necessity restrictive and undesirable, if not impossible altogether (Checkland 1980, 1981; Ulrich 1984; Zeleny 1986). To ask people to conform to these designs is equivalent to asking them to give up their individuality -their own purposes- in the benefit of the grand design. Since the viable system model is derived from this law it must be that organisational design based on it must assume that people give up their own purposes and conform to the organisational purposes. In this scenario the designer is assumed to believe (tacitly?) that organisations have purposes of their own and that people are prepared to give up their own purposes in order to comply with the criteria of effectiveness offered by the viable system model.

The above scenario, rooted in the belief that the viable system model is an organismic model, is indeed frightening.

In contrast to these concerns, this thesis has argued that the management of complexity is a key issue in human activities, an issue that cannot be brushed aside without reducing substantially the capacity of making them more humane.

The meaning of the law of requisite variety becomes more clear -less frightening- once it is understood that complexity is not an objective property of a situation, nor something that can be established independently of the purposes of a viewpoint, but something that fully depends on these (tacit?) purposes. And, therefore, that no statement about requisite variety makes sense unless it is made with reference to a viewpoint. Complexity depends on the viewpoint. Once this subject centred nature of complexity is understood, and made operational, then the law of requisite variety becomes a much more useful construct. Indeed, it becomes a most powerful heuristic for the design of human activities.

The discussions in chapters 4, 6 and 9 were intended to make operational the law; the law permits designing effective ways of producing 'real world' transformations, minimising the related human costs. This understanding can only be used as a means to negotiate desirable transformations and criteria of stability. Human activities are multisystems and

not single systems. Each viewpoint is constantly negotiating its organisational position, yet, at the same time it is perceiving how the law asserts itself with reference to the 'tacit' purposes it ascribes to the situation.

Human activity systems do need to be "engineered", otherwise the cost of doing anything may well be much higher than should be necessary. In any organised activity, whether one likes it or not regulation does exist, the problem is to make this regulation as "benign" as possible, that is, to make it as consistent as possible with the autonomy of all the individuals involved. Defining regulatory mechanisms by chance is equivalent to abdicating the responsibility of creating the organisation's future, thus increasing the likelihood that unnecessary suffering and waste may take place.

Indeed, it is clear that no interpretation of human activities should be privileged, and therefore, that producing several alternative interpretations of them should be the rule. In this sense, when discussing the viable system model the thesis made clear that there were many possible, and equally relevant, models of a 'real world' organisation; each model would interpret the purposes ascribed to the organisation by a different viewpoint.

It was also made clear that it would be an extreme attenuation of complexity if any one viewpoint attempted by itself the design of an organisation, without taking into

account the contributions of other viewpoints; simply that viewpoint lacks the capacity to see the complexity that is the concern of the other viewpoints.

Methodologically, the design of human activities requires the participation of all the relevant viewpoints, and in no case the methodology unfolded in this work allows for the unilateral intervention of one viewpoint. A common mistake is to confuse the apparent simplicity in producing models with the possibility of producing unilateral designs of human activities. While producing a model is an abstract activity, designing an organisation, or for that matter any human activity, is not; it is a process in the real world in which all the relevant viewpoints need to participate.

### **11.3 Change in human activities**

Any viewpoint dominated by a belief in an objective world is likely to approach the management of complexity from a unilateral point of view. For this viewpoint who sees "reality" or thinks it knows how it should be, the key question is going to be "how do we manipulate the world in order to make it as it should be".

On the other hand, for a viewpoint aware of the "multisystemic" nature of human activities, the key questions are more likely to be "how do we recognise instability with other viewpoints", "how do we recognise

desirable change" and "how do we participate with the other viewpoints in producing this change".

The situational complexity to be generated and tacitly accepted in each of these cases is very different.

The former worldview (i.e. the naive positivistic) assumes that human situations are somehow objectively defined, that is, that all concerned people will see in the problem situation the same system and boundaries. In this case the problem is to know how to pull the right strings to achieve "the" desired results. Problems are mainly seen as control problems.

Though this assumption is clearly inadequate; it inhibits the creativity and potentials of the people participating in the situation, it still reflects the tacit view taken by a large number of people, in particular by the so called 'practical' managers. Fortunately, the case is that more and more people are not prepared to accept blindly the views of those in authority. This fact is forcing management viewpoints to recognise a growing complexity in the activities they are accountable for, and their problem is more to work out what to do to maintain stability in interpersonal interactions than to achieve unilaterally defined goals in the 'real world'.

This transformation in the appreciation of social relationships is being paralleled by an emerging



paradigmatic shift away from 'fayolism' and taylorism' as management theories, that is, away from the naive positivistic views of management. New, more sophisticated paradigms of management are evolving.

For those leaning heavily upon the phenomenological tradition (e.g. Checkland 1981) the feasibility of 'changes' is culturally defined by ongoing processes of appreciation. In this view reality is itself the outcome of the social intercourses in progress, and therefore it does not make sense to refer to human situations as if they were independent of the cultural and historical processes supporting their formation. The appreciations emerging from interpersonal interactions define the "situations" of social concern. The boundaries of these "situations" are perceived to be in a constant flux, not fixed, and therefore their management cannot be extricated from the social processes in progress. This stance tacitly accepts a much greater complexity in real world situations but is blind to the relevance of the actual management of complexity; its emphasis, as far as the production of change is concerned, is in the need to orchestrate debates to create shifts in appreciation towards deeper, more insightful appreciations.

For those in the cybernetic paradigm, as developed in this work, social organisations (i.e. the entities defining the context of interactions) reduce, as a matter of fact, to different degrees the space for appreciations. The structure of organisations, because the law of requisite variety

asserts itself, is responsible for varying degrees of constraint upon individuals. The structure constrains all viewpoints' perceptual and appreciative spaces. Since this is always the case, organisational debates are always bounded by the operating structures. In the extreme, where the structures are very rigid, debates may change appreciations only slightly: the orchestration of debates could in fact just mean to reinforce the views already held by the different viewpoints. Inflexibility of the structure, as expressed by inadequate communication channels between different viewpoints, means that viewpoint are more likely to reinforce their own appreciations than take into account the views of other viewpoints.

Failure to take proper account of the structures in use (i.e. of the actual capacity of communication channels available for the interactions of the different viewpoints) makes it unlikely that any one viewpoint will question these systemic constraints.

In a way the cybernetic stance is saying that it is an illusion that radical change can be the outcome of conversational processes alone; to different degrees the underlying organisational structures inhibit these conversations and therefore, if the viewpoints are highly constrained (as they usually are) , conversations can only be responsible for slight modifications in appreciations.

The cybernetic worldview accepts that there are "systemic" constraints and therefore that there is always a degree of rigidity in the situations of management concern. However -and this is the key point- by organisational design and structural adjustments it is possible to increase the autonomy of the different viewpoints and reduce the presence of unwarranted barriers. Therefore the emphasis of this paradigm is in the management of structural change as a means to make appreciative processes more effective.

However more relative autonomy does not alter the fundamentally constrained nature of organisational situations.

People in the phenomenological, hermeneutic traditions seem prepared to recognise the relevance of the cybernetic approach for "machines" but not for situations in which the intersubjectivity and the purposeful character of individuals is a key factor: they consider that accepting human activities to be constrained by systemic laws implies an affirmative answer to the question "Are organisations machines?" (Checkland 1980, Zeleny 1986). For them such an answer is radically reductive of the social tapestry and requisite variety remains a tool of logic alone.

This thesis recognises that organisations are in point of fact constrained by systemic laws, and if this is a definition of a machine, then social organisations are machines. However, such a conclusion does not at all deny

the purposeful nature of individuals, and their constitutive role in the formation and continual evolution of social organisations.

The conclusion is that any proposed change in human activities needs to be both, systemically desirable and culturally feasible and systemically feasible and culturally desirable. To understand the problem of change only from one perspective would be to deny either the paramount role of purposeful individuals or the constraining nature of social organisations.

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