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Railway Management:
An Evaluation of Management Cybernetics
in a Public Enterprise

Volume 1

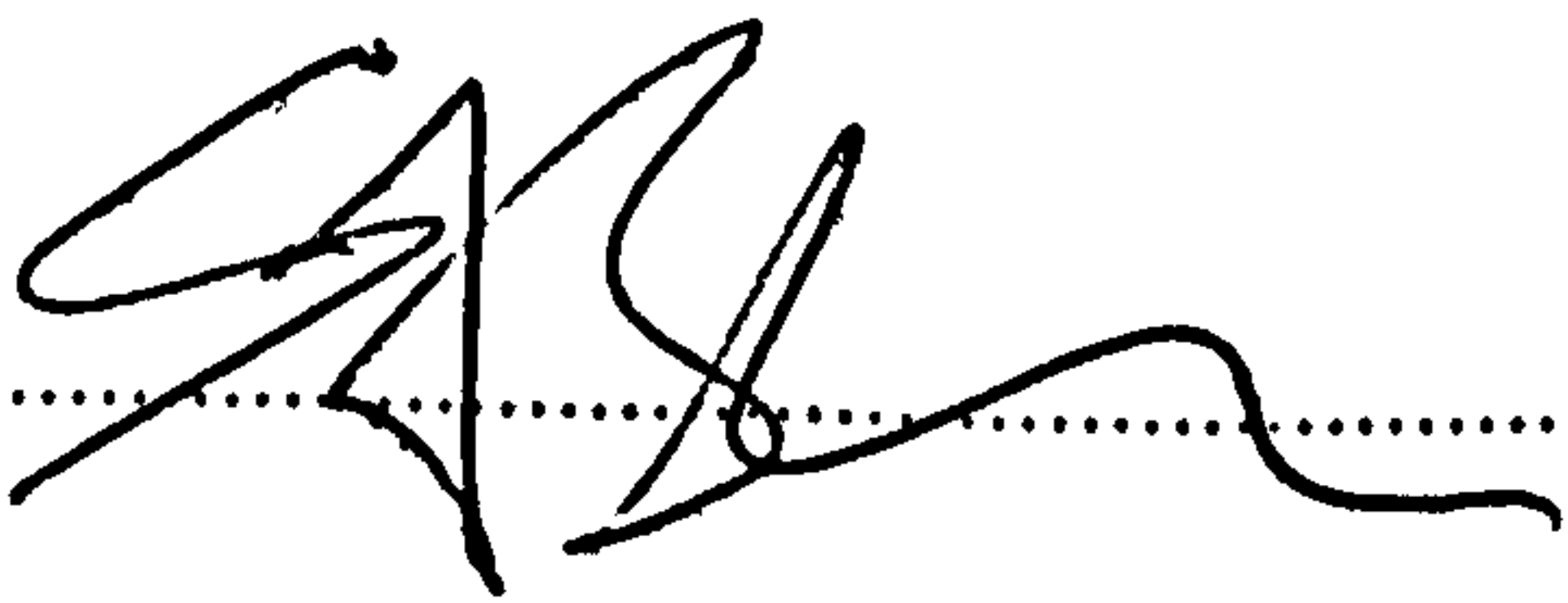
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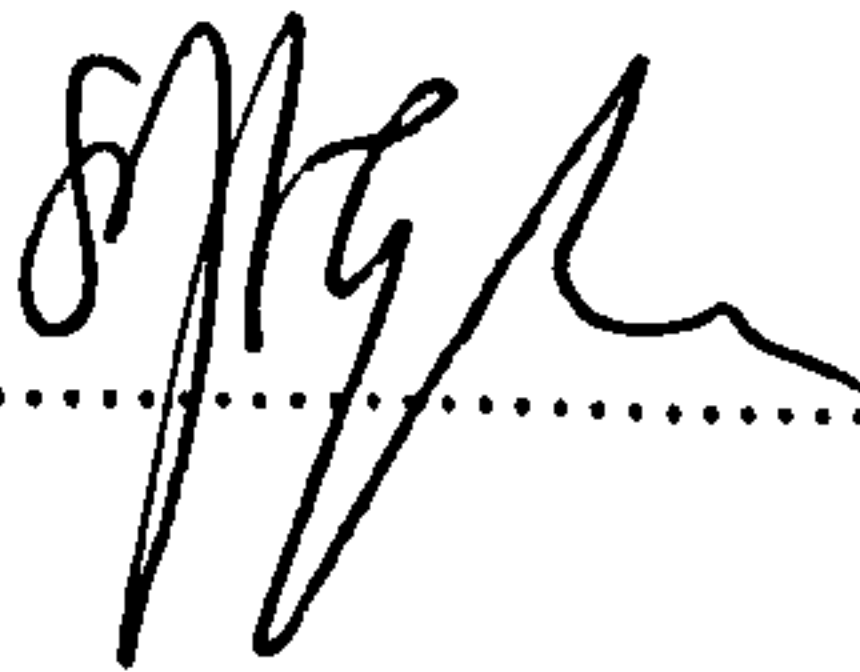
IORDANIS K. PARADISSOPOULOS

**Railway Management: An Evaluation of Management Cybernetics in a Public
Enterprise - Amendments**

It was agreed at the Board of the Faculty of Management and Administration meeting held on Wednesday, 16 September 1992, that the attached amendments should be included in the PhD thesis by I K Paradissopoulos.



J F Blagden
Institute Librarian



Professor S Tyson
Dean of the Faculty of Management & Administration

1 March 1993

AMENDMENTS

Among the material reviewed and/or used in this thesis there were three articles by Professor Jackson: (a) Jackson (1985), a review of Beer's model; (b) Jackson (1987), an article on the new directions in Management Science; and (c) Jackson (1988), a paper on the appreciation of the management cybernetics viewpoint of managerial practice. These three articles have frequently been referenced in this thesis, either explicitly in the text or in the many footnotes at the end of each chapter. However it has become apparent that misunderstandings might occur concerning the adequacy of referencing to these and also to a textbook, Schoderbek et al (1975). The reader is requested to bear in mind the following amendments while reading the thesis. All the above material is referenced in full in the References in the thesis.

1. CHAPTER 1, PAGES 1-2

- 1.1 In the section of Chapter 1 of the thesis, starting on page 1, eight lines from the bottom ("*...have been proposed by Jackson (1988)...*") up to the end of page 2, three lines from the bottom ("*... are in fact derived.*") should be amended as follows:

Starting at page 1, seven lines from the bottom, immediately after "*have been proposed by Jackson (1988)*" and ending at page 2, fourteen lines from the bottom, with "*... an emancipatory interest in their functioning*" should appear in italics and/or quotes.

2. CHAPTER 2, PAGES 33-34

- 2.1 In the section of Chapter 2 of the thesis, starting on page 33, sixteen lines from the bottom, with "*In a recent paper, Jackson (1987) identifies...*" up to the middle of page 34, sixteen lines from the bottom, ending with "*...This strand is based on Beer's work.*" should be amended as follows:

The section starting with "*All three thinkers are concerned...*", page 34, twelve lines from the top, should appear in italics and/or quotes.

3. CHAPTER 3, PAGES 45-55

3.1 Section 3.2, pages 45-54, entitled "Methods of Dealing with Cybernetic Systems" is part of an introductory chapter of the thesis aiming at demonstrating the linkages between Cybernetics and Management. Among the material reviewed for the purposes of this chapter there was a textbook Schoderbek et al (1975) which collates and comments upon relevant material. This book has itself been reference in footnotes but there were also instances where the original sources used in that book were also consulted. In such cases this source material is also attributed to where it originally appeared. However, such material, referenced in footnotes numbered 13, 19,21,24,25,26,28,29, and 30 should also be understood as also contained in Schoderbek et al (1975)

- 3.2 On page 55 the page should be amended to start with "*According to Jackson (1987)...*"

4. CHAPTER 4, PAGES 65-68

- 4.1 Page 65, second paragraph, starting with *"According to Beer, maintenance of viability means capability to respond to environmental changes..."* should read:

"Jackson (1987) says that according to Beer, maintenance of viability means capability to respond to environmental changes, even if those changes could not have been foreseen at the time the system was designed. Any viable system has to achieve requisite variety (at a level concordant with its effective performance) with the complex environment with which it is faced."

- 4.2 Page 65, fourth paragraph, starting with *"Beer (1981) has pointed..."* should read:

"Jackson (1987) says that Beer (1981) has pointed out a number of strategies that can be used in management in order to balance the variety equation for organisation in a satisfactory way. These strategies are aiming either at attenuating the variety of the external environment or at amplifying management's own variety"

- 4.3 Page 65, fifth paragraph, starting with *"Essentially the variety engineering strategies that Beer prescribes...."* should read as:

"Jackson (1987) says that essentially the variety engineering strategies that Beer prescribes are designed to fulfil two requirements: ((1)) that the organisation should have the best possible model of the environment relevant to its purposes; (2) that the organisation's structure and information flows should reflect the nature of that environment, so that the organisation is responsive to it¹³".

- 4.4 Section 4.3.1 of the thesis (pages 65-66), attributed to Jackson (1985) by footnote 14 (page 66) should be understood as a summarised description originating in Jackson (1985). In detail,

- 4.4.1 Page 65, seventh paragraph, starting with *"Systems ONE of an organisation are the various parts...."* should read as:

"According to Jackson (1985), Systems ONE of an organisation are the various parts of it directly concerned with implementation, i.e carrying out the tasks that the organisation is supposed to be doing. Each System ONE of the organisation should be autonomous in its own right so that it can absorb some of the massive environmental variety that would otherwise flood higher management levels. Systems ONE possess their own relations with the outside world and their own localised managements".

- 4.4.2 Page 65, eighth paragraph continuing in page 66, starting with *"Under normal circumstances, compatible instructions from higher management should ensure..."* should read as:

"According to Jackson (1985), under normal circumstances, compatible instructions from higher management should ensure that the various System ONE of an organisation act in harmony. However, the actual interactions set off amongst the Systems ONE may lead to unpredictable and dangerous effects for the whole organisation and the divisions themselves. there is a need, therefore, for a co-ordinating function provided by System TWO. System TWO consists of the regulatory centres of the Systems ONE linked to a corporate regulatory centre, which receives information about the actions of the various divisions and is able to prevent dangerous oscillations arising the system created by all the divisions".

- 4.4.3 Page 66, first paragraph, starting with *"System THREE is the control function...."* should read as:

"According to Jackson (1985), System THREE is the control function ultimately responsible for the internal stability of the organisation. This system must interpret the policy decisions of higher management and allocates resources to the divisions to carry out policy. It must ensure the effective implementation of policy..."

- 4.4.4 Page 66, second paragraph, starting with *"System FOUR, the intelligence function of the organisation"*, should read as:

"According to Jackson (1985), System FOUR, the intelligence function of the organisation, has two main tasks: (1) It switches instructions from the 'thinking chamber' of the organisation, System FIVE, down to the lower level systems, and it switches upwards from Systems ONE to THREE, information required by System FIVE to take major strategic decisions. (2) It captures for the organisation all relevant information about its total environment. having recognised environmental threats and opportunities, System FOUR filters the information and redistributes it downwards or upwards according to its implications. System FOUR is the point in the organisation where internal and external information can be brought together".

- 4.4.5 Page 66, fourth paragraph, starting with *"system FIVE is responsible for the direction..."* should read as:

"According to Jackson (1985), the model described can be used: (1) wither for the design of new organisational systems, according to the cybernetic principles elucidated in the model; (2) or for the diagnosis of deficiencies in existing organisation structures; (3) or, finally, as part of the design of efficient and effective information systems".

- 4.5 Page 66, last paragraph, starting with *"The model described can be used....."* should read as:

According to Jackson (1985), the model described can be used: (1) either for the design of new organisational systems, according to the cybernetic principles elucidated in the model; (2) or for the diagnosis of deficiencie in exisiting organisatonal structures; (3) or, finally, as a part of the design of efficient and effective information system".

- 4.6 Page 67, first paragraph, starting with *"The most ambitious attempt to use the model..."* should read as:

"According to Jackson (1985), the most ambitious attempt to use the model in this way was Project Cybersyn, involving the regulation of the Chilean social economy..."

- 4.7 Page 67, third paragraph, starting with *"The model can also be employed as a diagnostic tool..."* should read as:

"According to Jackson (1985), the model can also be employed as a diagnostic tool..."

- 4.8 Page 67, sixth paragraph, the sentence *"The following features would be regarded as a threat to the organisation's continued existence"* should read as:

"According to Jackson (1985), the following features would be regarded as a threat to the organisations' continued existence".

- 4.9 Page 67, seventh paragraph, starting with *"Mistakes in articulating the different level of recursion..."* should read as:

"According to Jackson (1985), mistakes in articulating the different level of recursion, so that the system is not logically organised at each of its levels of operation often lead to no recognition of the importance of certain Systems ONE³². Therefore, they are not treated as viable systems in their own right and a lack of localised System ONE management to attend to their affairs³³".

- 4.10 Page 67, eighth paragraph, starting with "System TWO is often not fully established..." should read as:

"According to Jackson (1985), System TWO is often not fully established because the localised management of Systems ONE resent interference from this relatively junior control echelon. However, unless System TWO is able to assert itself, co-ordination between the various activities of the Systems ONE will be put in jeopardy³⁴".

- 4.11 Page 68, first paragraph, starting with "System FOUR is often weak because..." should read as:

"According to Jackson (1985), System FOUR is often weak because it is regarded in many organisations as a 'staff' function. For this reason, it may lack good communications with other parts of the organisation, and its recommendations may frequently be ignored".

- 4.12 Page 68, second paragraph, starting with "However, if System FOUR is weak..." should read as:

"However, according to Jackson (1985), if System FOUR is weak, System FIVE will lack the knowledge of the organisation's environment, necessary for it to give proper attention to developmental activities. It will forget its higher-level duties and will instead tend to get too involved with the work of System THREE, or even try to intervene at Systems ONE level³⁶".

- 4.13 Page 68, fifth paragraph, starting with "system FIVE should represent..." should read as:

"According to Jackson (1985), System FIVE should represent what Beer calls the "essential qualities of the whole system..."

- 4.14 Page 68, sixth paragraph, starting with "an autopoietic system is one..." should read as:

"According to Jackson (1985), an autopoietic system is one which has the ability to 'make itself' to continue to produce those aspects of its organisation which are essential to its identity. However, according to the VSM, viability is a property which should be embodied only in the system's totality and in its Systems ONE. An organisation developing autopoiesis in any of its Systems TWO, THREE, FOUR or FIVE is 'pathologically autopoietic' and this threatens its viability. In an organisation, Systems TWO, THREE, FOUR and FIVE should serve the whole system, by prompting the implementation function, and should not be allowed to become viable systems in their own right. If they do develop as autopoietic systems it will inevitably be at the expense of the system as a whole. The faults of rigid bureaucracies can be traced to these organisations becoming pathologically autopoietic⁴¹".

5. CHAPTER 4, PAGE 77

- 5.1 The sentence of page 77 (Chapter 4, 15 lines from bottom) "Ulrich (1981) argues that it is enough for the model to subvert for authoritarian usage⁹⁶" should read as:

"According to Jackson (1985, p48), Ulrich (1981) argues that is enough for the model... to subvert for authoritarian usage⁹⁶".

6. CHAPTER 12, Pages 279-282

- 6.1** Page 279, first paragraph, the sentence "to deal with organisations possessing parts which are both horizontally and vertically interdependent" should read as:

" ...to deal with organisations possessing parts which are both horizontally and vertically interdependent Jackson (1988)".

- 6.2** Page 280, last paragraph, the sentence " ...corporate constraints only to the degree required for overall systematic cohesion and viability. This constraint rather than limiting liberty facilitates it because if less control was exercised, the result would not be greater freedom for the part, but anarchy" should read as:

" ...corporate constraints only to the degree required for overall systematic cohesion and viability. This constraint rather than limiting liberty facilitates it because if less control was exercised, the result would not be greater freedom for the part, but anarchy (Jackson 1988)".

- 6.3** The last sentence in page 280, last paragraph "in the extreme, the VSM strongly implies employees' involvement... they are going to benefit by seeking its viability" should read as:

"in the extreme, the VSM strongly implies employees' involvement in the determination of overall purposes. This is the only way to convince the parts that the system is serving their purposes and that they are going to benefit by seeking its viability (Jackson, 1988)".

- 6.4** Page 281, sixth paragraph, middle, "since variety" (as discussed in Chapter 3) ... "and significance of these purposes for the participants of the enterprise" should read as:

"Jackson (1988) argues that "since variety" (as discussed in Chapter 3) " is just and information-theoretic measure of complexity, it refers as pointed by Ulrich (1981), to the number of distinguishable states that a system or its output can assume syntactic level. This kind of explanation leads, probably, to the view that 'good' management is the one that establishes requisite variety between itself and the operations and between the enterprise and the environment, and nothing more. This view is not compatible with the previous discussion, i.e. that good management must also be concerned with the nature of the purposes served and the meaning and significance of these purposes for the participants of the enterprise".

- 6.5** Page 282, the sentence "the model places the source of viability of an organisation in its structural arrangements rather than in its corporate culture" should include a reference to Jackson (1988) where it has previously earlier.

.....

Note: All publications referenced in the above pages are listed in the body of the thesis, both in the bibliography (pp 283-295) and in numerous footnotes at the end of each chapter.

To the memory of Kostas N. Paradissopoulos,
who didn't manage to change the world,
though he tried hard,
and is, therefore, still blamed by those
who try hard
for the world not to change.

ACKNOWLEDGEMENTS

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- The State Scholarships Foundation (IKY), Greece.**
- The management of the Greek Railways (OSE).**
- The academic and administrative staff of the Centre for Transport Studies, especially RAF Seaton and IG Black.**
- The staff of the management library, especially Doreen.**
- Numerous Greek railwaymen from the very beginning, especially Manolis and Antonis.**
- Relatives and friends.**

All them I wish to thank.

My gratitude to my family, Helene and sons, Kostas and Nikos, for their support and apologies for any difficulties they experienced during these three years.

ABSTRACT

Two are the objectives of this thesis:

To identify structural and cultural causes of ineffectiveness in a state-owned railway enterprise in the light of the management cybernetics area of knowledge.

To assess the capacity of this area of knowledge, especially in its abstract and coded form (Beer's Model of the Viable System), to provide adequate explanations of organizational performance and organizational failure.

The objectives are sought in the analysis of an actual enterprise, the Greek Railways Organization (OSE).

An *'ethnographic type'* pilot study is initially undertaken, to highlight organizational problems under a management cybernetics perspective. The study, though demonstrating structural problems associated with a certain organizational culture, is assumed in itself inadequate, as it reflects a subjective interpretation of reality.

A *'survey within the case study'* is therefore undertaken aiming at deriving the real dimensions of organizational problems from an analysis of managerial responses.

Responses are designed to provide a picture of both

the actual way in which the enterprise organizes in the pursuit of its tasks, and

the organizational culture.

The first subtheme (organizational structure) is examined in terms of the *cybernetic model of the viable organization*. The findings, in general, validate the assumptions of the ethnographic study. Numerous structural problems are identified.

The second subtheme (culture) is examined in terms of *managerial cohesiveness*, defined as the agreement between managers on key issues of the identity of the enterprise. The overall conclusion is that though managers are, in general, in agreement, the content of this agreement tends rather to reflect a shared pessimistic view of the future than cohesiveness facilitating viability and development.

The conclusion, as regards the enterprise, is, that though many problems are reflected in the organizational structure, proper modifications of this structure may not suffice to guarantee improved performance, unless considerable attention is paid in the building of a relevant organizational culture, quite difficult under the specific circumstances.

The conclusion, as regards the adopted methodology, is that though Beer's model of the viable system assists in a diagnosis of many organizational deficiencies, it may not suffice to promote organizational change, especially when narrowly perceived, i.e., when results to a concentration on structural arrangements in the expense of the building of a corporate culture. Certain methodologies should develop, which, while making use of the advantages of the model, will not underestimate other significant aspects of organizational reality.

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CHAPTER 1

INTRODUCTION

"If a railway is to operate properly, responsible management is essential, but sound operation cannot be achieved if there is no scope for initiative or if responsibilities are not clearly defined..."

...It now seems to be the right time to put matters in order, since scarcer resources are an incentive to make better use of them".

A. de Waele, 1986 ¹

1.1. THE RESEARCH PROBLEM

This thesis deals with railway management. For many reasons, managing a state-owned railway enterprise in a western european context is much more complex than either public administration or private enterprise management.

Thus, though railway enterprises produce services and are therefore fundamentally no different from industries producing goods (in the sense that if they do not innovate they grow old and worn-out), they are different in that they have a public, state-supported function, are difficult to manage and it is particularly difficult to set clear and precise objectives for them.

In addition, their traditions, administrative structures and sometimes also a kind of *esprit de corps* (which is as much akin to the army as to a commercial enterprise) make the railways different from a purely commercial undertaking.

Obviously, management control in a railway enterprise is a sub-topic of the wider management control issue, which was defined by Tricker and Boland (1982) as *"the process that guides the enterprise to its objectives"* ². They have arrived at this definition after assuming that the 'classical' definition proposed by Anthony (1965), i.e., that management control is *"the process by which managers assure that resources are obtained and used effectively and efficiently in the accomplishment of the organization's objectives"* ³, though emphasising the purpose, excludes many inherent important ideas. Such ideas which establish a suitable basis from which to proceed in deciding to select and test a theoretical model of management control, have been proposed by Jackson (1988), using the examples of Vickers' writings on the nature of management, on the popular conception of organizations as socio-technical systems, and on the sociological theorizing of Habermas ⁴.

Vickers (1967) argues that *"business is a social activity and management a form of social regulation"* ⁵. He supports his argument on two sets of concepts:

The first emphasises the role of circular processes of control as found in feedback assemblies, and involving the comparison of 'what is' with 'what ought to be'.

The second set emphasises the part played by socially generated human expectations, which change the manifold and often conflicting standards of what *'ought to be'*, and hence determine and constantly alter the *'states'* which human organizations are set to seek.

Vickers' perception of the management function is concerned with both the social generation of objectives and the efficient pursuit of those objectives. This view, therefore, is compatible with contemporary views in organization theory, i.e. that organizations are best considered as open socio-technical systems ⁶. From this perspective, organizations are represented as having a technical aspect, being systems which seek effectively and efficiently to pursue goals in often volatile environments. They also possess a human and social aspect and depend for their viability on the establishment of shared understanding among their members about the goals to be pursued ⁷.

The nature of organizations as socio-technical systems and, therefore, the task of management may also be deduced from the sociological basis offered by Habermas (1979), who distinguishes two fundamental conditions, which define the sociocultural form of life of human beings ⁸. These he calls *'work'* and *'interaction'*. *'Work'* enables human beings to achieve goals and to bring about material well-being through social labour. The importance of work leads people to have a *'technical interest'* in the prediction and control of natural and social affairs. *'Interaction'* enables human beings to secure and expand the possibilities for mutual understanding among those involved in social systems. The importance of interaction leads people to have a *'practical interest'* in the progress of intersubjective communication.

Work and interaction have for Habermas pre-eminent anthropological status, but the analysis of *'power'* and the way it is exercised is also important, he believes, if we are to understand past and present social arrangements. The exercise of power in the social process can prevent the open and free discussion necessary for the success of interaction. Human beings have, therefore, an *'emancipatory interest'* in freeing themselves from constraints imposed by power relations and in learning through a process of genuine participatory democracy, involving discursive will-formation, to control their own destiny.

Organizations are at the heart of the socio-cultural life of humans, being the primary centres of social labour, social interaction and the exercise of power. People, therefore, all have a technical, a practical, and an emancipatory interest in their functioning ⁹.

Putting together the insights above, Jackson (1988) proposes a set of prerequisites against which the validity of any organizational model should be judged. Thus, the model

- (1) should serve the *'technical interest'*, by providing principles which can become the basis for the efficient and effective design of adaptive goal-seeking systems.
- (2) it should also seek to support the *'practical interest'* by facilitating debate about purposes and providing mechanisms through which genuinely shared purposes can emerge; and
- (3) it should support the *'emancipatory interest'* by permitting reflection on whose purposes are actually served and how purposes are in fact derived.

The interpretation of the work of this thesis, as regards the choice and the testing of an organizational model in the context of railway enterprises, will be structured in these terms.

1.1.1. Preliminaries to Problem Definition

It should be stated that this view of organizations does not necessarily imply a perception of social reality compatible with the prevailing one. Since human knowledge, as every other cultural manifestation, is a result of the complex interaction between the members of a particular socio-economic formation and between them and their environment, as long as a culture remains valid to its creators, so do their values, knowledge, beliefs, and social practice in general. Kuhn (1962) has introduced the concept of paradigm as *"...a set of recurrent and quasi-standard illustrations of various theories in their conceptual, observational, and instrumental applications. These are the community's paradigm, revealed in its text-books, lectures, and laboratory exercises"* ¹⁰. The prevailing paradigm is then what characterises the state of knowledge at any given time in history, and its stability is defined by its capacity to respond to society's contemporary needs.

Kuhn has distinguished periods of crisis, when the scientific community perceives a growing concern about the ability of the prevailing paradigm to respond adequately to the problems currently encountered. A crisis period normally precedes a major change in the state of scientific knowledge. In this sense, the force defining the dynamics of knowledge towards more stable forms is provided by the confrontation of theoretical knowledge with experimentation and social practice on one hand, and with the epistemological reformulations that such a confrontation provokes, on the other. Scientific knowledge may be perceived as a system that is being continuously tested, in order to reinforce or deny its validity, depending on how well it is capable of contributing to the solutions of contemporary social problems.

This thesis is dealing with Railway Management, which can be considered as a discipline in its own right, with its own community of theoreticians and practitioners and, of course, with its prevailing paradigm. This discipline in turn may be viewed as a part of a wider one, Management Science, the latter being an integral part of Social Science. Attempting to tackle the Railway Management issue outside the prevailing paradigm would be justified if serious indications of a *'Kuhnian crisis'* were encountered. This point will be discussed soon after an alternative reasoning has been provided.

1.1.1.1. Need for Scientific Research outside the Prevailing Paradigm

Knowledge and Science are systems achieved through social practice. They are, therefore, linked to the historical and cultural experience. Values, perceptions and customs affect the way knowledge develops. The way in which a society organizes in order to provide material conditions for the survival of its members also affects the development of knowledge. Society as a system itself fixes the references for the development of knowledge within limits that ensure or tend to ensure the viability of its prevalent institutions. Waddington (1977) defines this condition as *"Conventional Wisdom of the Dominant Group"* ¹¹. Wiener (1964), illustrating the problems encountered by a scientist working outside the conventional wisdom, has noted:

"...Even in the field of science, it is perilous to run counter to the accepted tables of precedence. On no account is it permissible to mention living beings and machines in the same breath. Living beings are living beings in all their parts; while machines are made of metal and other unorganised substances, with no fine structure relevant to their purposive or quasi-purposive function. Physics -or so it is supposed- takes no account of purpose; and the emergence of life is something completely new.

If we adhere to all these tabus, we may acquire a great reputation as conservatives and sound thinkers, but we shall contribute very little to the further advance of knowledge. It is the part of the scientist -of the intelligent and honest clergyman as well- to entertain heretical and forbidden opinions experimentally, even if he is finally to reject them".¹²

This thesis somehow responds to Wiener's demand, i.e., that 'heretical' opinions should be encouraged, as it attempts to tackle the Management issue on grounds different to the ones that support most current developments.

1.1.1.2. Questionable Stability of the Prevailing Paradigm

We may now return to the question whether the prevailing paradigm in the discipline of Management Science, shows serious symptoms of instability. To answer this question, we should consider what type of model of the social system is employed in analyses within the 'classical' or 'traditional' school of management.

Ackoff (1981) has assumed that a 'mechanistic' model underlies 'traditional management' analyses ¹³. The organization is conceptualised as a machine that works with a regularity dictated by its internal structure and the natural causal laws of nature. This type of model is based on two assumptions: that the world can be completely understood and that such understanding can be obtained by analysis. Analysis is thought to be a three-step process. First it takes apart that which it seeks to understand. Then it attempts to explain the behaviour of the parts taken separately. Finally it tries to aggregate understanding of the parts into an explanation of the whole.

"Mechanistically modelled organizations are structured hierarchically and are centrally controlled by a completely autonomous authority. Such an authority can affect any part of the system without being affected by any of them. This separates the ultimate authority from the system making the authority an external controller.

All members of the system other than the one with ultimate authority are deprived from all information except that required to do their jobs. Instructions from above are not explained or justified.

The operations of an ideal machine do not vary. Therefore, as long as its input does not vary, its output will not vary. For this reason, controllers of mechanistically modelled social systems focus on inputs rather than on outputs. For example, they assume that control of costs is equivalent to control of outputs. The quantity of output is assumed to be determined by the quantity of input. The system is thought of much as a vending machine". ¹⁴

Since a social system conceived in terms of a mechanistic model is inflexible, it can operate effectively only in a static environment. However, the rapidly changing environment of social systems requires continuous adaptation and learning by organizations if they are to remain effective. Prerequisites to adaptation and learning are precisely these characteristics that mechanistically managed and structured organizations lack; i.e., the readiness, the willingness and the ability to change.

Every organization is contained in a wider social system, which it shares with other embedded organizations. No organization is any more permitted to ignore its effects on its

environment. Equally, it is not permitted to ignore the effects of the environment on it. The recognition of this inevitable interaction by mechanistically conceptualised organisations poses to them a severe dilemma:

As they have either difficulties or virtually inability to respond to environmental changes, their effectiveness suffers.

Increasing ineffectiveness results in reinforcement of their rigidity, and closer adherence to rules and regulations. Their effectiveness further deteriorates.

Concentrating on this vicious circle, in which such organizations become more and more dysfunctional, Ackoff argues that the performance of a system is not the sum of the independent performances of its parts. It is the product of their interactions. Therefore

"effective management of a system requires management of the interactions of its parts, not their independent actions. Moreover, since a social system interacts with its environment, management of this interaction is also required for it to function effectively".

1.1.2. Problem Formulation

Attempting to locate an organizational model without the disadvantages assigned to the mechanistic model employed by 'traditional' management science involves a move towards the periphery, or even outside this discipline, where, as discussed, multiple alternative approaches have developed, each of which declares incompatibility with any other. To the non-specialist in the partial disagreements among the various 'schools of thought' the choice of a certain methodology tends more to reflect specific requirements imposed by the nature of his research than certainty concerning the soundness of the methodology adopted. However, any attempt to apply a model to a situation under investigation inevitably leads also to a deeper understanding of the tool selected and the scientific principles that underwrite it. Thus, a possibility arises to conclude on both the subject of the 'experiment' and the 'apparatus' itself. The objective of this thesis is to pursue this possible outcome.

The selected 'apparatus' is the management cybernetics methodology, summarised in Stafford Beer's Model of any Viable System (VSM).

The subject of the 'experiment' is a nationwide state-owned railway enterprise, namely the Greek Railways Organization (OSE-CH).

Explanations for both choices are provided in subsequent sections of this Chapter.

1.1.2.1. The Theoretical Framework

The view that management control is essentially the same basic process as is found in physical, biological and social systems is attractive. As pointed out by Wiener (1948) ¹⁵, communication, or information transfer, and control occur in the functioning of many systems. All types of systems control themselves by information feedback, which discloses error in accomplishing goals and initiates corrective action. A whole scientific discipline has emerged around the concepts of information, communication and control, defined, by Wiener, as *Cybernetics*. Within cybernetics, several orientations have evolved, the most well-known of which, as regards human organizations, is Management Cybernetics. This alternative to 'traditional' Management Science builds mainly on Beer's work ^{16 17}, central to which is the Model of the Viable System. The model depicts the organization as consisting of five subsystems (labelled systems ONE to FIVE), the existence and the proper

functioning of each of which is a necessary and sufficient condition for organizational effectiveness and viability.

As this thesis utilizes Beer's model, both detailed description and application may be found in several chapters and appendices. However, the dangers incorporated into any attempt to describe and analyze a social system by means of an abstract construct, even as elaborate as the VSM, should be stressed here. This is why the strict criteria for the assessment of the validity of an organizational model have been adopted.

As it will be discussed, concerning Beer's model, debate has mainly focused on its application for the regulation of the economy at a national scale ¹⁸. An experiment of this size inevitably involves wider considerations and does not facilitate the distinction between the actual weaknesses of the model and the '*conventional wisdom*' or '*institutionalised truth*' on abstract and sensitive issues such as '*freewill*' or '*democracy*'. However, at a minor scale or, in VSM terminology, at a lower level of recursion, two sets of justifications may be offered, for the choice of Beer's model for the purposes of this thesis.

Plausibility of the Theoretical Framework

The first reason is that various researchers have discussed the plausibility of the model. Morris (1983) argues ¹⁹, that Mintzberg (1979), from an independent viewpoint as may be judged by the lack of significant overlap in mutual referencing among his work and that of Beer, having conducted a detailed analysis of the literature in organizational design and development, seeks the underlying structure and proposes five sub-systems, which he calls

- (1) the operating core,
- (2) the middle line,
- (3) the strategic apex,
- (4) the support staff sub-system, and
- (5) the programming sub-system (the technostructure) ²⁰.

According to Morris, *"if one looks carefully at the examples, given by Mintzberg, and especially at the preferred ways of working chosen by each of these subsystems, one has little difficulty relating them to Beer's viable system model"*.

Britton and McCallion (1985) ²¹ believe there is independent validation of the model and support the argument by comparing Beer's model to the set of propositions about organizational design and behaviour, developed by Thompson (1967) ²² from a theoretical framework different to that used by Beer.

Duncan (1977) ²³ finds a convergence between Beer's theoretical model and the concepts of the practitioner, Alfred P. Sloan ²⁴, underlining Sloan's following point: *"If you can describe the functions of the parts and the whole, you have laid out a complete working organization, for by implication the apportionment of responsibility for decisions at various levels is contained in the description"*. He further compares Beer's model to Miller's work ²⁵ and argues: *"The identification of Miller's subsystems processes within the components of the Beer schematic can be achieved and both conceptual systems remain intact. No processes beyond those identified by Miller are called for by Beer. The Beer scheme does not alter the Miller concept; it merely elaborates on it"*.

Jackson (1988) finds some close parallels between the way in which Beer deals with the problem of '*centralization versus decentralization*' and the '*contingency theory*' approach to differentiation and integration offered by Lawrence and Lorsch (1969) ²⁶.

Strongly Purposive Character of the Railway Enterprise

The second reason that justifies the selection of Beer's model for the purposes of this thesis relates to the strongly purposive character of the railway enterprise which reduces the risks associated with an arbitrary definition of systemic objectives and hence with partial modelling. That is, besides ambiguities concerning the objectives of a railway as a public enterprise, the purpose of the system at functional level is more or less clear. Even clearer are the goals or purposes of the sub-systems within the enterprise. Thus, the '*purposiveness*' of this system is to a large degree self-evident and not arbitrarily assumed. According to Jackson (1985), Beer's model is the best conceptual model available for understanding transport systems and hinting at possible improvements to the operation of organizations in the transport sector ²⁷. Jackson (1988) testifies that the VSM was the only management model capable of integrating into a book six diverse contributions to a seminar series about the management of transport systems ²⁸.

1.1.2.2. Subject of the Research

The thesis proceeds in examining the issue of railway management control by means of a study of the Greek Railways Organization (OSE). Thus the type of research undertaken may be defined as a field- or single case-study.

According to Miller (1983), this type of research design is concerned primarily with processes and patterns under investigation of a single group, institution, organization or community. Emphasis is on the social structure, i.e., interrelationships of parts of the structure and social interaction which are taking place. It attempts observations of social interactions or investigates thoroughly the reciprocal perceptions and attitudes of people playing interdependent roles ²⁹.

A case-study, defined as an empirical inquiry that investigates a contemporary phenomenon within its real-life context,

when the boundaries between phenomenon and context are not clearly evident, and

in which multiple sources of evidence are used, ³⁰

distinguishes from other research strategies. For example,

an experiment deliberately divorces a phenomenon from its context, so that attention can be focused on a few variables (typically, the context is 'controlled' by the laboratory environment).

a history does deal with the entangled situation between phenomenon and context, but usually with noncontemporary events.

a survey tries to deal with phenomenon and context but its ability to investigate the context is extremely limited. A survey designer constantly struggles to limit the number of variables to be analyzed (and hence the number of questions that can be asked), to fall safely within the number of respondents that can be surveyed.

The following reasons justify the selection of the specific single case-study design for the purposes of this thesis:

Case-Study as a Revelatory Case

The case of Greek Railways (OSE-CH) is a revelatory case. The author of this thesis had an opportunity to observe and analyze the company from within, being himself an employee (civil engineer) for more than ten years. At the same time, due to his relation with the enterprise, he had the ability to conduct a substantial number of interviews with managers, to an extent difficult to achieve by an outside researcher. Moreover, since both the selection of the topic and the methodology adopted relate only to personal discretion, the thesis is to a large degree freed from formal limitations in the expression of ideas and conclusions, except for self-imposed ones. The advantage of this situation should not be underestimated, to the degree that similar favourable prerequisites of within-organizations social research are not very frequently satisfied.

Case-Study as an Extreme Case within both Functional and National Contexts

The case of Greek Railways (OSE-CH) tends to constitute an extreme case, according to, at least, two points of view:

Greek Railway is probably the least developed railway within the European Community. Since *"a chain is only as strong as its weakest link"* ³¹, rail transport efficiency within the community is to some degree determined by the efficiency of the least effective partner. Though the geographical position of Greece within the continent may seem to prove this argument exaggerated, it should be kept in mind that this country provides physical and other links between the rest of the community and major markets within the Asian and African continents.

The Greek Railway is probably the most problematic of all public interest state-owned enterprises in the country. Though this reality is the outcome of historical conditions discussed in several parts of this thesis, it highlights both the managerial dilemma as regards decisions on priorities between today's and future needs, and the environmental uncertainty within which these decisions are made.

Case-Study as a Representative Case in Public Enterprises Context

The extreme character of the under-study enterprise, regarding its performance, as assessed both in respect to other European Railways and to Greek Public Enterprises should not lead to an underestimation of principle common features of state-owned enterprises, globally. In the specific case, a decision has been made to invest heavily in the modernization of the company, though such modernization has been narrowly perceived mainly as infrastructure update and new rolling stock acquisition. However, even this narrowly, technologically perceived modernization progresses very slowly and is put in danger when considering that it takes place within a context defined by:

- the reliance on government funding, being an argument of the overall development of financial indices at a national scale;
- the almost complete dependence on foreign technology, influencing both the availability of required materials/equipment, as it directly affects the balance of payments, and the ability to digest and make the most of complicated technological products, perceived, designed, produced and utilized in much different environments.
- the absence of short-term pay-offs which could both result in substantial political profit on behalf of any ruling party, and justify to the public opinion the large expenditure involved.

Similar managerial constraints are associated with the very nature of many public enterprises; thus, a thorough study of any of such enterprises may produce conclusions useful to the wider spectrum.

1.1.3. Research Objectives

The following two main objectives of this piece of research derive from the formulation of the problem, as discussed above:

To identify structural and cultural causes of ineffectiveness in a state-owned railway enterprise, in the light of the management cybernetics area of knowledge.

To assess the capacity of this area of knowledge, especially in its abstract and coded form (VSM), to provide adequate explanations of organizational performance and organizational failure.

1.2. RESEARCH DESIGN

The twin objective of this thesis and the non-traditional character of the model employed have dictated the need both to review literature on diverse but related areas and to contain many of the various findings of the review in this volume. In order this to be achieved without loss of clarity of both the methodology and the assumptions, a certain format has been employed, which allows the distinction between various stages, but also demonstrates their linkage in the form of a sequential flow. However, both the stages of information collection and the thesis layout, as illustrated in the following paragraphs, provide a useful schematic, which does not correspond to the exact way in which the task was achieved, since much of the feedback is kept implicit to allow for readable material.

1.2.1. Stages of Information Collection and Processing

Schematically, this thesis may be perceived as the outcome of three stages of information collection and processing.

The first stage involves examining material related to state-owned railway enterprises, aimed at realising fundamental dimensions of the management control problem within this context. The material processed is either in itself inadequate or gives rise to wider considerations, which inevitably lead to a further stage.

The second stage involves an examination of the literature on management control and results in the selection of an organizational model assumed, initially, as appropriate for the purposes of this research.

By the end of these two stages the principle elements of the applied research methodology are decided. Specific information required is now sought. Though information drawing on both published material and on personal participation within the case-study company over a long period seems adequate and relevant to the requirements of an ethnographic type of research, increased objectivity is desired, the information for which is sought in a survey within the case-study based on a structured questionnaire.

1.2.2. Thesis Layout

The thesis develops in two volumes; *Volume 1* contains the main body and *Volume 2* contains the appendices.

Chapter 2 deals with Management Science within the '*traditional*' paradigm. Two related issues are examined: Management Control and Information Systems for Management Control.

Various indications are provided that the '*classical*' definition of Management Control offered by Anthony (1965) might not suffice. Two fundamental conditions are underlined:

the relation of control to planning, and

the relation of control to organizational structure.

The chapter reviews the development of computer based information systems for management control and records reported dissatisfaction associated with their implementation. Certain dimensions of this dissatisfaction are assumed to stem from the inadequacy of the "*official*" paradigm. The fundamentals of an alternative understanding are sought in a perspective of management satisfying the requirements from an MIS as proposed by Argyris (1977), i.e., that it should

contain abstract quantitative descriptions of key performance indicators,

represent stable variance,

represent the results of outputs of complex processes and not the processes themselves,

contain explicitly rational logic, and

confirm or disconfirm evaluations publicly.

This kind of perspective is understood as having much in common with cybernetics.

Chapter 3, therefore, deals with cybernetics as applied in Management. To the main part it is a rather technical chapter, introducing cybernetic definitions, concepts and methods. According to Beer (1962), the characteristics of a cybernetic system are complexity, probabilism and self-organization. These are also characteristics of a social organization. The chapter presents methods of dealing with these characteristics, i.e., the law of requisite variety, the '*black box*' technique, information transmission and transduction, and feedback. The exploitation of such methods characterises the organizational model employed for the purposes of this thesis.

The chapter also reviews alternative trends within Cybernetics as applied to managerial situations and deduces that, to a great extent, many of such applications are well contained within the traditional management science paradigm. An alternative perspective drawing on Beer's work is introduced and the resulting views of organizations and management are outlined.

Chapter 4 discusses the organizational model used in this piece of research, i.e., Beer's model of the viable system (VSM). The structure of the model is very briefly shown in this chapter, because a detailed illustrated presentation, based on Beer's own description and diagrams, is provided in *Appendix A*.

Three principle ways of utilizing the model are presented, i.e, the use for the design of new organizational systems, the use for the diagnosis of deficiencies of existing organizational structures and the use for the design of management information systems. Examples on applications are also reviewed.

The chapter ends with a discussion of various criticisms to the model, the conclusion being that, despite its diagnostic power, the model does not guarantee an effective organizational design.

Chapter 5 introduces the domain of the railway enterprise. Three dimensions are discussed:

the need for a regulated environment and, further, the extreme form of regulation, i.e., state ownership;

the objectives of the state-owned railway enterprise; and

the external assessment of the performance of the public railway enterprise.

Through the review of related literature the chapter concludes that the state ownership of a railway, whether or not justified on the grounds of the promotion of the public interest, has inherent disadvantages mainly related to the state's interventionism. Such disadvantages do not facilitate the setting of clear objectives, the operation of the enterprise and the assessment of its performance.

Many of the conclusions in this chapter are employed, examined and validated in further parts of the thesis. The understanding of this validation has, in many cases, been assumed obvious, and hence not explicitly quoted.

Chapter 6 provides the basics of the way in which the railway management issue is examined within this work. Discussing railway management implies knowing what the enterprise is doing at the implementation level. Hence, a view of the main functional systems is provided. The enterprise is illustrated in VSM methodology as consisting of sub-systems within systems. An unfolding of this complexity is offered for the first four recursive levels. This structure is one of the building bricks of this project.

Management control has been perceived earlier as an argument of planning and of organizational structure. These issues are discussed here within a railway context. The resulting list of managerial activities, accountability for which is a prerequisite for proper management, is a second basic point of this thesis.

Chapter 7 provides background information concerning the specific enterprise in which the ideas discussed in previous chapters will be tested. Much of the information contained here is discussed in the remainder of the thesis, which constitutes the 'applied research'. Besides a few historical notes and information concerning the resources and the performance of the enterprise the chapter provides an original account of the development of the organizational structure of the enterprise and of the external conditions which have governed this development. *Appendix B* contains organizational information related to this chapter. Finally, as the various organizational units are presented throughout this thesis under the latin-alphabet form closer to their actual abbreviated names this chapter starts the introduction of this format.

The way in which a railway enterprise is perceived within this thesis has been made explicit in *Chapter 6*. The author's experience as an employee of the specific enterprise

offers the possibility of a comparison between this company and the model set up in *Chapter 6*. For this comparison, undertaken in *Chapter 8*, there are two main sources of information as regards the case-study enterprise:

the author's personal experience of the structure and functioning of the railway, and

the legislation assigning specific duties to the various units of the state-owned enterprise.

The kind of research reflected by *Chapter 8* may be defined as ethnography. The task of this ethnographic study is to diagnose managerial problems of the enterprise vis-a-vis the cybernetic model.

By the end of this exercise several causes of ineffectiveness have been identified. It is shown that these causes are both structural and 'cultural'. However, this diagnosis, based on a personal interpretation of the reality, is subjective. A survey within the case-study is, therefore, decided upon. The survey is designed to provide information in order to illuminate both structural and cultural dimensions of organizational problems. Therefore, apart from understanding the actual organizational structure of the enterprise in terms of Beer's model, a method should be devised, in order to analyse the organizational culture. The design of the survey phase of the project is discussed in *Chapter 9*.

The fundamentals of the actual VSM construction have already been set up in *Chapter 6*, in the form of the list of managerial activities within the railway enterprise. During the interviews accountability for each of these activities is requested from the managers of the company as well as actual information exchange for each activity for which any manager declares responsibility.

The analysis of the organizational culture is attempted by the introduction of the concept of managerial cohesiveness. To this purpose, the discussion in *Chapter 5* proves useful. Certain dimensions characterising the organizational culture are identified in key issues such as objectives, operational tasks, internal functioning, performance assessment, performance constraints. Managers' opinion on these issues is requested. *Managerial cohesiveness* is defined as the degree of managerial agreement on these issues. Overall agreement indicates cohesiveness. However, this is not always a favourable sign, as much depend on the content of this agreement.

Appendix C contains the survey questionnaire and *Appendix D* the data collected by means of this questionnaire.

The two themes of the survey phase of this research are discussed in the following chapters.

In *Chapter 10*, the VSM of the enterprise as deriving from managerial responses is constructed. As regards accountability allocation, the chapter, in general, is in agreement with the description provided in the ethnographic phase. Additionally, the chapter utilises information related to 'information flows' within the enterprise and between the enterprise and the environment and demonstrates some further causes of ineffectiveness in terms of information handling. *Appendix E* support the arguments of this chapter.

the constraints posed by weaknesses in the organizational structure. *Appendix F* contains relevant information.

Finally, *Chapter 12* provides the conclusions of the project, as regards its objectives.

The main conclusion for the studied enterprise is that though many problems are reflected in the organizational structure, proper modifications of this structure may not suffice to guarantee improved performance unless considerable attention is paid in the development of a relevant organizational culture.

As regards the management cybernetics viewpoint employed in the analysis, the main conclusion is that though the model proved very useful in the identification of structural problems it could not always reflect alternative dimensions of ineffectiveness, though many of these dimensions are adequately discussed in the management cybernetics literature. Hence, a proper organizational diagnosis in terms of the VSM implies either modelling in multiple alternative recursive dimensions, or a functional cybernetic analysis supplemented by an examination of cultural problems (undertaken in this thesis in the form of the analysis of managerial cohesiveness).

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CHAPTER 2

MANAGEMENT CONTROL

2.1. CONTROL AS A MANAGERIAL ACTIVITY

2.1.1. Definition

Management control has been defined by Anthony (1965) as *"the process by which managers assure that resources are obtained and used effectively and efficiently in the accomplishment of the organisation's objectives"*. According to Tricker and Boland (1982), this view equates management control with the tactical operation of the enterprise and, by focusing on efficiency and effectiveness, usefully emphasises the purpose of management control. However, they argue, it excludes many of the subtle and important ideas inherent in management control. It does not question the value systems underpinning the organisation or its attitudes to control: it assumes a rational, constitutional enterprise whose members accept the need for control for the maintenance of good order and the pursuit of goals in the best interest of the individual, the enterprise and the state. This is a wide assumption in a society of changing values and expectations, in which ideas about the role and place of organisations are being revised, and on a world canvas of scarce resources, monetary uncertainties and political and social upheaval, in which previously accepted thinking is challenged. The notion of management control cannot now be separated from ideas about values, authority, responsibility and power. *Management control is the process that guides the enterprise to its objectives.* ¹

According to Koontz et al. (1980), the managerial function of controlling is the measurement and correction of the performance of activities of subordinates in order to make sure that enterprise objectives and the plans devised to attain them are being accomplished. It is thus the function of every manager, from president to supervisor. Koontz et al. (1980) point that occasionally, in view of the authority of the upper-level managers and their resultant responsibility, top- and upper-level control is so emphasised that the impression is gained that little controlling is needed at lower levels. Although the scope of control varies among managers, those at all levels have the responsibility for the execution of plans, and, therefore, *"control is an essential managerial function at each level"*. ²

2.1.2. Prerequisites of the Management Control Process

According to Koontz et al. (1980), two major prerequisites must exist before the management devises or maintains a system of controls. Yet people frequently concentrate on control techniques and systems, without having made sure that the prerequisites, i.e. plans and organizational structure, have been met.

2.1.2.1. Control Requires Plans

In a presentation to the members of the Academy of Management, Koontz (1956), expressing his view on the *"principles of planning and control"*, proposed the following classification of managerial activities: ³

- Planning
- Organizing
- Staffing
- Directing
- Controlling.

Focusing on two of these activities, planning and controlling, Koontz (1956) was one of the first to describe their "singularly inseparable" characteristic. His presentation outlined the principles of these two functions, which he categorised as:

- principles dealing with the nature of planning,
- principles having to do with the structure of plans,
- principles explaining the process of planning, and
- principles dealing with the managerial function of control.

This work was followed by more research along the same lines, this time focusing on the control function. ⁴

Whereas his past research had dealt primarily with planning principles, Koontz later realised that the perception of control as a "technical matter about which few generalisations could be made" was incorrect. He emphasised the importance of control as he had done with planning:

"Controls are the reverse side of the coin of planning. First, managers plan; then plans become the standards by which desired actions are measured. This simple truth means several things in practice. One is that all meaningful control techniques are, in the first instance, planning techniques. Another is that it is fruitless to try to design control without first taking into account plans and how well they are made". ⁵

According to Anthony and Young (1984), planning is deciding what should be done and how it should be done, whereas control is assuring that the desired results are obtained. They distinguish three types of planning and control activities in most organizations:

Strategic Planning, i.e., the process of deciding on the goals of the organization and on the broad strategies that are to be used in attaining them.

Task Control, i.e., the process of assuring that the tasks (the processes that are used in carrying out the day-to-day activities) are carried out effectively and efficiently.

Management Control, i.e., an activity between the above two types of planning and control, which, accepting as given the strategies arrived at in the strategic planning process, deals with the implementation of these strategies. ⁶

Management control does not involve the detailed operating decisions and activities that are the focus of task control; rather it is the means by which management assures that the organization carries out its strategy effectively and efficiently.

2.1.2.2. Control Requires Organizational Structure

Koontz et al. (1980) argue, that since the purpose of control is to measure activities and take action to ensure that plans are being accomplished, there is a need to know where in an enterprise the responsibility for deviating from plans and taking action to make corrections lies. Control of activities operates through people. But we cannot know where

the responsibility for deviation and needed actions is, unless organizational responsibility is clear and definite.

Therefore, a major prerequisite of control is the existence of organizational structure. The clearer, more complete, and more integrated this structure is, the more effective control action can be.

Tricker and Boland (1982) show how organizational structure and style can be characterised by their capacity for processing information. The same set of individuals using different organizational structures will have different abilities for processing information. In an organization with dependence on a central authority and very restricted, formal channels of communications will not be able to process as much information as a whole, as in an organization with a matrix structure, decentralised responsibility and open, informal communication channels.

Galbraith (1980) presents a framework for assessing the information processing capacity of organizational structures. The information processing required of the organization can be characterised as function of the inherent uncertainty of the task to be performed (including technological and environmental considerations), the number of elements to be coordinated and the interdependence of subunits. ⁷

Assume an organization that initially has adequate information processing capacity with a classical structure that includes a set of standard operating procedures, and an annual planning process to establish goals and revise the operating programmes as necessary. Assume further that there is a change in the technology, environment, number of task elements or interdependence of units that increases the demand for information processing on the organization. The result will be an increased number of exceptions to standard procedures and variances from established goals which will create an increased number of requests for resolution and coordination from the hierarchy. Eventually, the hierarchy is overwhelmed with exceptions.

2.1.3. The Management Control Process

According to Anthony and Young (1984), the management control process takes place in the context of an organization that has goals and that has decided on broad strategies for achieving these goals. As already noted (*para. 2.1.2.1*), decisions on these goals and strategies are made in the strategic planning process, which is largely unsystematic and informal. The management control system collects information that is useful in strategic planning, but since strategy decisions are made only occasionally, and since each strategic issue requires information that is tailor-made to the requirements of that issue, this information cannot ordinarily be collected in any routine, recurring fashion. Rather it must be put together when the need arises and in the form required for the specific issue.

Anthony and Young (1984) insist that much of the management control process is informal. It occurs by means of memoranda, meetings, conversations and even by such signals as facial expressions. However, they state, many organizations have also a formal system, in which the information consists of planned (or estimated) and actual data on both outputs and inputs. They distinguish four principle steps in a formal management control process:

1. Programming.
2. Budget formulation.
3. Operating (and measurement).
4. Reporting and evaluation.

The steps reccur in a regular circle, and together they constitute a 'closed loop'. 8

Koontz et al. (1980) show that control techniques and systems are essentially the same for cash, office procedures, morale, product quality or anything else. According to them, the basic control process, wherever it is found and whatever it controls, involves three steps:

1. Establishing standards.
2. Measuring performance against these standards.
3. Correcting deviations from standards and plans. 9

The essence of the control process is that information, from monitoring divergences of activities for requirements, is fed back to form the basis for control; i.e., for taking action to vary the plan or to bring the ongoing activity into line.

Tricker and Boland (1984) have stated that the application of this view in management control implies that *"the manager responsible for a performance centre can bring the unit into line, i.e. that s/he does have the power to act"*. Early works on management control systems did not question this assumption. The manager could expect to be obeyed when s/he gave an order. This assumption of an authoritarian climate remains the conventional wisdom behind many management control systems today. 10

However, in some cultures in the world, the old order is giving way to a new. Management control analysis needs to consider where each decision maker derives his power and how is he able to take controlling action.

Tricker and Boland (1984) identify three ways of derivation of power within organizations:

Position power, where power stems from organizational position. This is the classical command situation in which the authority of the 'boss' is perceived and accepted. Positional power is no longer the dominant power base in many organizations. Indeed, positional power is frequently challenged, even rejected.

Action power, where power is derived from the ability to act rather, than from position. The ability to manipulate the use of essential resources, where no substitute is available, provides a source of power.

Knowledge power, which stems from the ability to cope with uncertainty. It is typified in the enquiry, discussion and persuasion. The sensible application of knowledge power can produce power sharing, without a dilution of position power. The use of such power presupposes an organizational climate of trust.

Tricker and Boland (1984) argue that, in many situations today, positional power alone is insufficient to manage. Management control has to be exercised in the context of both action and knowledge power. The skills and abilities needed by a manager, consequently, have additional dimension: negotiating and concilation skills, political awareness, sensitivity to developing issues and ability to make firm, clear actions reducing the area for conflict. Such skills are seldom intuitive and not, traditionally, considered part of management control.

2.2. SYSTEMISING THE MANAGEMENT CONTROL FUNCTION

Anthony and Young (1984), as already stated (*para. 2.1.3*), believe that a management control system as a whole includes both formal and informal systems.

Some of the key mechanisms in the formal system are budgets, committees, standards and reviews. Components of the informal system are the daily communications that go among organizational personnel and the informal work groups that appear because of the personal preferences and desires of the workers. Since the formal management control system forms many of the guidelines for the informal system, the design of a formal system is to some extent the design of an informal system.

Anthony and Dearden (1976) define a formal management control system as consisting of some or all of the following phases:

Programming: Deciding which projects the organization will undertake and allocating the organization's resources among these projects.

Budgeting: Preparing financial and other quantitative plans for future periods.

Operating and Accounting: Keeping records during the period of actual operations.

Reporting and Analysis: Communicating information throughout the organization. ¹¹

Though a management control system focuses on programs and responsibility centres, it is a total system in that one of its primary purposes is to assure that all parts of the operation are in balance. Coordination of the individual activities is integral in assuring organizational efficiency and effectiveness.

2.2.1. Requirements from a Managerial System for Adequate Control

According to Koontz et al. (1980), every manager would want to have an adequate and effective system of controls, to assist him in making sure that events conform to plans. If a control system is to work, it must fulfil the following requirements: ¹²

It should reflect the plans it is designed to follow. Every plan and every kind and phase of an operation have unique characteristics.

It should be tailored to positions. Different positions within an organization have differing control needs.

It should reflect the organizational pattern. The more a control system is designed to reflect the place in the organization where responsibility for action lies, the more it will facilitate correction from deviation of plans.

It should be tailored to the personalities of individual managers. Control systems are intended to help individual managers to carry out their function of control. If they are not of a type that a manager can understand, they will not be useful.

It should point up exceptions at critical points. By concentrating on exceptions from planned performance, managers are allowed to detect those places, where their attention is required and should be given. However, it is not enough to look for exceptions. Managers must also look for them at those points which are critical to appraising performance.

It should be objective. Where controls are subjective, a manager's or a subordinate's personality may influence judgements of performance inaccurately.

It should be flexible. Control should remain workable in the face of changed plans, unforeseen circumstances, or outright failures.

It should fit the organizational climate. A tight control system applied in an organization where people have been given considerable freedom and participation will fail. On the other hand, people with a low desire to participate, or who have not been accustomed to participating, are likely to want to have clear standards and measurement and be told what to do.

It should be economical. Control techniques and approaches are efficient when they detect and illuminate the causes of actual or potential deviations from plans with the minimum of costs or other unsought consequences.

It should lead to corrective action. Control is justified only if indicated or experienced deviations from plans are corrected through appropriate planning, organizing, staffing and leading.

2.2.2. Management Control Systems Design

A framework for designing management control systems for computers was proposed by McFarlan, Nolan and Norton (1973). This framework identifies resource inputs, processing and outputs as key monitoring points. It identifies processing and inputs as control points. ¹³

Anthony (1965) proposed a framework for the analysis of planning and control systems ¹⁴. This framework was the result of his earliest research in the area and was based on his division of planning and control into three categories: strategic planning, management control and operational control. Though the boundaries between the categories are not sharply defined lines, the processes are sufficiently distinct, so they can be discussed somewhat independently.

Anthony and Dearden (1976) discussed this three-way division of planning and control further, also describing control systems in general. Their work describes the impact of structure on the management control system and gives a step-by-step analysis of the management control process.

Anthony and Dearden (1976) include six functions as parts of an organization's control system:

- Planning, establishing the organization's goals and objectives,
- Coordinating the activities of the organizational units,
- Communicating information,
- Evaluating information and deciding what action should be taken,
- Influencing people to change their behaviour, and
- Processing information that is used in the other functions.

The goals established through the planning process specify a desired state for the organization. The organization's control system is supposed to help maintain that state.

Kinnunen and Kaplan (1978) have also presented a general description of management control. Following the lead of Koontz and Anthony, they attempt to provide more structure to the area, defining it as the process employed to: ¹⁵

- specify the goals of the organization,
- formulate plans for attaining these goals,
- allocate the organization's resources,
- communicate goals and plans throughout the organization,
- provide goal congruence among managers,
- maintain organizational balance and coordination,

- measure and evaluate performance (in relation to the specified goals), and
- identify areas of unsatisfactory performance.

Vancil (1973) has stressed fairness and goal congruence as two key criteria in the design of any management control system ¹⁶. He has discussed alternatives for the design of such systems in organizations, identifying three types of responsibility centers: standard cost centers, profit centers, and revenue centers. The type of configuration needed in a company depends on the strategy of the firm.

Vancil (1979) has done further research into the relationship of structure and control in decentralised organizations. He gathered data from 291 manufacturing firms, using a questionnaire designed to measure profit and decentralisation. Data from the questionnaire were used to quantify three indices:

functional authority index, indicating the extent to which a profit center is self-sufficient in providing the goods and services required for its own operations,

financial responsibility index, indicating the extent to which a profit center is charged for all the goods and services it utilises in its operations, and

management control index, depicting the degree of control that a profit center manager has over all the costs assigned to him from other operating units in the firm. ¹⁷

Similar work was done by Rumelt (1974) , in analysing the interrelationship of diversification strategy, organizational structure and economic performance. Rumelt's work is especially interesting for its methodology and his development of ratios to measure and classify organizational structure, and diversification strategy. ¹⁸

Cammann and Nadler (1976) emphasised the need for a proper fit between the management control system and the individual manager and his style ¹⁹ . They point out the fact that while organizations spend a great deal of time and money designing the technical aspects of their management control systems, they seldom invest much in the training of managers in the use of the systems. They stressed the importance of the "human element" in management control, since the organization is made up of people.

As Koontz and Anthony indicated many years ago, planning and controlling go hand in hand. Green (1976) states that control would be unnecessary if we had "perfect planning". However, perfect knowledge of the future is not available. As he says, *"the need for control varies inversely with planning quality"*. ²⁰

Newman (1979), Hughes (1978), and Mears (1978) have also discussed the relationship between planning and controlling.

Newman (1979) states that the output of the planning process serves as the input to control. ²¹

As Hughes (1978) points out *"it is doubtful, therefore, that the quality of control will differ greatly from that of the planning input"*. ²²

Mears (1978) suggests that the individuals to be controlled should be involved in the planning process to ensure the commitment that is necessary to attain the organization's objectives. ²³

2.2.3. Computer Based Management Control Systems

The effect that computers would have had in society has fascinated commentators and researchers since their potential became apparent. Prognostications were made about :

the reduction in middle management powers as top executives were able to control operations directly;

the avoidance of functional conflicts as systems became integrated;

the centralisation of decision making and the move towards the 'total system', run from the chief executive's chair.

As subsequent research has shown, there have been discernable trends, but nothing as dramatic as originally postulated. Organizational changes have followed systems study and the redesign of data handling systems and management control systems. Overall, greater rigidity is met. In the manual system, human intervention can adjust and amend when abnormal circumstances occur. In the computer based system there is no such opportunity. ²⁴

In subsequent sections, the evolution of computer based information systems and the widespread dissatisfaction felt by management with the assistance they provide will be presented and discussed. At this stage, the following remark should be kept in mind:

"Those studying Management Information Systems need a great awareness of the extent to which organization style and structure and the power bases on which they exist are affected by the availability of information. MIS is about Organization and Management Control before it is about computers".

(Tricker and Boland, 1982)

2.2.4. Management Control as a Cybernetic System

Managerial control is essentially the same basic process as is found in physical, biological and social systems. As pointed out by Wiener (1948), communication, or information transfer, and control occur in the functioning of many systems. Wiener used 'information' in the general sense, to include a mechanical transfer of energy, an electric impulse, or any other means by which a 'message' might be transmitted. In the science he called 'Cybernetics' ²⁵, Wiener showed that all types of systems control themselves by information feedback which discloses error in accomplishing goals and initiates corrective action.

The evolution of Cybernetics and its application in Management are discussed in Chapter 3.

2.3. THE EVOLUTION OF INFORMATION SYSTEMS

2.3.1. Definition

An information system is "a set of organized procedures that, when executed, provides information to support decision making and control in the organization". ²⁶

Formal organizations, from their inception, have required information systems to operate successfully.

Production, accounting, financial, and external data on consumers and markets are vital to the operation of most modern businesses. As governmental bodies provide more services, they too develop greater needs for information.

Information systems existed long before the development of electronic computers. However, the explosion of information and the need to process large amounts of data to extract small amounts of information have contributed to the increasing importance of computer-based information systems ²⁷.

Almost all organizations have to acquire and analyse information and take action based on their interpretation of that information. Therefore, organizations may be perceived as information processing entities.

Too frequently, the designers of an information system have considered output to be information, while users have not. The decision maker, not the systems designer, defines and uses information. It is extremely important for users of information systems to be aware of different types of information and to think about how they interpret that information.

Lucas (1982) defines information as *"a tangible or intangible entity that serves to reduce uncertainty about some state or event"*. Another definition for information has been suggested by Davis (1974): *"Information is data that has been processed into a form that is meaningful to the recipient, and is of real perceived value in current or prospective decisions"* ²⁸. This definition of information systems stresses the fact that data have to be processed in some way to produce information; information is more than raw data.

2.3.2. The Impact of Information Systems on the Organisation

Many times, information systems have failed because the reactions of users were ignored or because designers did not consider the impact of the system on the organization. A technically elegant system is successful only if it is used.

Early studies of the impact of computers on organizations were completed after the systems had been installed; these studies were broad in nature and in general were not oriented toward the design of better information systems ²⁹.

Leavitt and Whisler (1958) suggested that firms would recentralise as a result of new computer technology. Computers offer the power to make centralised management possible, so the organization can be tightly controlled by a group of top managers ³⁰. Little evidence supports this early prediction ³¹. *There is no real reason why computer systems lead naturally to centralisation* ³².

According to Lucas (1982), the real problem with the impact of information systems on organizations is concerned with the distribution of power in the organization. Different departments in organizations have different levels of power. The information services department meets the conditions for high power as proposed by Hickson et al. (1971) ³³, and, by its activities, alters the distribution of power in an organization ³⁴.

Early studies of the impact of computer systems were also concerned with user reactions. Some of these studies dealt with the psychological reaction of workers and others, concentrated on overall changes in levels of employment. Although isolated changes in employment have occurred, it is difficult to find an overall trend. ³⁵

Writers were also interested in the impact of computer systems on jobs and job content. Turner (1980) suggests creating jobs with more decision latitude and more opportunities for problem solving, to mitigate the negative aspects of systems. ³⁶

A major impact of computers occurs when conflict arises between users and the information services department.

Mutual dependence increases the potential for conflict, because the failure to perform by one party causes serious difficulties for the other.

Task differences also create conflict. Computer work is highly specialised and there are many differences between the tasks of a programmer and the average user.

Uncertainty and ambiguities also lead to conflict.

Communications obstacles have become a major problem between the computer staff and users. The computer field has developed its own jargon, and many computer professionals do not realise they are using strange and unfamiliar terminology. The user may feel that the information services department staff members are trying to demonstrate superior knowledge or avoid making an accurate explanation of a problem by using jargon. ³⁷

2.3.3. Theoretical Framework for Designing Information Systems

The necessity for a conceptual reference for the design and implementation of computer-based information systems grew together with the growth in the use of computers in business and public services.

The prevailing view of Information Systems draws upon the framework for analysis first put forward by Anthony (1965) ³⁸. According to Mc Cosh, Rahman and Earl (1981), this framework *"has proved very worthwhile and helpful in the analysis of control systems for nearly two decades"*. ³⁹

Employing Anthony's (1965) division, the following kinds of control systems are identified:

Since operational control is concerned with getting an assigned job done efficiently, operational control systems are intended to measure performance against a clearly defined target. Such systems are characterised by large volumes of repetitive data, by reasonably clear-cut operating rules, and by fairly high degrees of automation.

Management control includes the process of designing an organization which will carry out policies, and also entails the measurement of the performance of groups of people, including managers. The task in this case is usually defined only in broad terms and the management control systems design issue includes the selection of a procedure for carrying these tasks out.

Strategic planning is the least precise. It is concerned with the problem of deciding what goals the organisation should strive for. It is also concerned with selecting broad methods of approach, which can later be worked out in detail as part of the management control process. Therefore, strategic planning support information systems are, necessarily, more vague, more forward looking and long-term than those required for the support of management decisions and operational decisions.

An underlying assumption in Anthony's approach is the consideration that organizations not only have objectives, but also that these objectives are decided in the process of strategic planning by the top management. It assumes that organizations are to achieve goals, set by the individuals that occupy the highest positions in the hierarchy.

Anthony's concepts of Management Control and Strategic planning respectively correspond to the distinction between programmable and non-programmable decisions, made by Simon (1960). 40

Blumenthal (1969) made an early attempt to provide a rationale to the process of planning Information Systems' developments. He recognised the need for systemic planning in order to overcome the organizational problems created by the then rapidly expanding use of computers. He argued that *"Information systems planning is important enough to be formalised and not left to emerge namely from the interplay of interests that are narrower than those of the business as a whole, although this interplay will remain an important regulating mechanism"*. 41

Blumenthal's framework for planning consists of two major elements:

- a theoretical construction of the process of decision making derived from the synthesis of the feedback loop conception in the decision process (Forrester, 1968) 42, the distinction between programmable and non-programmable decisions (Simon, 1960), and the three-levelled analysis of managerial decision making (Anthony, 1965).

- a set of criteria, assisting an orderly and coherent classification of the basic components of a business system.

It is noticeable that Blumenthal (1969) ruled out the possibility of designing information systems for the top level of the hierarchy, on the grounds that it was unknown how to encapsulate the necessary information *"in the kind of data bank we know to construct today"*. He argued, that as strategic decisions were based in something else than historical records, it was not possible to design systems to support decisions of that kind.

2.3.4. Operational Control Systems and Management Control Systems

Ansoff (1969) has developed a distinction between the logistic process and the management process within an organization.

In the logistic process, resources are transformed into products and services.

The logistic process is directed and supported by the management process. In the management process the manager transforms signals from the logistic process (inner environment) and from the outer environment into action instructions, which lead to adaption of

- either the logistic process (inner environment),
- or the outer environment,
- or the goals of the company. 43

These action instructions are usually called decisions. Hence Simon's (1971) definition of the management process as the decision making process. 44

Both logistic and management processes within an organisation can be supported by information systems. Logistic (operational) processes, however, are supported by logistic

2.4. MANAGEMENT INFORMATION SYSTEMS

2.4.1. Definition

"The frequency with which the term management information system (MIS) is employed today is matched perhaps by no other phrase in our current business vocabulary. Current computer installations all purport to be information systems, and the majority of these in turn claim to be management information systems. Connotations run from sophisticated hardware systems to routine accounting reports.; from real time systems depicting the status of space shots to basic data sources such as billings and accounts; from central data bases which collect, structure, store, and summarize information to the present inventory system in existence for the past 20 years; from the holistic "integrated" system of central management to remote terminals of specialists connected to the computer".

(Schoderbek et al., 1975)

A management information system is a formal system in the organization which provides management with the necessary reports to be utilized in the decision-making process ⁴⁵. Eventhough this system may also collect, store, process and retrieve data, its ultimate goal is to provide information for managers to assist them in making decisions. Management information systems are basically developed for providing information for planning and control purposes. A management information system may be contrasted to a 'data processing system', which is concerned with the collection and storage of data and its direct application to operating procedures and administrative tasks. ⁴⁶

An essential part of classical MIS is the use of a common storage medium (e.g., a data base or a data bank) to store frequently accessed data. The storage medium is accesible to all authorised users. With the storage of on-line data, standard and some complex mathematical models, taken from the discipline of Operational Research, can be brought into play with these data to produce meaningful output to control ongoing operations.

The foregoing characteristics of classical MIS center on producing periodic reports designed not only to recap past operations with an accent on exception items, but also to pinpoint possible control problems about current operations for lower and middle management. According to Thierauf (1982), although these factors represent improvements over prior information systems, they can be viewed from a two-dimensional framework; that is, the computer gives a periodic answer which is indicative of what should have been done or what should be done to control operations. ⁴⁷

As indicated earlier in this chapter, management control faces complexity and uncertainty, relies on judgement and interpersonal interaction, focuses on line management and seeks congruence, however ambiguous organisational goals may be.

Management control information is, thus, both internal and external, broad in scope, sometimes detailed and sometimes aggregated, and equally variable in currency, accuracy and frequency of use. This information serves the twin functions of decision and control.

The complexity of management control comprises complexity of goals, interrelationships and environment. The uncertainty comprises the turbulence of the environment and the unpredictability of responses to control actions. Consequently, few management control problems are structured. Many are semi-structured, with all three of Simon's phases of intelligence, design and choice being a mix of programmable and non-programmable elements. Therefore, *"many management control information systems tend to be decision support*

systems, where man's judgement, insight and evaluative strength are combined with the analytical and processing power of the computer" ⁴⁸ . Thlerauf (1982) argues, that, overall, classical MIS is rather narrow in its perspective (two-dimensional framework) versus a much broader perspective (three-dimensional framework) for a decision support system, which allows the manager or assistant to utilize the query capabilities of the computer to obtain requested information and retain control over the decision-making process, as changes occur.

2.4.2. The Development of Management Information and Control Systems

As already stated (*para. 2.3.3*), one of the early attempts to provide a framework for planned developments in information systems was that of Blumenthal (1969).

There are at least two important characteristics in Blumenthal's network:

The term Management Information System is used to refer to the formalised aspects of management control, leaving out the strategic or non-programmable decisions.

The framework aims to be a holistic approximation, because in addition to hierarchical classification and to horizontal functional grouping of activities it adds a third dimension in the form of modules, that cross over the boundaries of organizational divisions.

According to Blumenthal (1969), the purpose is to provide a framework, which is not derived from *"traditional pictures of a firm, such as the organization chart, in order to rationalise the information network into its component systems"* .

On the same conceptual basis, Zani (1970) put forward a very similar platform for Information Systems design and development. He argued that most of the implemented designs *"had spurn-off as by-products of the process of automating or improving existing systems within a company"* ⁴⁹, and that it was necessary for effective design to make a rational planning of the process of implementation in a way facing the organisation 'top-down', instead of the current practice of looking the company 'bottom-up'.

According to Zani (1970), the strategy of an organization is the result of external forces and internal resources. Accordingly, the resulting strategy determines, in turn, the organizational structure, and the way in which the strategy itself evolves via long- and short-term planning. Every development in information systems is conditioned to strategic considerations that manifest themselves in terms of an organizational structure. Zani (1970) adopts Anthony's framework and states that a decision analysis should be carried out for each level of the hierarchy, in order to answer the following questions: ⁵⁰

- "What decisions are made ?"
- "What decisions need to be made ?"
- "What factors are important in making these decisions ?"
- "How and when should these decisions be made ?"
- "What information is useful in making these decisions ?"

The answer to these questions would define the information requirements for each level of management, while the overall objective, defined by the global strategy, is kept in mind. An important outcome of the decision analysis should be the specification of tasks and their interrelations in the context of the organizational structure and their effect on the 'key success factors', such as opportunities, risks and competitors.

Gorry and Scott-Morton (1971) ⁵¹, although based on similar to Blumenthal's conceptions, introduced some new elements, especially in relation to the peculiarities of decision-making at different levels of the hierarchy. They explicitly expanded the scope of information systems design, to deal with problems that are less dependent on internal factors, promoting, thus, the idea of model building. They noted that the systems designer should possess greater managerial skills, as to elicit from top management itself views of the business and the environment. A new and special role was given to managers, as they were expected to work together with the analyst to develop a model jointly.

The three frameworks discussed so far show how the prevailing views on management determine a particular way of tackling organizational problems. This is more clearly illustrated by the fact that they all adopted Anthony's decision types (operational control, management control, and strategic planning) and Simon's decision categories (structured and unstructured) in organisational management. This approach to organizations is pervasive in Management Information Systems literature and widely found in textbooks and research programmes. ^{52 53 54 55 56}

2.4.3. Dissatisfaction with Management Information Systems

According to Lucas (1978), many organizations are experiencing only limited success in implementing computer-based information systems, in spite of the increased sophistication of management science techniques, on which they are based ⁵⁷. Similar dissatisfaction has also been reported by other researchers. *"Managers frequently complain of information overload on the one hand and an information gap on the other. The professional information providers (systems analysts, accountants and management scientists) proudly describe their achievements and earnestly explain their current plans. The information users listen with mixed feelings ranging from hope to scepticism, from commitment to antagonism and from understanding to incomprehension. There are problems in the current state of MIS".* ⁵⁸

Earl and Hopwood (1980) argue that the existence of any *a priori* relationship between formal MIS as commonly conceived and effective organizational performance is being increasingly questioned. Grinyer and Norburn (1975), in a planning context, found no significant relationship between formal information systems and financial performance. Instead, they found that the use of both informal channels of communication and informal decision-making processes was associated with success ⁵⁹. Lorsch and Allen (1973) found that the complexity of management control information systems facilitated upward information flows, but not downward flows. However, they argue, both downward and upward flows are found to be associated with favourable financial performance; thus, alternatives to formal MIS appear to be essential. ⁶⁰

One of the early critics to the way management information systems were designed and implemented comes from Ackoff (1967) ⁶¹. He questioned five assumptions commonly made by designers of MIS and argued that these are not justified in most cases and hence lead to major deficiencies in the resulting systems.

The questioned assumptions were:

that the critical deficiency under which most managers operate is the lack of relevant information.

that the manager needs the information he wants.

that if a manager has the information he needs, his decision making will improve.

that better communication between managers improves organizational performance.

that a manager does not have to understand how his information system works, only how to use it.

According to Ackoff (1967), to overcome these assumptions and the deficiencies which result from them, a management information system should be embedded in a management control system. In his paper provides a procedure for designing such a system and an example of the type of control system which it produces.

Earl (1978) argues that the reasons why many MIS fail to meet either their stated objectives or management's real needs generally center on the MIS design process. ⁶²

He identifies the following problems related to the design process of management information systems:

- Lack of top management support. ⁶³
- Inadequate management involvement. ^{64 65}
- Poor management of the design process. ⁶⁶
- Inattention to design decisions. ⁶⁷

Argyris has examined the problems of human factors in systems design. According to Argyris (1971), if management information systems achieve their designers' highest levels of aspiration, they will tend to create conditions where executives will experience:

- reduction of space of free movement,
- psychological failure and double bind,
- leadership based more on competence than on formal power, and
- decreased feelings of essentiality. ⁶⁸

These experiences will tend to create genuine resistance to MIS. MIS specialists, in turn, are not equipped to cope with the emotional problems caused by their systems. They react overrationally, which is an emotional response, and have difficulty in coping with their own and the executives' feelings and behaviour. In Argyris's view, the crucial problem of dysfunctional behaviour in organizations is the presence of over-defensive attitudes, which are unveiled by the introduction of an increasing rationality to managerial activities. No solution can be achieved without considering the fact that *"emotional problems within organizations do not simply disappear when they are not faced; instead, they remain to obstruct continually the implementation of rational plans"*.

In a further paper, Argyris (1977) relates the problems of information systems implementation to the more fundamental and subtle problem of organizational learning. He argued, that explanations for the information systems implementation gap could be broken down into eight different categories: ⁶⁹

MIS were not well understood by line management.

Top line management was not involved in persuading and selling the use of MIS to the users in the organization.

MIS were not as foolproof as they could be.

MIS were technically too complex and too costly to create and utilize.

MIS specialists and line managers did not understand each other's job requirements, perspectives and pressures.

MIS ignored line managers' cognitive style.

The implementation of MIS was too narrowly conceived.

MIS were not adequately humanised.

He suggested that there were other and perhaps deeper reasons for the implementation gap, which, if valid, then the above explanations would provide solutions containing inner contradictions and counter-productive consequences. Thus, in order to get at the inner contradictions, Argyris (1977) suggested viewing MIS as part of a more general problem of organizational learning. *"An organization may be said to learn to the extent that it identifies and corrects errors. This requirement, in turn, implies that learning also requires the capacity to know when it is unable to identify and correct errors".* 70

Finally, Argyris (1980) points some inner contradictions in management information systems. By the fact that these systems are designed to use information that is objective, precise, generalisable, trendable and comparable, conditons of distancing and injustice are generated, which, in turn, may lead individuals to distort the information in order to protect themselves. Hence a contradiction: *"the conditions required for useful, valid information lead to conditions that may distort the information"*. As managers require management information systems to fulfill their responsibility for managing the system, it is necessary for the organization to be able to detect and correct error, which, in turn, also implies detecting when the unit cannot detect and correct error. If learning is defined as the detection and correction of error, then learning is a core activity of any organization and any MIS. Hence the inner contradiction: *"Learning about other's performance in order to control their performace may inhibit learning"*. 71

Argyris (1980) pointed several other inner contradictions flowing from the above one. Some are related to the way administrators tend to use MIS while others are related to the very fact that MIS must use information if they are to be effective. He concludes that inner contradictions are features of systems that lead to success and failure, effectiveness and ineffectiveness. Unfortunately, most organizations contain people who are programmed with *Model I* and who, therefore, create *0-I learning systems* in their organizations. These learning systems are ill-suited to dealing with such double-loop problems as contradictions, paradoxes and dilemmas that are embedded in the underlying theory of design of MIS. 72

One of the many interesting conclusions of Argyris's work is that managers cannot use local information systems without having to be unjust with their subordinates, and that what managers really need are distant information systems containing abstract information about overall performance rather than about the way as the tasks are being carried out. The type of information systems that managers require is one that:

Contains abstract, quantitative descriptions of key performance indicators.

Represents stable variance.

Represents the results or outputs of complex processes, and not the processes themselves.

Contains explicitly rational logic in that they attempt to satisfy the logical systematic rules for defining categories, making inferences, and confirming or disconfirming evaluations publicly.

Excludes as much as possible tacit knowledge and tacit processes. 73

Other authors have also dealt with problems in the design and implementation of management information systems.

The problem of resistance to implementation and dysfunctional behaviour in organizations has also been discussed by Dickson and Simmons (1970). They distinguished three types of dysfunctional behaviour:

Aggressive behaviour, aiming to damage the object that brings innovation, this being typical of operating personnel whose jobs are more directly threatened by elimination or change of processes.

Projective dysfunctionality, expressed in the form of blaming the new systems for problems originated in entirely different causes, this behaviour being typical of managers whose job content is modified by newly introduced methods.

Avoidance, as defensive attitude, characterised by indifference and withdrawal, typical of top level management. 74

Dickson and Simmons (1970) state that dysfunctional behaviour always takes place; it can be minimised by ensuring greater involvement from managers and everyone affected by changes. The message to the system designer is that in his work he should consider behavioural elements as much as computer technology.

Burton Swanson (1974) too, argues that failures in the implementation of management information systems can be attributed, in part, to a lack of managerial 'involvement' and 'appreciation'.

However, the constraints imposed on a manager by the multiplicity of his roles have to be considered. Mintzberg (1975) 75 defines the following roles of a manager:

Interpersonal roles:

The figurehead role. By virtue of his position as head of an organizational unit, every manager must perform some duties of a ceremonial nature.

The leader role, because being in charge of an organizational unit the manager is responsible for the work of the people of that unit.

The liaison role, in which the manager makes contacts outside his vertical chain of command.

Informational roles:

The monitor role, scanning his environment for information, interrogating his liaison contacts and his subordinates, and receiving unsolicited information, much of it as a result of the network of personal contacts he has developed.

The disseminator role, passing some of his privileged information directly to his subordinates, who would otherwise have no access to it.

The spokesman role, sending some of his information to people outside his unit; informing and satisfying the influential people who control his organizational unit.

Decisional roles:

The **entrepreneur** role, seeking to improve his unit, to adapt it to changing conditions in the environment.

The **disturbance handler** role, responding to pressures and changes beyond his control.

2.4.4. Alternative Paradigms for Management Control

The reported disappointment from the performance of management information systems could probably be assigned to technical problems, which could be solved by a better understanding of the organization, the consideration of intraorganizational power at the stage of design ⁷⁶, the greater involvement of top management in the design and implementation process, etc.

Alternatively, this disappointment might be taken as a symptom of instability in the consensual system ⁷⁷. Considering this case, it has been argued that, indeed, Information Systems -and probably Management Science as a whole- as an area of knowledge and social practice shows symptoms of instability. This argument is based on the results of empirical observation of a sustained reporting of dissatisfaction with implementations, a proliferation of 'new' methodological approaches to design and implementation, and the explicit questioning of the assumptions on which most of current developments and methodologies are supported. ⁷⁸

A number of new approaches to Management Science have evolved as a result of the realisation of these symptoms of instability. Dando and Bennett (1981) ⁷⁹, assessing the debate expressed in Ackoff's (1979) papers ^{80 81}, have suggested that efforts to move away from the 'classical' or 'official' paradigm indicate the presence of a 'Kuhnian crisis' ⁸².

In a recent paper, Jackson (1987) identifies three new tendencies in management science, which *"appear to represent genuine breaks with the kind of thinking found in the traditional literature"*. He labels them respectively:

- soft systems thinking,
- radical or critical management science, and
- organisational cybernetics. ⁸³

The work of Churchman ^{84 85}, Ackoff ^{86 87} and Checkland ^{88 89} is taken to be representative of soft systems thinking. According to Jackson (1987) the significant similarities between these three approaches are that: ⁹⁰

All three thinkers are concerned to cope with ill-structured 'messes'. ⁹¹

All are opposed to tackling messes by the method of reductionism.

Rather than attempting to identify and analyse systems in the real world, all three approaches prefer to work with the different perceptions of systems that exist in people's minds.

Multiple perceptions of reality are admitted and explored.

Values are included rather than excluded from the methodological process.

The privileged role of experts in the systems approach is questioned.

The aim in each case is to encourage learning so that an accommodation can be reached between participants involved with a problem-situation.

Radical or critical management science emerged as a distinctive tendency in the 1970s. The first steps in its evolution consisted of attacks upon other forms of management science.

Traditional management science, already under fire from the soft systems thinkers, came under further attack from Marxist-inclined scholars ^{92 93 94}, on the grounds that it accepted existing structures of inequality of wealth, status, power and authority as given, and indeed helped to buttress the status quo. ⁹⁵

Alternative approaches to management science, presented in this section, have been attacked too by the radical critics as not being radical enough. ^{96 97 98 99 100}

Organizational cybernetics is taken by Jackson (1987) to mean especially the work of Beer and his adherents (mainly Espejo and Clemson) ¹⁰¹, distinguishing thus from management cybernetics, where he places the work of George ¹⁰², Pask ¹⁰³, Schoderbek et al. ¹⁰⁴, and Strank ¹⁰⁵.

According to Jackson (1987), between management cybernetics (as he defines it) and traditional management science there is little to choose. Conventional management scientists are able to take cognisance of its key insights and to employ concepts such as feedback in their traditional analyses. *"Management cybernetics offer no new direction in management science. Whether based on a machine analogy or on a biological analogy, it can be criticised for exactly the same reasons as traditional management science: an inability to deal with 'subjectivity', and with the extreme complexity of organizational systems and for an inherent conservatism"* ¹⁰⁶. He distinguishes another strand of cybernetic work concerned with management and organizations which *"breaks completely with the mechanistic and organismic thinking that characterises management cybernetics"* ¹⁰⁷. This strand is based on Beer's work.

In this thesis, an alternative paradigm for management control, capable of overcoming problems encountered in traditional applications, will be sought in the example of Beer's cybernetic model. An evaluation of this paradigm will be attempted by employing it in the study of a state-owned railway enterprise.

2.5. SYNOPSIS

Management control is the process which guides the enterprise to its objectives. Control is an essential managerial function at each level.

Controlling is the reverse side of the coin of planning. Trying to design control systems without first taking into account plans and how well they are made is fruitless.

Control requires organizational structure. The clearer, more complete, and more integrated this structure is, the more effective control action can be.

Control over a unit implies manager's power to act. This power, within modern organizations, stems from organizational position (position power), the ability to act (action power), and the ability to cope with uncertainty (knowledge power). Position power alone is insufficient to manage.

An effective control system must:

- reflect the plans it is designed to follow;
- be tailored to positions;
- reflect the organisational pattern;
- be tailored to the personalities of individual managers;
- point up exceptions at critical points;
- be objective;
- be flexible;
- fit the organizational climate;
- be economical;
- lead to corrective action.

An information system is a set of organized procedures that, when executed, provides information to support decision making and control in the organization.

Information is data that have been processed into a form that is meaningful to the recipient, and are of real perceived value in current or prospective decisions. Therefore, information is defined and used by the user.

A management information system is a formal system with ultimate goal to provide information for managers to assist them in making decisions. A management information system is something different from a data processing system, which is concerned with the collection and storage of data and their direct application to operating procedures and administrative tasks.

Formal management information systems are designed accordingly to Anthony's distinction of managerial levels (operational control, management control, strategic planning) and Simon's classification of decision categories (structured and unstructured).

The limited success in the implementation of management information systems is attributed:

either to technical and behavioural deficiencies at the stages of design and introduction; in this case solutions are sought within the paradigm of traditional management science;

or to the very nature of traditional management science; in this case a new and efficient paradigm is sought.

This thesis will test the capacity of the management cybernetics paradigm in tackling the problem of management control, by employing it in the study of a state-owned railway enterprise.

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 71. C.Argyris, 1980: "Some Inner Contradictions in Management Information Systems", in Lucas, Land, Lincoln, Supper (eds.): *The Information Systems Environment* (North-Holland Publishing Co., Amsterdam), pp.15-25.
 72. According to C.Argyris and D.Schon, 1974: *Theory in Practice* (Jossey-Bass, San Francisco), *Model I theories-in-use* are theories of top-down, unilateral control of others in order for the actors to win, not to lose; to control the environment in which they exist in order to be effective. *Model I theories-in-use* lead to effective problem solving primarily for issues that do not require that the underlying assumptions of *Model I theories-in-use* be questioned (single loop learning). *Model I theories-in-use* do not make it possible for people to have problem solving skills that question the governing values of their theory-in-use (double loop learning). A *Model II theory-in-use* is needed that includes behavioural strategies such as advocacy combined with inquiry; the minimal use of face-saving and unilateral censorship actions, the advocating of positions in ways that are publicly disconfirmable, and making discussable any information (cognitive or emotional) that is relevant to the problem. Teaching *Model II* and helping people to create an *0-II learning system* is not easy, but it appears achievable. The change must reach the individual participant's respective theories-in-use and the *0-I learning system*.
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The key element in Kuhn's alternative account is that of a 'Paradigm', the set of assumptions within which a group of practitioners function during times of what he calls 'Normal Science'. During such periods, science proceeds much as is commonly thought. The guiding assumptions allow a set of problems to be isolated and solved one after another, within the criteria set by the accepted frame of reference. Moreover, whilst such 'Puzzle-Solving' is succesful, there is very little questioning of the paradigm.

Yet, every paradigm tends to define the world in limited ways and to deal efficiently with its own particular sort of puzzle. Sooner or later, problems of a quite different order arise. The paradigm-induced expectations about the real world do not work out. Things begin to go wrong. If the lack of success is important and prolonged, the life of the community starts to alter. A period of 'Extraordinary Science' or 'Crisis' sets in, during which the community focuses on the perceived anomaly and is forced to reexamine its own framework of assumptions.

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91. R.L.Ackoff 1981: "The Art and Science of Mess Management", (*Interfaces*, vol.17, pp.20-26) introduces the term 'mess' to refer to situations where decision-makers are confronted with a complex of problems. In such situations, decision-makers typically identify manageable portions of the mess and concentrate their attention on these. Messes are therefore broken down into distinct problems. Ackoff suggests that the problems are chosen so as to minimise the interconnectedness between them. This then

aids the use of analysis applied to the separate problems. Such a strategy emphasises a focus upon the technical aspects of decision-making and, by omitting to consider the connections between the problems, essential properties of the mess are lost. A means of overcoming this is provided by Ackoff's 'interactive planning'. 88

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CHAPTER 3

CYBERNETICS AND MANAGEMENT

3.1. THE BACKGROUND OF CYBERNETICS

"Cybernetics is a discipline which, like applied mathematics, cuts across the entrenched department of natural science; the sky, the earth, the animals and the plants. Its interdisciplinary character emerges when it considers economy not as the economist, biology not as a biologist, engines not as an engineer. In each case its theme remains the same, namely, how systems regulate themselves, reproduce themselves, evolve and learn. Its high spot is the question of how they organise themselves."

(G.Pask, 1961)

3.1.1. Introduction

In *Chapter 2*, it was stated that the thesis will proceed in examining the Management Control issue under a cybernetics methodology, by employing Beer's model. This chapter provides a brief description of cybernetics and its application in managerial situations.

According to Pask (1961) ¹, a great deal of cybernetics is concerned with how stability is maintained with 'control mechanisms'. One of the first of such mechanisms was Watt's invention of the 'governor', a device illustrating the 'negative feedback' principle.

Perhaps the earliest cybernetic thinking comes from the field of physiology, where the notions of information feedback and control appear as the ideas of reflex and homeostasis. Whereas reflexis preserves the organism against the flux of its environment, homeostasis counters the internally generated changes which threaten to disrupt the proper structure and disposition of parts in the organism. Homeostatic mechanisms maintain the 'milieu interieur' ² of Claud Bernard, the proper values of acidity, water balance and metabolites, i.e., a body temperature which the cells of the body can tolerate.

In much, though not all, of the process of physiological control the brain is chief controller, and in effective control, chief recognizer, rationalizer and arbiter. Hence, cybernetic thinking stems also from psychology, where, in turn, it also applies.

A further related notion is that of 'purpose'. All the homeostatic and reflexive mechanisms are goal-directed and self-regulating. Therefore, when a goal is sought by several interacting mechanisms, or several goals appear to be sought by one, the resulting behaviour can be characterized as 'purposive'.

In zoology and embryology there used to be a problem equivalent to the teleological dilemma of purposive behaviour which took the name 'equifinality'. By the early 1920's biologists were thinking in terms of organization and it became obvious that in a wholly

pedestrian manner the whole of an organization is more than sum of its parts. Von Bertalanffy (1956) ³, thinking in this direction, exerted considerable influence, not only in biology but also in the social sciences, and he gave the name 'system' to the organization which is recognised and studied. He further realised that when looking at systems many apparently dissimilar assemblies and processes show features in common. He called the search for unifying principles which relate different systems General Systems Theory.

General Systems Theory found little acceptance in engineering and had little relation to the physiological developments until the mid 1940's. About then, engineers had to make computing and control devices elaborate enough to exhibit the troublesome kinds of purposiveness already familiar in biology. Also it was in the 1940's that Julian Bigelow, then Rosenblueth and Wiener realised the significance of the organisational viewpoint, and had the insight to wed together the developments discussed above and the rigorous mathematics of communication engineering.

3.1.2. Definition of Cybernetics

Since born, cybernetics has been variously defined. At one extreme, there is the original definition, *"the science of control and communication in the animal and the machine"*, advanced by Wiener (1948), ⁴ when he adopted the word in the book *"Cybernetics"*, which is the first complete statement of the discipline. As Pask (1961) states, at the other extreme is Gouffignal's (1956) proposal, put forward as an expansion: *"La Cybernetique est l'art d'assurer l'efficacite de l'action"*.

The gap between 'science' and 'art' is filled by a continuum of interpretations. Thus, Beer (1962) ⁵ looks upon cybernetics as the science of proper control within any assembly that is treated as an organic whole. In industry, for example, this could be the science of management, which in fact is made explicit by Beer's (1981) ⁶ recent definition of cybernetics as *"the science of effective organisation"*. Ashby (1956) ⁷, on the other hand, gave emphasis to abstracting a controllable system from the flux of a real world, and was concerned with the entirely general synthetic operations which can be performed upon the abstract image. He pointed out that cybernetics is no more restricted to the control of observable assemblies and the abstract systems that correspond with them, than geometry is restricted to describing figures in the Euclidean space which models our environment. Pask (1961) subscribed to both Ashby's and Beer's views, finding them compatible and both included by Wiener's global dictum.

According to Bateson (1978), the subject matter of cybernetics is information, which is regarded as different to the events and things that can be perceived in nature. In this sense, cybernetics covers the whole realm of phenomenology, but it restricts its scope to the communicational aspects. The universality of information is what endows cybernetics with its multidisciplinary value. As a science, it deals -across the frontiers of conventional disciplines- with the *"information carried by events and objects"*. ⁸

3.1.3. Characteristics of Cybernetic Systems

Beer (1962) argues that a cybernetic system is recognisable by three outstanding characteristics. It is: ⁹

Exceedingly complex, to the point where its interconnectivity is indefinable in detail.

Exceedingly probabilistic, to the point where its structure, though complex, becomes undifferentiated, and every trajectory is equiprobable. Such a system cannot be controlled by the imposition of rules from outside, because the system, by

definition, defies analysis, and therefore no test can be applied, by which the adequacy of the rules could be judged.

Self-organizing, because, therefore, the fundamental organization it displays is generated from within.

Thus, as Clemson (1984) states, cybernetics is concerned with the general patterns, laws and principles of behaviour that characterize complex, dynamic, probabilistic, integral and open systems. ¹⁰

3.1.3.1. Complexity

The explanation of the term complexity can be approached from many different viewpoints. From the mathematical systems viewpoint, complexity can best be understood as a statistical concept: complexity can be explained in terms of the probability of a system's being in a specific state at a given time. ¹¹

From a non quantitative viewpoint, complexity can be defined as the quality or property of a system, which is the combined outcome of the interaction of four main determinants:

the number of elements comprising the system;

the attributes of the specified elements of the system;

the interactions among the specified elements of the system; and

the degree of organization inherent in the system (i.e., the existence or lack of predetermined rules and regulations which guide the interactions of the elements and/or specify the attributes of the system's elements). ¹²

3.1.3.2. Probabilism

Probabilism is defined in philosophy as the doctrine which asserts that "*certainty is impossible; probability suffices to govern faith and practices*". As known, in statistics probability refers to the likelihood of the occurrence of a certain event and is measured by the ratio of the number of actual occurrences to the number of possible occurrences. It is obvious from this definition that probabilism refers to the degree of knowledge of the system's behaviour at a certain point of time. Since the degree of knowledge is closely related to the availability and the obtainability of information, the statistical treatment of information appears as a candidate for dealing with systems whose behaviour is not perfectly predictable.

3.1.3.3. Self-Organization

Complex systems organize themselves. The characteristic structural and behavioural patterns in a complex system are primarily a result of the interactions among the system parts.

According to Ashby (1962), ¹³ self organizing system is one which:

changes from '*unorganized*' to '*organized*' (e.g. the nervous system of an embryo), and/or

changes '*from a bad organization to a good one*'.

Mechanisms emerge to cope with the several areas of complexity that are perceived as relevant. The structure of the system is continuously adapting. Self-organization is a mechanism for survival in the long-run. ¹⁴

3.1.3.4. Self-Regulation

As long as there are some references for systemic behaviour, the different parts of the system will develop naturally the relevant information flows to control each others' behaviour. This is immanent to the purpose of viability of complex organizations and is called self-regulation.

3.1.3.5. Holistic Behaviour ¹⁵

Cybernetics (and General Systems Theory) deal with systems which exhibit 'holistic' behaviour, i.e., they have characteristics which belong to the system as a whole and don't belong to any of its parts. In other words, they have 'emergent' properties; properties of the part give no hint of some property that the whole possesses. Ashby has shown that emergent properties are also due to interactions among the parts and more particularly to unexpected characteristics of those interactions.

The issue of emergent properties would never arise if there was a 'full' knowledge of the parts of a system. However, due to complexity, full knowledge of the parts of any system is quite impossible.

3.2. METHODS OF DEALING WITH CYBERNETIC SYSTEMS

3.2.1. Dealing with Complexity

3.2.1.1. The Law of Requisite Variety

Ashby (1956) has proposed variety as a precise measure of systemic complexity. Variety is the number of distinguishable elements in a system, or, by extension, the number of distinguishable systemic states.

Variety in social systems is supposed to be kept under control by a legislative mode of regulation that restrains variety proliferation. ¹⁶

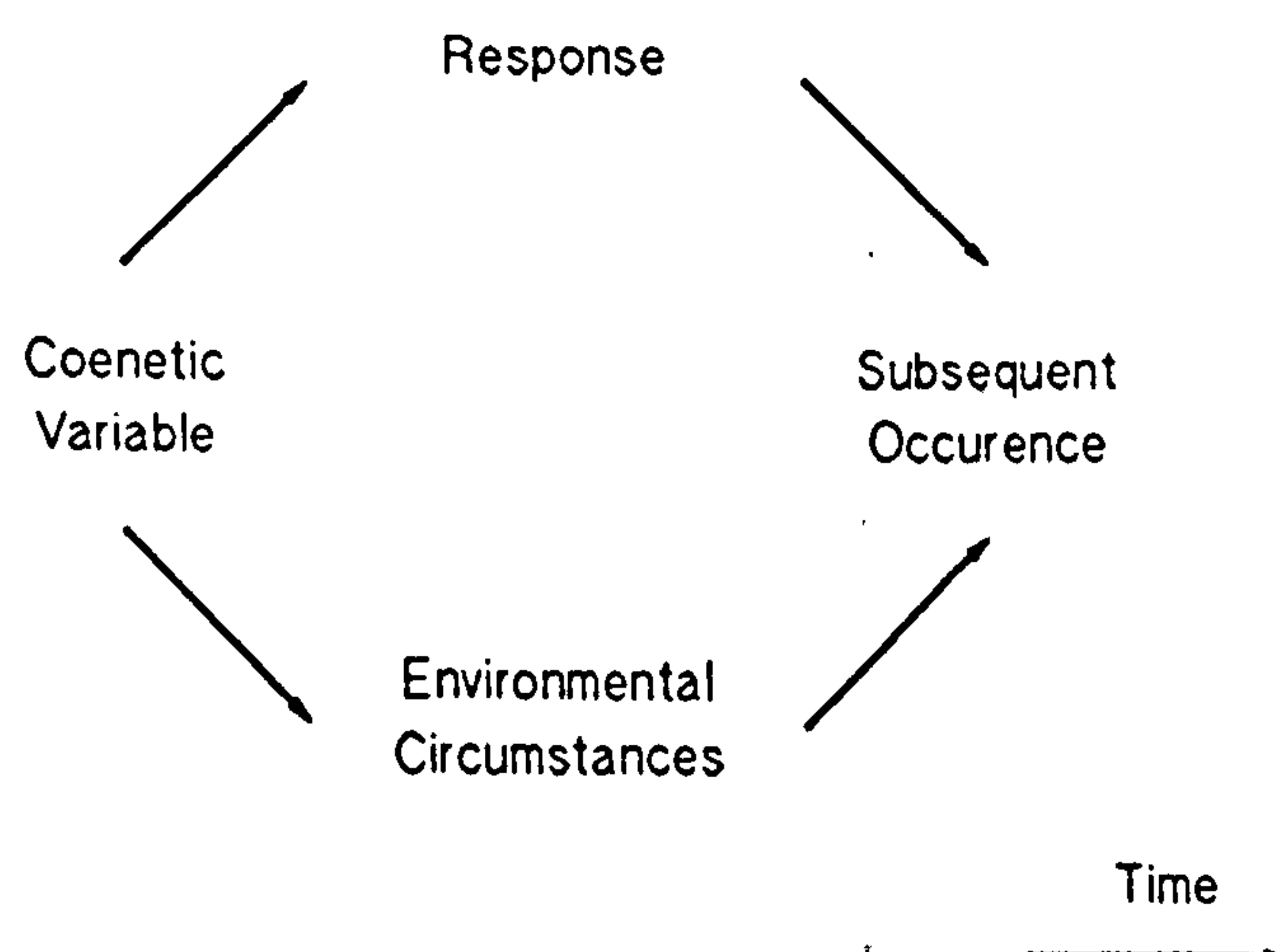


Figure 1: Sommerhoff's Account of 'Directive Correlation'

However, as Ashby deduced from biological systems, something more subtle underlies any such technique. The delimitation of the variety of environmental circumstances and of regulatory responses at the same time is explained by the notion of a 'coenetic variable'.
17

According to Sommerhoff (1950),¹⁸ coenetic variables simultaneously delimit variety, so that trajectories of the system converge onto a subsequent occurrence (*Figure 1*). Sommerhoff called this 'directive correlation'.

In the very process of disturbing environmental circumstances, the coenetic variable evokes a response that converges on an adaptive outcome.

Ashby (1956) had developed the following schematic treatment (*Figure 2*), based on Shannon's¹⁹ notation.

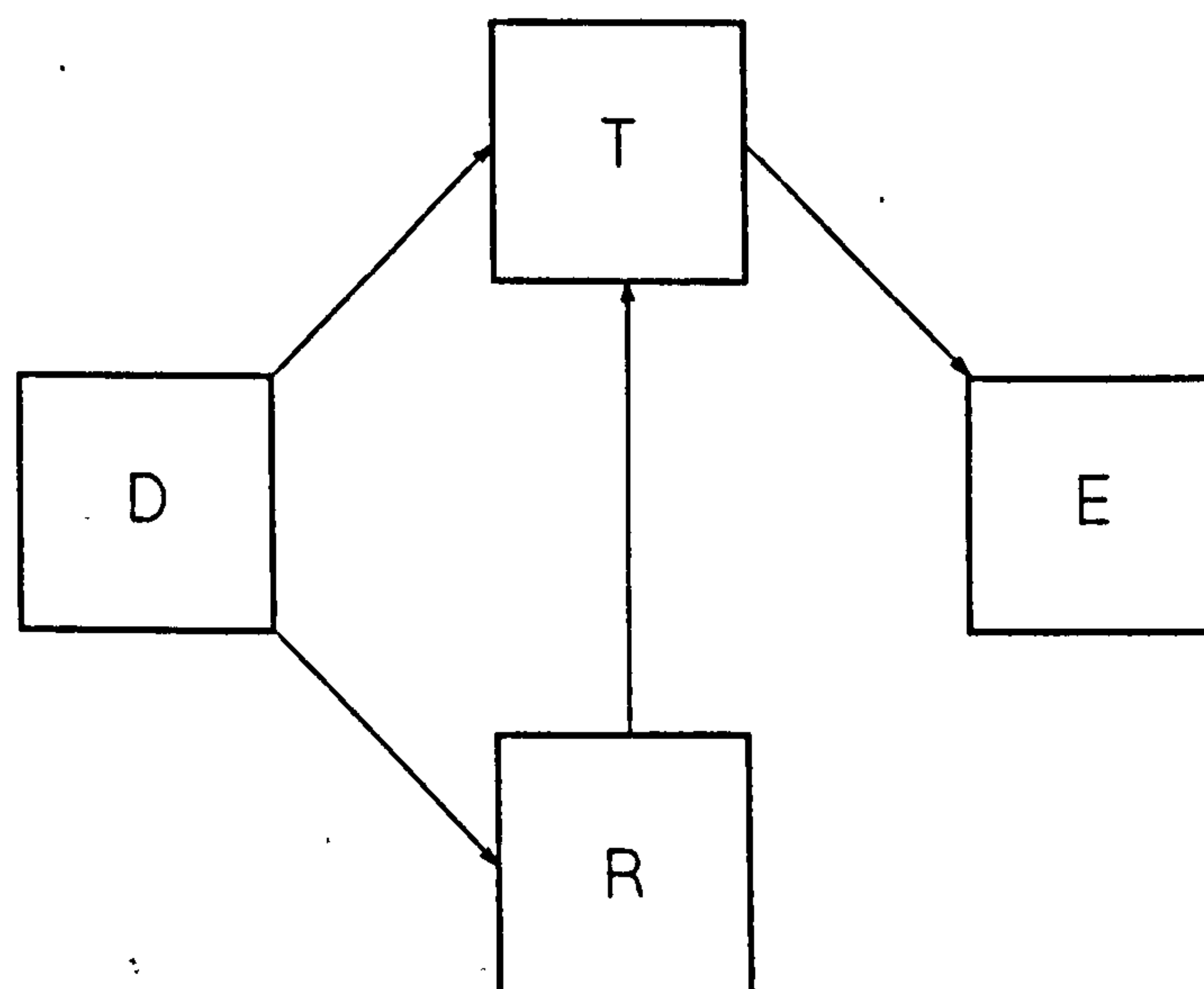


Figure 2: Ashby's Account of 'Requisite Variety'

In this diagram,

D stands for disturbance (equated by Ashby with the coenetic variable),

E is the outcome set, consisting of good and not-good subsets in relation to viability,

T is a table of transformations which D will undergo to generate E, and is equated by Ashby with Sommerhoff's environmental circumstances, and

R is the systemic response, which, according to Ashby, may directly influence T in its task of modifying E.

Ashby argues that if R's state is always to have the same effect on T whatever state D may adopt, then the variety of E will be the same as the variety of D. But if R may adopt two states, then the variety at E can be halved. And so on: *"If the variety in the outcomes is to be reduced to some assigned number, or assigned fraction of D's variety, R's variety must be increased to at least the appropriate minimum. Only variety in R's moves can force down the variety in the outcomes"* (Law of Requisite Variety).

Therefore, if D is a coenetic variable, so that R and T are directly correlated, then the variety of the outcomes E will be constrained. Since in both biological and social systems there may be coenetic variables that are unrecognized as such, this would account for a more regulated system than the unrecognized observer would have any right to expect. Even so, and as Ashby says:

"Variety comes to the organism in two forms. There is that which threatens the survival of the gene pattern: the direct transmission by T from D to E. This part must be blocked at all costs. And there is that which, while it may threaten the gene-pattern, can be transformed (or re-coded) through the regulator R and used to block the effect of the remainder (in T)".

Beer argues that Ashby's Law stands to management science as Newton's Laws stand to physics: it is central to a coherent account of complexity control. "Only variety can destroy variety".

"People have found it tautologous; but all mathematics is either tautologous or wrong. People have found it truistic; in that case, why do managers constantly act as if it were false? Monetary controls do not have requisite variety to regulate the economy. The Finance Act does not have requisite variety to regulate tax evasion. Police procedures do not have requisite variety to suppress crime. And so on. All these regulators could be redesigned according to cybernetic principles". 20

3.2.1.2. Complexity and the "Black Box"

According to Ashby (1956), the problem of the Black Box arose in electrical engineering. The engineer is given a sealed box that has terminals for input, to which he may bring any voltages, shocks or other disturbances he wants, and terminals for output from which he may observe what he can. He is to deduce what he can of the contents of the box.

In our daily lives we are confronted at every turn with systems whose internal mechanisms are not fully open to inspection and which must be treated by the methods appropriate to the Black Box.

The primary data of any investigation of a Black Box (of given input and output) consists of a sequence of values of the vector with two components: input state, output state. From this there follows the fundamental deduction that all knowledge obtainable from a Black Box (of given input and output) is such as can be obtained by recording the protocol; all that and nothing more. 21

The black box technique is illustrated in Figure 3, from where can be seen that by thus acting on the box, and by allowing the box to affect him and his recording apparatus (i.e., the protocol), the experimenter is coupling himself to the box, so that the two together form a system. When a generous length of record has been obtained, the experimenter will examine it for regularities in the behaviour of the system represented by the box.

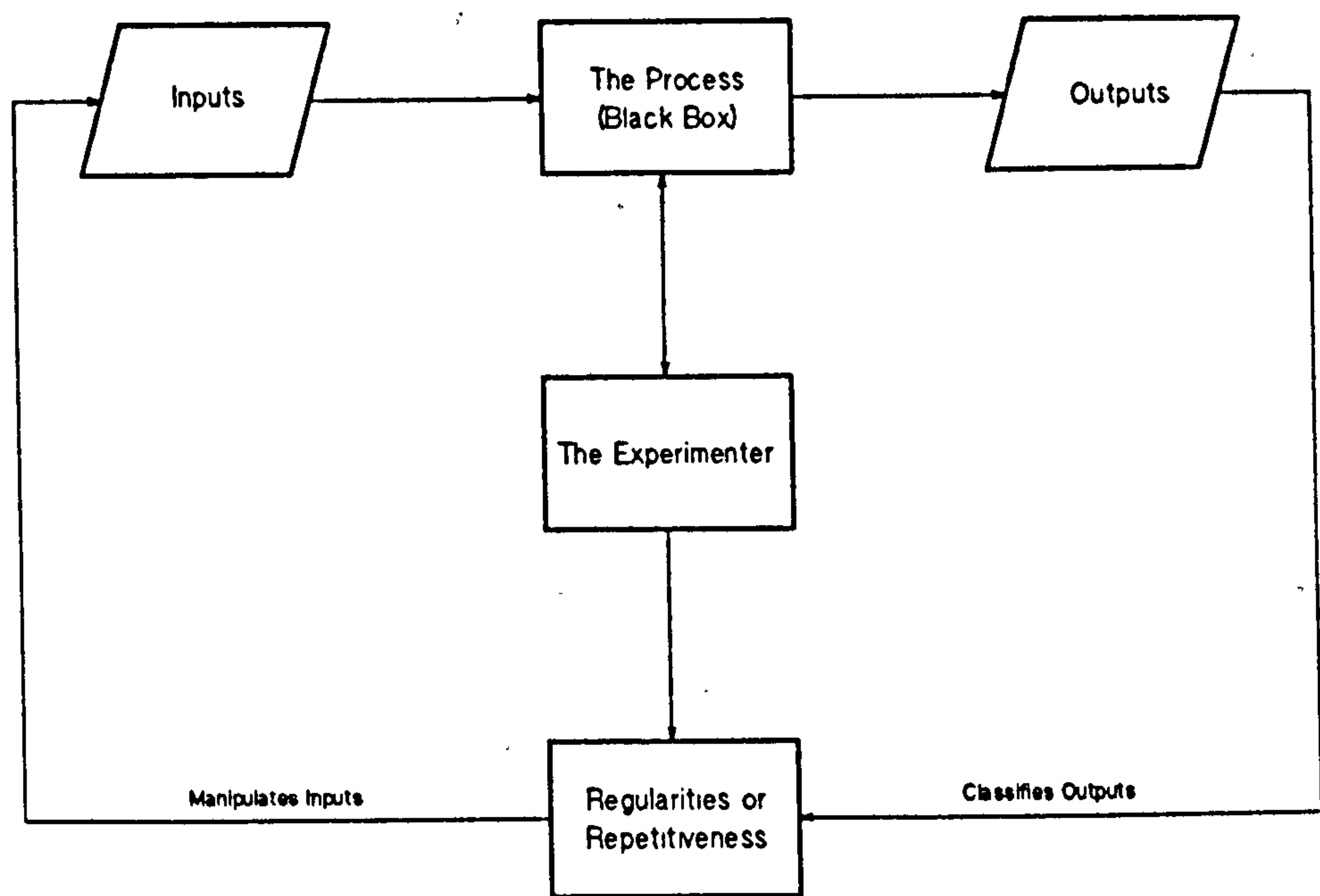


Figure 3: The Black Box Technique

The following example of the above reasoning is given by Ashby (1956). Suppose that a system had two possible input states **a** and **b** and four possible output states **f**, **g**, **h**, and **j**. Thus, a typical protocol might read as in *Table 1*.

Output	f, g, h, j									
	1	2	3	4	5	6	7	8	9	10
Input										
a or b	ag	aj	af	af	aj	bf	ah	bj	bf	af

Table 1: The Protocol

As this protocol reveals, the primary data of any black box investigation consist of a sequence of values of the vector with two components: an input state and an output state. One can also note the regularity or repetitiveness in the black box's behaviour. For example, the protocol entry **aj** is always followed by either **af** or **bf**; the transaction of **j** is single value (**f**), although **a**'s is not. The more such regularities in the system's behaviour the observer or experimenter can detect, the more knowledge he is said to have about the box. In some instances, combinatorial behaviour may be exhibited. In others, the pattern may be strictly sequential.

One of the merits of the black box technique is that it provides the best antidote against the tendency of the investigator to oversimplify a complex phenomenon by breaking it into smaller parts. The black box technique for dealing with complexity represents a selection procedure based on a series of dichotomies. In other words, the investigator of a complex situation manipulates the inputs to the black box and classifies the outputs into certain distinct classes based upon the degree of similarity of the output state. He

then converts each class into a 'many-to-one' transformation. In this way, the observer obtains a black box with a binary input and a large number of input variables which permute themselves and their interconnections to represent one output state. ²²

Concluding, the black box technique involves the following sequential steps:

1. input manipulation,
2. output classification, and
3. many-to-one transformations.

3.2.2. Dealing with Probabilism

It has already been noted that, since the degree of knowledge of a system is closely related to the availability and the obtainability of information, the statistical treatment of information appears as a candidate for dealing with systems whose behaviour is not predictable (probabilistic systems).

3.2.2.1. A Communication Model

A communication system ²³ (Figure 4) will consist of the following five elements:

1. an information source,
2. an encoder/transmitter,
3. a channel,
4. a detector, and
5. a decoder.

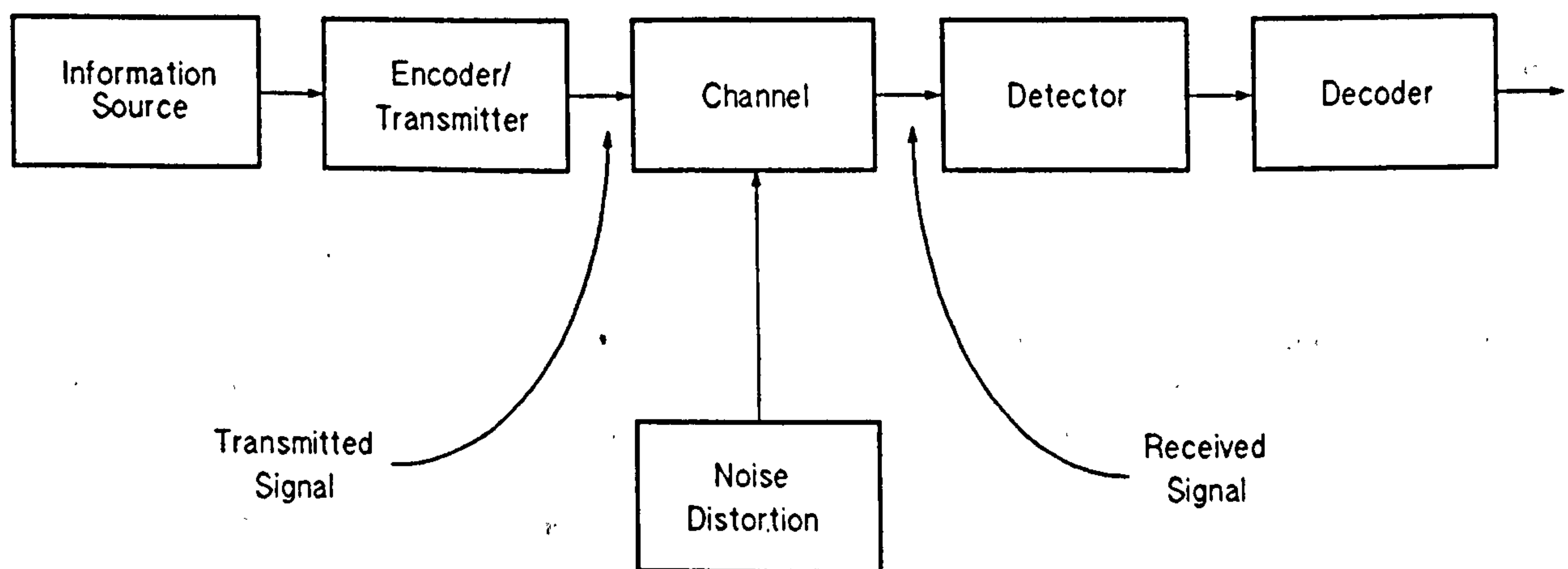


Figure 4: A Communication Model

The information source selects the desired message out of a finite set of possible messages (verbal, written, etc.). The message is then transformed into a signal (encoded) and sent over the channel, which is the medium used for sending messages from the source to the receiver. The detector picks up the transmitted signal. The signal is finally decoded into a message.

Prerequisites of communication are:

A common agreement, specifically between the sender and the receiver, as to the language (symbols, phonemes, etc.) to be used. When the symbols or words that the sender selects are unknown to the receiver, no information is transmitted.

The existence of the same information bank (source) between sender and receiver, that makes possible the quantification of information. The larger the information bank of the sender and the receiver is, the greater the number of choices available, and the more information needed to resolve the uncertainty.

3.2.2.2. Measuring the amount of information

"Information is a measure of one's freedom of choice when one selects a message. To be somewhat more definite, the amount of information is defined, in the simplest cases, to be measured by the logarithm of the number of available choices. It is convenient to use logarithms to the base 2. The information, when there are only two choices, is proportional to the logarithm of 2 to the base 2. But this is unity; so that a two choice situation is characterized by information of unity, as has already been stated above". ²⁴

(C.Shannon and W.Weaver, 1949)

In measuring the amount of information the unit used is the 'bit', short for binary digit. A bit is the smallest amount of information possible, and it represents a single selection between two alternatives. Using logarithms,

$$1 \text{ bit} = \log_2 2 (= 1)$$

Hence, when N is the number of alternative signs available in the entire repertoire of the sender and receiver, the amount of information required (number of bits per alternative) is

$$\log_2 N.$$

Taking account of differences in the probability of messages, a message is assigned a probability p when it is selected from a predetermined set of 1/p messages. The amount of information that must be transmitted for that message is then

$$\log_2 1/p = -\log_2 p.$$

If all N messages have an equal probability of being chosen, then the probability of any of these is

$$p = \frac{1}{N},$$

thus

$$-\log_2 p = -\log_2 \frac{1}{N} = \log_2 N.$$

If the probabilities assigned to n messages are

$$p_1, p_2, \dots, p_n.$$

then the amounts of information associated with each message are

$$- \log_2 p_1, -\log_2 p_2, \dots, -\log_2 p_n.$$

The average amount of information from a particular source is generally given by the equation

$$H = - (p_1 \log_2 p_1 + p_2 \log_2 p_2 + \dots + p_n \log_2 p_n) = - \sum_{i=1}^n p_i \log_2 p_i.$$

3.2.2.3. Channel Capacity

Information transferred from one location to another travels over some sort of channel. The upper limit of the amount of information that can be transmitted over a channel is termed the channel capacity. Channel capacity is measured in bits per second.

3.2.2.4. Transduction

According to Beer (1981), all interconnections entail the crossing of boundaries. Because the 'language' of each sub-system is unique to it, messages have to be 'translated' when a boundary is crossed. There has to be a mechanism at the boundary capable of coding or decoding these messages as they pass. This mechanism is called a transducer. Whenever the information carried on a channel capable of distinguishing a given variety crosses a boundary, it undergoes transduction. The variety of the transducer must be at least equivalent to the variety of the channel.

3.2.3. Dealing with Self-Regulation and Self-Organization

3.2.3.1. Feedback

From the definitions of self-regulation and self-organization it follows that they can only be achieved by means of feedback mechanisms, built into the system. According to Wiener (1948), *"when we desire a motion to follow a given pattern, the difference between this pattern and the actually performed motion is used as a new input to cause the part regulated to move in such a way as to bring its motion closer to that given by the pattern"*. 25

3.2.3.2. Negative Feedback

Figure 5 depicts a closed-loop feedback system. The output in this is obtained by the multiplication of the transfer function (K) by the input to the block (e).

This system may be described by the following set of equations:

$$e = d_i - d_o$$

$$d_o = K e$$

which can be reduced to the single equation

$$d_o = \frac{K d_i}{1 + K}$$

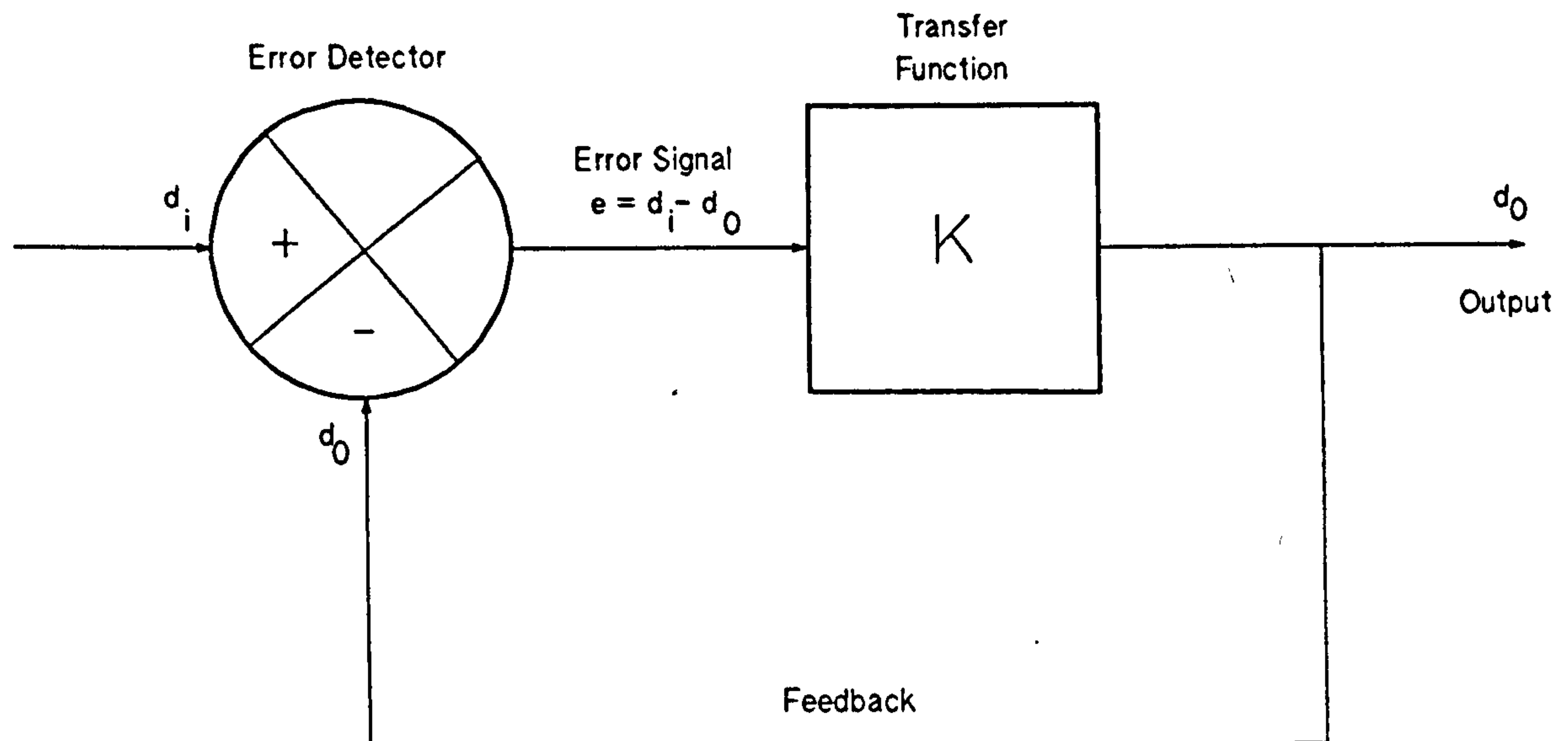


Figure 5: Close-Loop Feedback System

An example of negative feedback is illustrated in Watt's governor. The difference between the homeostatic parameter desired in the machine (in this case the speed of the engine) and its actual output will be detected as positive deviation and the feedback action is to counteract this. ²⁶

3.2.3.3. Positive feedback

Positive feedback systems utilize part of their output as inputs to the same system, in such a way that they are, in fact, deviation-amplifying rather than deviation-counteracting systems. ²⁷

Power-assisted brakes, using machinery which detects the small manual movements made and enlarges them until the force applied is capable of stopping a vehicle in motion, are an example of positive feedback. ²⁸

Positive feedback mechanisms are growth-promoting devices, while negative feedbacks are control-maintaining processes.

3.2.3.4. Automatic Goal Attainment (First-Order Feedback Systems)

In goal-directed systems which operate on the principle of negative feedback, the system is maintained by correcting deviations from the goal. There is no other choice to the system but to correct the deviation. Thus, the purpose of a first-order feedback system is to maintain the system at a desired state of equilibrium. The system cannot make any conditional response. It has no memory nor does it have available any alternative action.

Figure 6 depicts a first-order feedback system. In this type of control system the operation is clearly circular, since, after the comparison against the standard, a recycling must take place. A first-order feedback system always operates in this manner irrespective of changes in the environment.

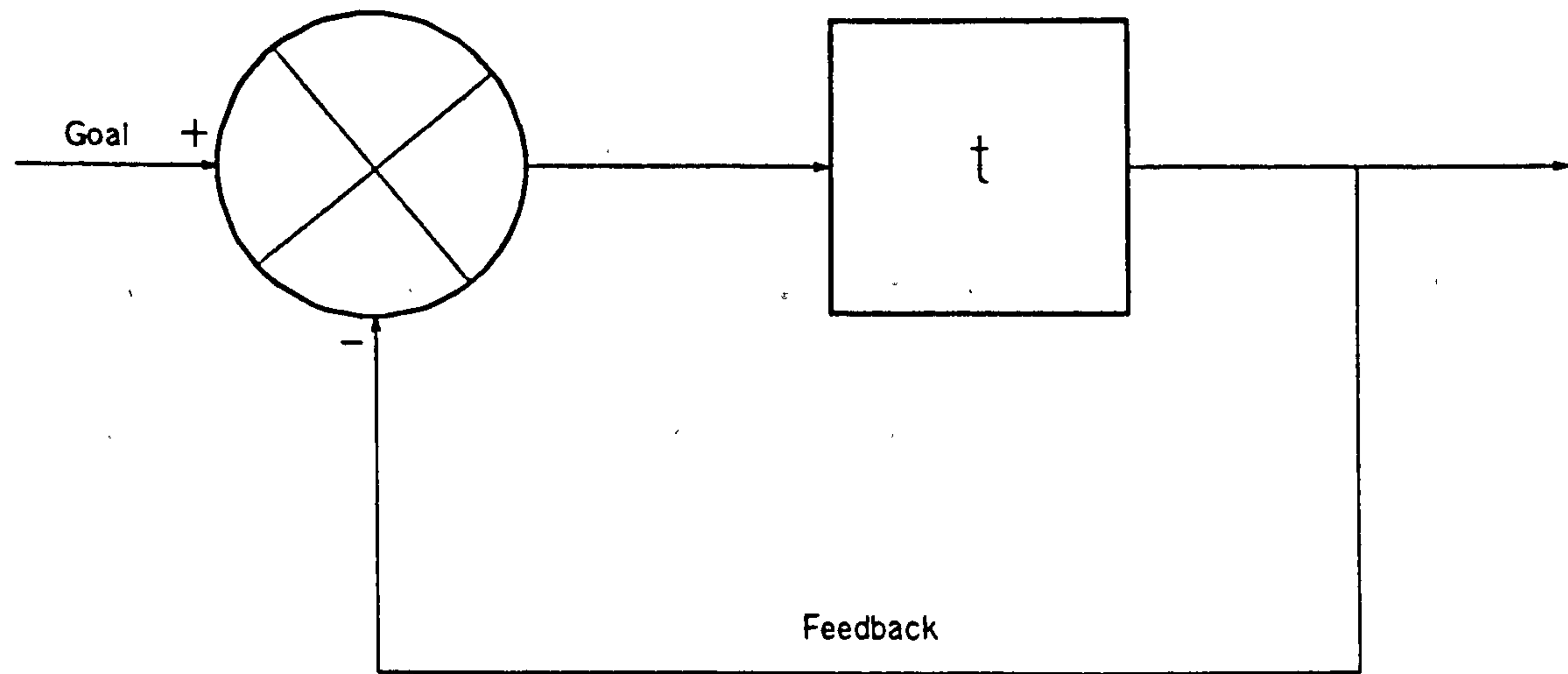


Figure 6: First-Order Feedback System

3.2.3.5. Automatic Goal Changer (Second-Order Feedback Systems)

When a system contains a memory unit and can initiate alternative courses of action in response to changed external conditions, and can choose the best alternative for the particular set of conditions, it is said to be a second-order feedback system. A memory includes all the facilities in the feedback loops available to the system for storing or recalling data from the past.

Churchman et al. (1957) ²⁹ use a telephone exchange as an example of an automatic goal-changing unit (Figure 7).

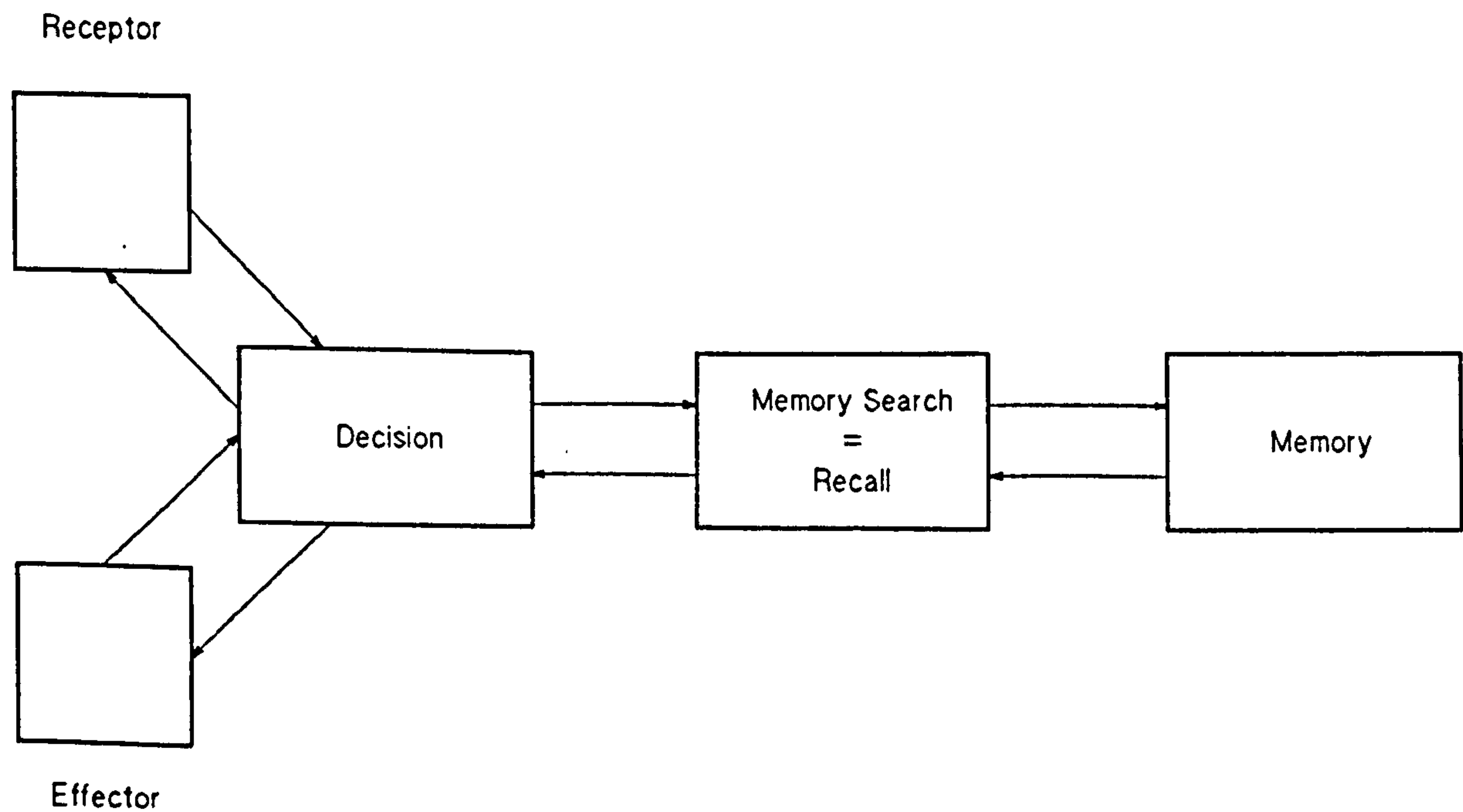


Figure 7: Second-Order Feedback System

3.2.3.6. Reflective Goal Changer (Third-Order Feedback Systems)

A thrid-order feedback system is one that can reflect upon its past decision making. It not only collects and stores information in its memory, but it also examines its memory and formulates new courses of action.

30 *Figures 8 and 9 illustrate two possible feedback structures of a system of this kind.*

In *Figure 8*, a device making simple predictions is illustrated.

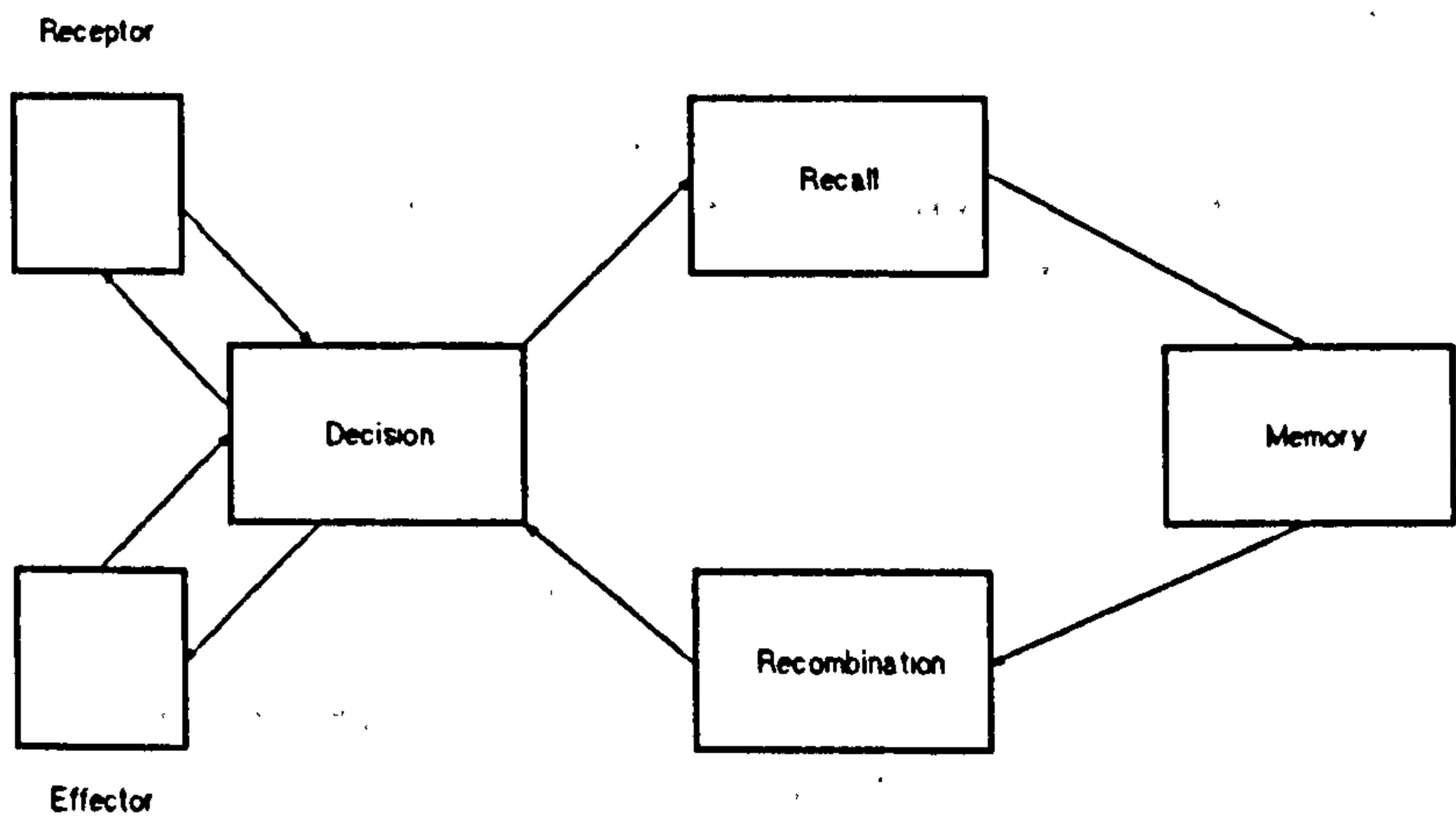


Figure 8: Third-Order Feedback System: Device Making Simple Predictions

The system becomes more versatile and autonomous, because information in the memory can be recombined and new alternatives produced for action by the system itself.

Figure 9 depicts a system developing a consciousness. If many memories can be combined, and if from the many combinations a few can be selected for further consideration, further recombination, etc., the system will have reached a still higher level of versatility or autonomy. The dashed lines indicate comparisons of what is going on with what has happened in the past and what might occur in future (second- and third-order predictions).

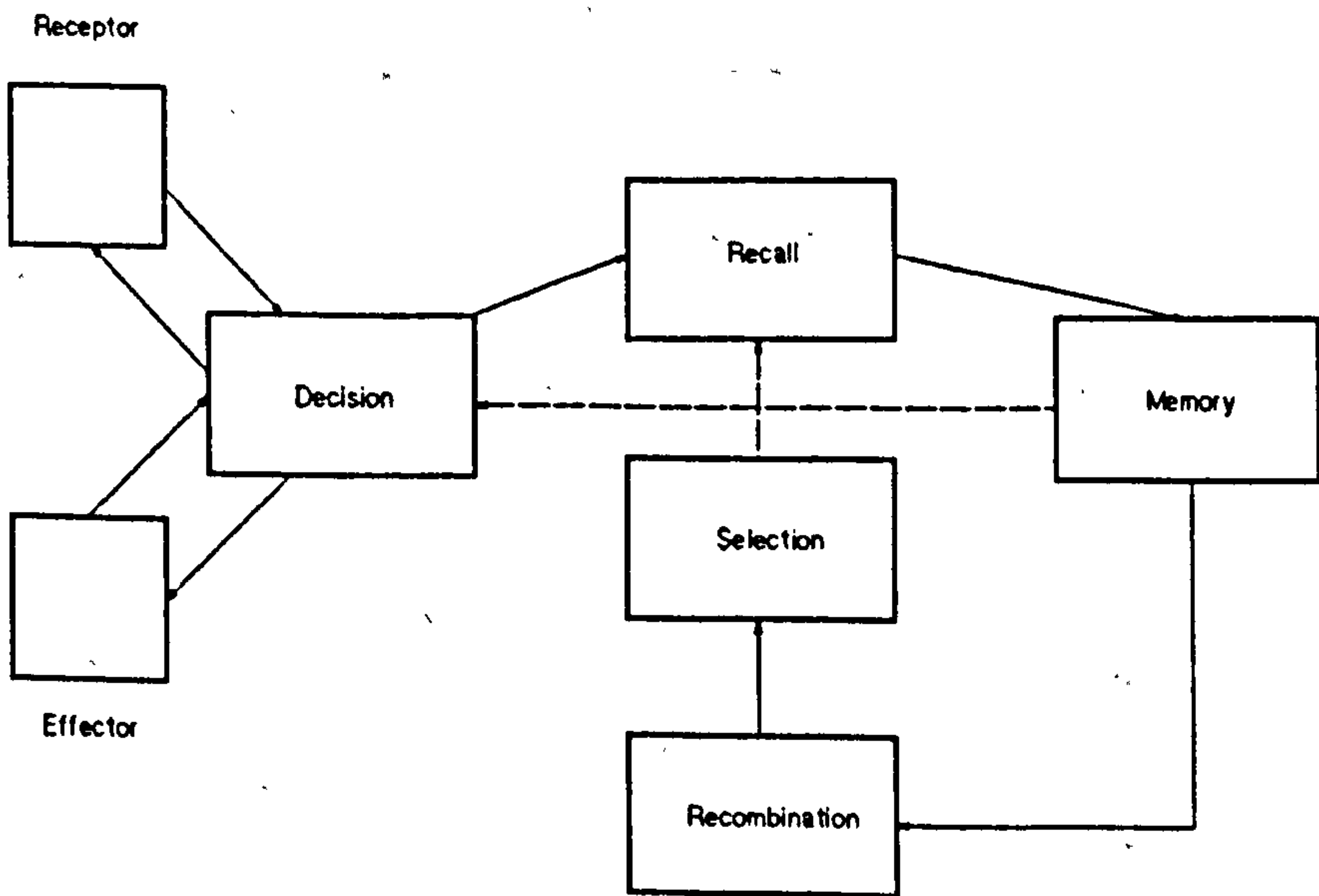


Figure 9: Third-Order Feedback System: Development of a Consciousness

3.3. CYBERNETICS AND MANAGEMENT

Cybernetics as a recognised field of study possesses as long a history as the various methodological approaches that make up traditional management science (operational research, systems analysis, systems engineering). The publication of Wiener's book *Cybernetics* in 1948 brought together contemporary ideas about control processes and established the definition of cybernetics as the science of control and communication in the animal and the machine.

However, from the very beginning, this definition appeared to be very limiting. Wiener himself was applying the insights of cybernetics to human concerns ³¹. Ashby (1956) notes that cybernetics should reveal numerous interesting and suggestive parallels between machinery, brains and society.

The early pioneers of cybernetics frequently employed analogies in their work to illustrate particular insights. A tendency grew up in the secondary literature on the applications of cybernetics to management to treat organizations as if they were actually machines or organisms.

This comes through, for example, in the discussions concerning management cybernetics in George ³², Pask ^{33 34}, Schoderbek et al. ³⁵, and Strank. ³⁶

In this branch of management cybernetics, organization is presented as an input-transformation-output system. The goal or purpose of the enterprise is invariably determined outside the system. Then, if the operations are to succeed in bringing about the goal, they must be regulated in some way. This regulation is effected by management, equipped with a number of cybernetic 'tools', chief amongst which are the 'black box' technique and the use of 'feedback', to induce self-regulation into organizations.

As stated, this branch of management cybernetics offers no new direction to management science. Concepts such as feedback can be employed in traditional management analyses. It has no ability to deal with 'subjectivity' and with the extreme complexity of organisational systems. ³⁷

An other branch of management cybernetics, with which this study will deal, is the one stemming from Beer's work. Beer (1979) succeeded in building a model of the organization from cybernetic first principles, enabling thus cybernetic laws to be understood without reference to the mechanical and biological manifestations in which they were first recognised ³⁸. At the same time, this branch gives more attention to human purposefulness and the role of the observer. Clemson (1984) makes a distinction between first-order cybernetics, appropriate to organized complexity because it is concerned with matter, energy and information, and second-order cybernetics, with which one can tackle relativistic organized complexity, because it also includes the study of the observing system ³⁹. Beer's work is second-order cybernetics. ⁴⁰

However, this branch of management cybernetics can only be found in developed form in the later work of Beer and in the writings of two adherents of his thinking, Espejo and Clemson, in spite of the respect which is accorded to Beer in, for example, the OR community.

Jackson (1987) examines whether the lack of serious attention to Beer's work indicates that Beer's thinking stems from a different paradigm. He argues that the philosophical/sociological paradigm underpinning Beer's work rests upon 'structuralism', whereas traditional management science is based on 'positivism/functionalism'. ⁴¹

3.3.1. Cybernetic View of the Organization

Espejo (1987) argues, that while traditional cybernetics was more concerned with the natural world, and, therefore, evolved in the tradition of **positivism**, managerial cybernetics has had to evolve taking into account the purposeful and intentional nature of human beings. The view of current managerial cybernetics is that social structures do have a great influence in the 'creation' of reality by individuals, and, therefore, in a sense, that this reality is not created by these individuals. However, the implied **organizations** (the contexts of their interactions) are not independent of the communities of individuals defining them, and, in the broadest sense, all individuals participate, consciously or otherwise, in the creation of these organizations. ⁴²

In any case, whatever might be the implications of the 'creation' of organizational reality, **constraints** are imposed upon the mental states and actions available to any individual, by the actual capacity of the operating communication channels throughout the multiple organizations in which s/he is embedded. **Organizational structure is a limiting factor to appreciations and actions.**

3.3.1.1. Nature of Organizations

While for certain entities, like objects, there might be a large degree of agreement about identity, for social activities in which interacting people are the very parts of the processes creating the wholes, ⁴³ identities are much less clear.

Somewhere in between the extremes of well-defined objects and ill-defined social problems organizations may be found, characterised by possessing a closed structure of communications, which defines them as wholes, independent of any particular observer. ⁴⁴

In social situations, the idea of an object for which one name is adequate (but potentially misleading), is overtaken by the idea of a **multi-system**, i.e. a social reality as created by the on-going processes of interaction, for which multiple names are necessary. The multi-system is the fluid outcome of the multiple viewpoints exchanging descriptions, i.e. systems, in their on-going interactions. ⁴⁵

If, with reference to particular activities in the world (not necessarily well-defined), the multi-system of concern defines a closed network of interpersonal interactions, i.e., a network with autonomy vis-a-vis particular tasks or missions, then the **multi-system is an organization.** ⁴⁶

3.3.1.2. Purpose of Organizations

Ascribing a purpose to an organization implies choosing the essential variables of concern to the viewpoint. In other words, the boundaries of the system are defined by the variables the viewpoint pays attention to.

In the extremes, the purpose of an organization refers to:

the description of a real world as it is perceived by a viewpoint (e.g., "the purpose of this hospital is to produce its own output"), or

the description of a notional world, with no reference to actuality (e.g., "the purpose of the hospital should be to improve the health standards in the community").

Of course the truth value of a purpose in the former mode of description is not guaranteed. However, in this mode the inference is that the intention of the viewpoint is to describe the actual world, while the latter mode of description suggests the intention is to change the world from a current state to a new one.

3.3.2. Cybernetic View of Management

From the cybernetic standpoint, management processes are best regarded non-hierarchically. They are not, then, necessarily pyramidal power structures, although they may approach this model in the limiting case of an authoritarian value system. ⁴⁷

Management is not confronted with 'discrete' problems; it faces interlocking sets of problems that can be separated only by artificially (and unhelpfully) carving the organization up into pieces ⁴⁸. Successful management does not solve problems in the sense that something is dealt with and disposed of. Rather, successful management performs a more or less continuous balancing, adjusting, steering of very messy situations. ⁴⁹

The naive positivistic world view assumes that human situations are objectively defined, that is, their boundaries are shared by the concerned people and the problem is to know how to pull the right strings to achieve the desirable results. If this assumption is unrealistic, as is more and more the case in modern organizations, then the complexity that has to be recognised becomes much larger, and the problem is more that of working out what to do to maintain stability in interpersonal interactions than that of achieving well-defined results. ⁵⁰

Organizations maintain internal stability through homeostasis ⁵¹. This means that the whole and each of the parts are maintaining a dynamic equilibrium, in which each part has, in Ashby's words: *"a power of veto over the state of equilibrium of the others"*.

In this regard, the critical task of management is to be alert to incipient instability, by means of a sort of model, that identifies the essential variables and some system to monitor those variables and set off an alerting signal if the variables diverge from their normal limits.

This view of the organization and its management and the evolution of a model will be discussed in details in *Chapter 4*.

3.4. SYNOPSIS

Cybernetics as a field of study initiated as *'the science of communication and control in the animal and the machine'*. By broadening its view towards the concept of general systems it has been defined as *'the science of the effective organization'*.

Cybernetics deals with exceedingly complex, probabilistic, and self-organizing systems. It treats them as wholes, in order to obtain a knowledge of the total system's behaviour which is not fully obtainable from a division in parts and a subsequent examination.

Tools enabling a cybernetic analysis of a system are:

The concept of variety as a measure of the systemic complexity. The Law of Requisite Variety, asserting that *'only variety can destroy variety'*, defines that the capacity of a regulator cannot exceed his capacity as a variety generator, as a communication channel or as a transducer.

The concept of the 'black box', i.e. the recognition of the fact that there is inability of full knowledge of all the internal operations in a complex system. 'It is not necessary to enter the black box to understand the nature of function it performs'.⁵² Employing the 'black box' technique (input manipulation, output classification and many-to-one transformations), the observer obtains an understanding of systemic behaviour.

Concepts and terms of communication theory such as information, channel, channel capacity and transducer.

The concept of feedback for the regulation of complex systems, either as negative feedback in deviation-counteracting mechanisms, or as positive feedback in growth-promoting devices, or by combinations of types of feedback.

Early cybernetic studies in management and organization evolved in the tradition of positivism, just adding to traditional management science the concepts of black box and feedback and using mechanical or biological analogies in their analyses of organizations.

The work of Beer enables cybernetic laws to be understood in the context of organizations without reference to mechanical or biological manifestations and gives more attention to purposefulness and the role of observer.

This branch of management cybernetics views organizations as multi-systems defining, with reference to particular activities, a closed network of interpersonal interactions, i.e. a network with autonomy vis-a-vis particular tasks or missions.

Management's problem is to maintain stability in interpersonal interactions through homeostasis.

The critical task of management is to be alert to incipient instability by identifying the essential variables in the organization, monitoring them, and taking action when they diverge from their normal (planned) limits.

3.5. FOOTNOTES

1. G.Pask, 1961: *An Approach to Cybernetics* (Hutchinson, London).
2. *"The famed biologist Claude Bernard, who should certainly be regarded as a precursor of the group who first called themselves cyberneticians in the early nineteen-forties, uttered a dictum on viability more than a hundred years ago which has become extremely well known: 'La fixite du milieu interieur est la condition de la vie libre'".* (S.Beer, 1979: *The Heart of Enterprise*, John Wiley, Chichester, page 225).
3. L. Von Bertalanffy, 1968: *General Systems Theory* (George Braziller, New York).
4. N.Wiener, 1948: *Cybernetics: Control and Communication in the Animal and the Machine* (Wiley, New York).

5. S.Beer, 1962: "Towards the Cybernetic Factory", in H.Von Foerster and G.W.Zopf (eds.): **Principles of Self-Organization** (Pergamon Press, New York), pp.25-89.
6. S.Beer, 1981: **Brain of the Firm**, Second Edition (Wiley, Chichester).
7. W.R.Ashby, 1956: **An Introduction to Cybernetics** (Chapman and Hall, London).
8. G.Bateson, 1972: **Steps to an Ecology of Mind** (Ballantine Books, New York).
9. S.Beer, 1962: page 25.
10. B.Clemson, 1984: **Cybernetics: A New Management Tool** (Abacus Press, Tunbridge).
11. S.Beer, 1959: **Cybernetics and Management** (English Universities Press, London).
12. P.P.Schoderbek, A.G.Kefalas and C.G.Schoderbek, 1975 : **Management Systems: Conceptual Considerations** (Business Publications, Dallas, Texas).
13. W.R.Ashby, 1962: "Principles of the Self-Organizing System", in H. Von Foerster and G.W.Zopf (eds.): **Principles of Self-Organization** (Pergamon Press, New York), pp.255-278.
14. R.Espejo and J.Watt, 1979: "Management Information Systems: A System for Design", *Journal of Cybernetics*, vol.9, pp.259-283.
15. *"The members of a hierarchy, like the Roman god Janus, all have two faces looking in opposite directions: the face turned towards the subordinate levels is that of a self-contained whole; the face turned upward towards the apex, that of a dependent part. But there is no satisfactory word in our vocabulary to refer to these Janus-like entities... It seems preferable to coin a new term to designate these nodes on the hierarchic tree which behave partly as wholes or wholly as parts, according to the way you look at them. The term I would propose is 'holon', from the Greek word 'holos', meaning whole". (A.Koestler, 1967: The Ghost in the Machine, Mac Millan, New York, page 48).*
16. S. Beer, 1984: "The Viable System Model: Its Provenance, Development, Methodology and Pathology", *Journal of the Operational Research Society*, vol.35, no.1, pp.7-25.
17. 'Coenetic' (pronounced sennetic), from the Greek word 'coenos', meaning 'common'.
18. G.Sommerhoff, 1950: **Analytical Biology** (Oxford University Press).
19. C.Shannon and W.Weaver, 1949: **The Mathematical Theory of Communication** (University of Illinois Press, Urbana, Illinois).
20. S.Beer, 1984: page 11.
21. W.R.Ashby, 1956: pages 86-89.
22. S.Beer, 1959.
23. P.P.Schoderbek et al., 1975.
24. C.Shannon and W.Weaver, 1949: page 100.

25. N.Wiener, 1948: pages 6-7.
26. S.Beer, 1967: page 30.
27. P.P.Schoderbek et al., 1975: page 69.
28. S.Beer, 1967: page 30
29. C.W.Churchman, R.L.Ackoff and E.L.Arnoff, 1957: **Introduction to Operations Research** (John Wiley, New York), page 81.
30. C.W.Churchman et al., 1957: page 84.
31. N.Wiener, 1950: **The Human Use of Human Beings** (Eyre and Spottiswoode, London).
32. F.H.George, 1971: **Cybernetics** (Hodder and Stoughton, Sevenoaks).
33. G.Pask, 1961.
34. *"Certainly, Pask does not appear to feel there is any important distinction in principle between an organization and a biological organism"*. (R.H.D.Strank, 1983: **Management Principles and Practice: A Cybernetic Approach**, Gordon and Breach, London, page 40).
35. *"Cybernetically, enterprises/organizations are viewed as organisms.... that feed on transmission of information"*. (P.P.Schoderbek et al., 1975: page 306).
36. R.H.D.Strank, 1983.
37. M.C.Jackson, 1987: "New Directions in Management Science", in M.C.Jackson and P.Keys (eds.): **New Directions in Management Science** (Gower, Aldershot), pages 133-164.
38. S.Beer, 1979: **The Heart of Enterprise** (Wiley, Chichester).
39. B.Clemson, 1984: pages 20-21.
40. M.C.Jackson, 1987: page 142.
41. **Structuralism** refers to a particular theoretical orientation based upon a 'realist' approach to science and social science. Structuralism, in the realist form, is concerned with uncovering and understanding the underlying structures or systems of relationships which generate the surface phenomena perceived in the world. Positivism encourages empirical observation, analysis and classification of surface elements. Structuralism, by contrast, demands explanation of the phenomena available to our senses, in terms of the underlying, unobservable mechanisms that generate them.
42. R.Espejo, 1987: "From Machines to People and Organizations: A Cybernetic Insight on Management", in M.C.Jackson and P.Keys (eds.): **New Directions in Management Science** (Gower, Aldershot), pages 55-85.
43. *"A system is a mental construct of parts and relationships which make up a whole"* (G.Weinberg, 1975: **An Introduction to General Systems Thinking**, Wiley, New York).
44. R.Espejo, 1987: page 58.

45. *"The cybernetic insight does not insist on the subjective nature of the 'wholes'. It allows for entities with their own coherence, even though such coherence is beyond the experimental reach of the observer or the viewpoint"* (R.Espejo, 1987: page 58).
46. R.Espejo, 1987: page 65.
47. S.Beer, 1983: "The Will of the People", *Journal of the Operational Research Society*, vol.34, no.8, pp.797-810.
48. R.L.Ackoff, 1974: "Beyond Problem Solving", *General Systems*, vol.XIX, pp.237-239.
49. B.Clemson, 1984: page 171.
50. R.Espejo, 1987: page 65.
51. *"The constant conditions which are maintained in the body might be called equilibria. That word, however, has come to have fairly exact meaning as applied to relatively simple physio-chemical states, in closed systems, where known forces are balanced. The co-ordinated physiological processes which maintain most of the steady states in the organism are so complex and so peculiar to living beings, involving, as they may, the brain and nerves, the heart, lung, kidneys and spleen, all working co-operatively, that I have suggested a special designation for these states: homeostasis"* (W.Cannon, 1932: *The Wisdom of the Body*, W.W.Norton, New York, page 24).
52. S.Beer, 1979: page 40.

CHAPTER 4

BEER'S MODEL

"It would be disastrous if some neurotically disposed chairman or consultant tried to insist that everyone behave like the organization chart. But the questions whether real life in the firm is best described by this, and whether if so a structure specified like this really helps best in solving the problems that arise in transforming input to output, are unanswered".

(S.Beer, 1981)

4.1. INTRODUCTION

When discussing Management Control under the 'official' Management Science paradigm (*Chapter 2*), it was noted that recorded dissatisfaction could probably be taken as a symptom of instability in the consensual system. It was, therefore, decided to attempt to tackle the problem under an alternative paradigm. *Chapter 3* has introduced cybernetics as an alternative method of dealing with managerial situations. However, cybernetic concepts can be employed in traditional management analyses without offering any new direction. A certain branch of cybernetics, Beer's management cybernetics, proposes a model of the organization, indicating an approach under a different paradigm. The implied views of organization and management, under this paradigm, have been outlined in *Chapter 3*. This chapter provides a more detailed examination of Beer's model and its various applications. The main criticisms to this approach are also discussed, before proceeding in attempting an evaluation of the model, in the case of a state-owned railway enterprise, in the remainder of this thesis.

An organization is a system of high complexity, in which the input and the output are themselves high-variety sub-systems. An orthodox description used in discussing typical managerial problems as organization, efficiency and objectives is the organization chart. This indicates how each part of the company relates to each other part and its main intention is to determine where responsibilities lie.

Beer (1981) assumes that *"orthodox organization chart does not help in solving problems arising within the organizations"*, for three reasons:

The first reason is that today the description of the control of the organization by a formal organization chart is arbitrary. In the origins of large modern enterprises, i.e., in small companies controlled by autocratic entrepreneurs, who did everything that mattered themselves, it used to be true that the control of the firm was a function of these different types of people interacting with each other and nothing more. Then, there was a reason to draw up *ad hoc* organization charts showing which of these actual people were actually doing what. But to allow this heavily personalized structure to become depersonalized was a mistake, because it erected a structural convention which has no particular *raison d'être*. Today,

however, control in a business is something much more than the interaction of its senior managers. It has to do with information of an extent and complexity beyond the capacities of those senior people to absorb and interpret it.

The second reason is that today the manager is no longer the arbiter of sophistication in control. Computers have a capacity to cope with information which is vastly in excess of the human capacity. Managers have to organize the firm so that it can be computed with. However, people do not want, do not know how, and do not have tools or means of description which would enable them to work out a new mode of organization as needed from the reshuffle of responsibilities. Thus, something different from the archtypal organization chart is required. If people persist in drawing in computers on their existing organization charts, they cannot possibly succeed in doing more than overload the humanly limited control system they have already got.

The third key reason for objection to orthodox company descriptions and ways of discussing organizational structure derives from the other two. If the distinctions currently used are wholly arbitrary and indeed archaic (first objection), and if they are constrained by human limitation in a way which modern facilities falsify (second objection), then there is no guarantee that what really matters in modern management can be expressed like this at all. ¹

Therefore, in his work, Beer attempts to define an alternative model of the effective organization, which he calls the model of the viable system (VSM).

4.2. METHODOLOGY FOR DEFINING AN ALTERNATIVE ORGANIZATIONAL MODEL

Beer (1966) has discussed the process of building a 'scientific' model of a managerial situation ². These steps were followed for the construction of the Viable System's Model ³ and are illustrated in *Figure 10*.

- (1) The perception of similarities between two different systems (e.g., between the regulatory system of an individual and a group or between a brain and a firm), gives, initially, way to a comparison, often beginning in a literary manner (e.g., "*management communications are like the nervous system...*"). Such comparisons help to convey insights, although everyone knows better than to take them more seriously.
- (2) As perception of the two systems deepens, conceptual models of both systems are derived. At this stage it may be found that some circumstance understood in one system throws light in a parallel circumstance in another. It is now worth '*drawing analogies*'; on the other hand, everyone knows that "*analogies may be carried too far*".
- (3) The process continues, and begins to have the marks of a scientific method, when attempting to develop rigorous formulations of the two conceptual models. These will each be a homomorphic mapping, insofar as many elements in the system that is conceptually modelled will map onto one element in a rigorous model.
- (4) When mapping the two rigorous models onto each other, if invariances are found between the two systems, then these are isomorphic mappings, one-to-one in the elements selected as typifying systemic behaviour in some selected but important way. The generalized system that comes out of this process (which applied to all systems of a particular class) is a scientific model.

- (5) The generalization of some behaviour invariably and invariantly exhibited by the system as interpreted through this systemic model is usually called a law. However, a selection has been made: systemic variety has been reduced through homomorphisms. This is natural, as it is the very business of scientific discovery.

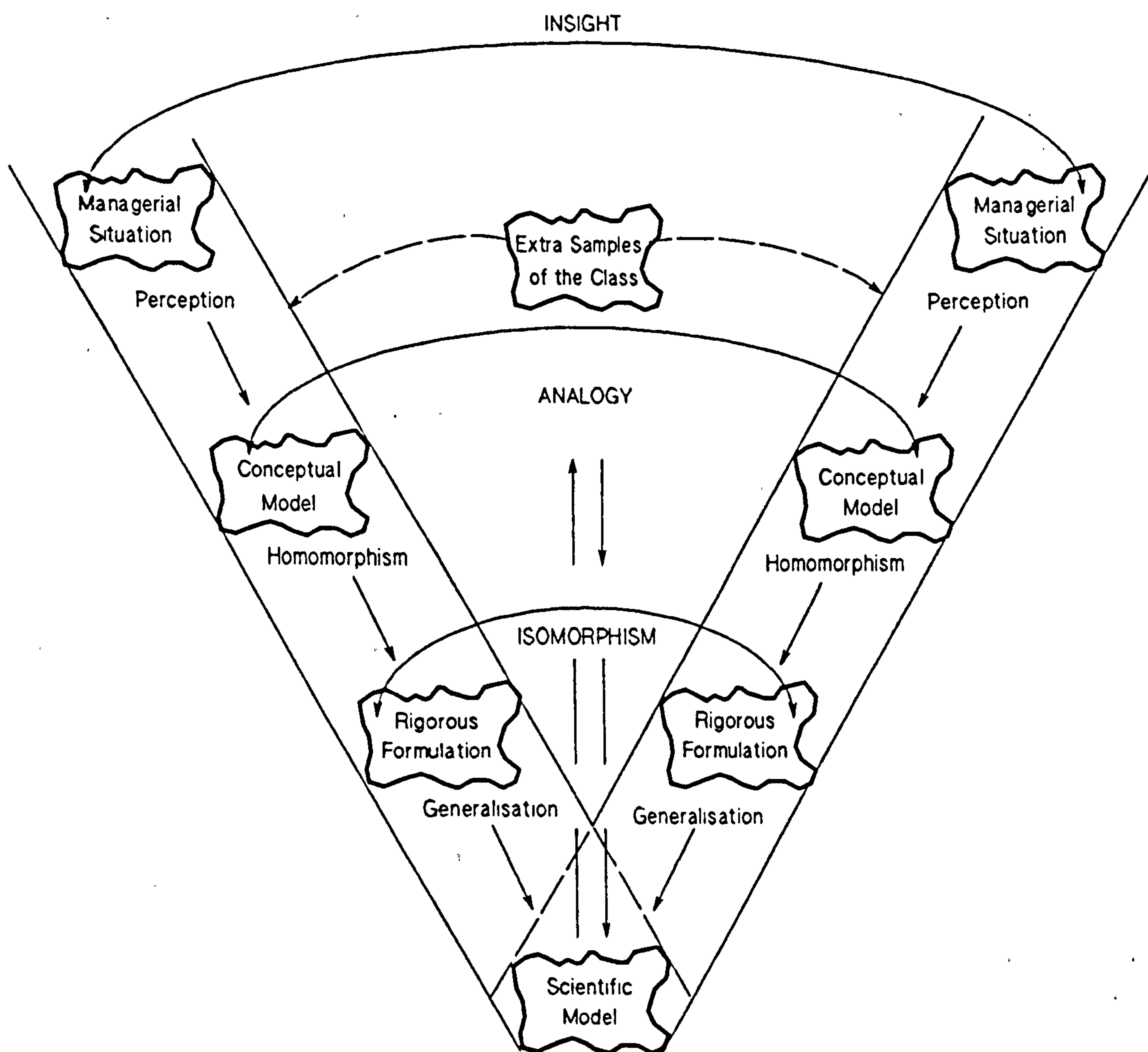


Figure 10: Beer's Account of Scientific Modelling

Employing this methodology he mapped a set-theoretic model of the brain onto a steel company ⁵, providing thus a first version of his model. Beer (1972) published for the first time his popular version of the VSM using neurophysiological terminology ⁶. To overcome accusations for analogical modelling, Beer (1979) developed a new version of the VSM from management principles ⁷, which is the one which will be presented and used in this thesis.

4.3. THE VIABLE SYSTEM'S MODEL (VSM)

The main assumption underlying the model is that there are invariances in the behaviour of all viable systems (i.e. capable of maintaining their identity independently of other such systems in a shared environment ⁸), whether they are organisms or organizations. Any viable system contains and is contained in a viable system (principle of recursion).

According to Beer, maintenance of viability means capability to respond to environmental changes, even if those changes could not have been foreseen at the time the system was designed. Any viable system has to achieve requisite variety (at a level concordent with its effective performance) with the complex environment with which it is faced. Obviously, then, Ashby's Law of Requisite Variety plays a central role in the design of the Model of The Viable System.

Though Ashby in his original formulation of the law put the emphasis on the channel capacity of the regulator (*para. 3.2.1.1*), asserting that "*R's capacity as a regulator cannot exceed R's capacity as a channel of communication*" ⁹, Beer recognised that, in the Viable System's Model, the requisite variety of the homeostats applies in three distinct ways:

- to the blocks of variety homeostatically related,
- to the channels carrying information between them, and
- to the transducers relaying information across boundaries. ¹⁰

Thus, at a methodological level, he has made a distinction of the regulator as a variety generator, as a communication channel and as a transducer. ¹¹

Beer (1981) has pointed a number of strategies that can be used in management in order to balance the variety equation for organizations in a satisfactory way. These strategies are aiming either at attenuating the variety of the external environment or at amplifying management's own variety. ¹²

Essentially, the variety engineering strategies that Beer prescribes are designed to fulfil two requirements:

- that the organization should have the best possible model of the environment relevant to its purposes;
- that the organization's structure and information flows should reflect the nature of that environment, so that the organization is responsive to it. ¹³

4.3.1. Summary of the Organization of the Viable System's Model

A full description of the VSM is provided in *Appendix A* of this thesis.

Systems ONE of an organization are the various parts of it directly concerned with implementation, i.e., carrying out the tasks that the organization is supposed to be doing. Each System ONE of the organization should be autonomous in its own right, so that it can absorb some of the environmental variety that would otherwise flood higher management levels. Systems ONE possess their own relations with the outside world and their own localised managements.

Under normal circumstances, compatible instructions from higher management should ensure that the various Systems ONE of an organization act in harmony. However, the actual interactions set off amongst the Systems ONE may lead to unpredictable and dangerous

effects for the whole organization and the divisions themselves. There is a need therefore for a co-ordinating function, provided by System TWO. System TWO consists of the regulatory centres of the Systems ONE linked to a corporate regulatory centre, which receives information about the actions of the various divisions and is able to prevent dangerous oscillations arising in the system, created by all the divisions.

System THREE is the control function, ultimately responsible for the internal stability of the organization. This System interprets the policy decisions of higher management and allocates resources to the Systems ONE to carry out policies. It must ensure the effective implementation of policy by monitoring (by means of System THREE-*) and controlling (by means of System TWO) the activities of Systems ONE, gathering information on their performance. Some of this information will require action from System THREE, some will need to be aggregated into corporate statistics, while some may have to be passed immediately upwards, for the urgent attention of higher management.

System FOUR, the intelligence function of the organization, has two main tasks:

It switches instructions from the 'thinking chamber' of the organization, System FIVE, down to the lower level systems, and it switches upwards, from Systems ONE to THREE, information required by System FIVE to take major strategic decisions.

It captures for the organization all relevant information about its total environment. Having recognised environmental threats and opportunities, System FOUR filters the information and redistributes it downwards or upwards, according to its implications.

System FOUR is the point in the organization where internal and external information can be brought together.

System FIVE is responsible for the direction of the whole enterprise. It is the thinking part of the organization, formulating policy on the basis of all the information passed to it by System FOUR and communicating this policy downwards to System THREE for implementation by Systems ONE. One of its most difficult tasks is balancing the sometimes conflicting external and internal demands placed on the organization. The internal demands are represented by the commitment of autonomic management to ongoing operations, while the external demands are represented by System FOUR which, with its links with the environment, tends to be outward and future oriented. System FIVE must ensure that the organization adapts to the external environment, while maintaining a degree of internal stability. Finally, System FIVE must represent the essential qualities of the whole organization to any wider system of which it is part, acting in this case simply as the localised management of a particular System ONE of the wider system. 14

4.3.2. Using the Viable System's Model

The model described can be used:

either for the design of new organizational systems, according to the cybernetics principles elucidated in the model,

or for the diagnosis of deficiencies in existing organizational structures,

or, finally, as a part of the design of efficient and effective management information systems.

4.3.2.1. Design of New Organizational Systems

The most ambitious attempt to use the model in this way was Project Cybersyn, involving the regulation of the Chilean social economy at the times of President Allende. Detailed accounts of this work have been provided by Beer ^{15 16 17 18}, Espejo ¹⁹, and Schwember ²⁰.

Beer ²¹ offers some more examples of the model's use for the design of new organizations, i.e., the organization of Manchester Business School ²², further discussed by Morris ²³ and Greiner ²⁴, the organization of the Operational Research Society ²⁵ and other applications. Beer (1984) provides a further list of uses of the model ²⁶. Espejo ^{27 28} and Davies, Demb and Espejo ²⁹ have also worked in the same direction.

4.3.2.2. VSM as a Diagnostic Tool

The model can also be employed as a diagnostic tool. The organization being analysed can be compared to the VSM to check that its structures and processes are such as to ensure viability and effectiveness.

Beer (1984), discussing the statement, that when dealing with an existing organization, which is actually there to be investigated, then surely it is by definition a viable system and nothing remains to be said, argues:

"The fact that the societal system is there does not prove that it is effectively there ... Monoliths and monopolistic systems in particular often operate at the margins of viability, creaking and choking like the valetudinarian organizations that they are. Moreover, many such are operating at such an enormous cost that they are becoming less and less viable in front of everyone's eyes". ³⁰

Diagnostic Points

The following features would be regarded as a threat to the organization's continued existence:

System ONE:

The absence of Beer's five necessary functions from any System ONE may threaten its abilities to operate successfully. ³¹

Mistakes in articulating the different levels of recursion, so that the system is not logically organized at each of its levels of operation often lead to no recognition of the importance of certain Systems ONE ³². Therefore, they are not treated as viable systems in their own right and lack a localised System ONE management to attend to their affairs. ³³

System TWO:

System TWO is often not fully established, because the localised managements of Systems ONE resent interference from this relatively junior control echelon. However, unless System TWO is able to assert itself, co-ordination between the various activities of the Systems ONE will be put in jeopardy. ³⁴

If System TWO is missing, activity in System ONE can turn deadly and self-defeating, as units fight for resources and against entropy. ³⁵

System FOUR:

System FOUR is often weak because it is regarded in many organizations as a 'staff' function. Thus, it may lack good communications with other parts of the organization and its recommendations may frequently be ignored.

However, if System FOUR is weak, System FIVE will lack the knowledge of the organization's environment, necessary for it to give proper attention to developmental activities. It will forget its higher-level duties and will instead tend to get too involved with the work of System THREE, or even try to intervene at Systems ONE level. 36

If System FOUR is missing, Systems THREE and FIVE collapse onto each other 37, leaving the critical System FIVE a mere functionary. 38

System FIVE:

System FIVE should represent what Beer calls "the essential qualities of the whole system" to the wider systems of which it is part. Inability to do that, questions the organization's survival.

Metasystem THREE-FOUR-FIVE:

Systems THREE, FOUR and FIVE need to form a THREE-FOUR-FIVE metasystem to encourage 'synergy' and interactivity. Without a constant interaction and exchange of information between them, System THREE is vulnerable to 'narrow tunnel' syndrome and System FOUR is exposed to the perils of 'flights of imagination'. 39

Pathological autopoiesis in Systems TWO, THREE, FOUR and FIVE: 40

An autopoietic system is one which has the ability to continue to produce those aspects of the organization which are essential to its identity. However, according to VSM, viability is a property which should be embodied only in the organization's totality and in its Systems ONE. An organization developing autopoiesis in any of its Systems TWO, THREE, FOUR and FIVE is 'pathologically autopoietic' and this threatens its viability.

In an organization, Systems TWO, THREE, FOUR and FIVE should serve the whole system, by promoting the implementation function and should not be allowed to become viable systems in their own right. If they do develop as autopoietic systems, it will inevitably be at the expense of the system as a whole. The faults typical of rigid bureaucracies can be traced to these organizations becoming pathologically autopoietic. 41

Diagnostic applications of the VSM

Beer (1984) states that no systematic archive of applications has been kept 42. Therefore, this section, besides presenting a number of applications of VSM as a diagnostic tool in the field of Management, might also facilitate in the future the construction of such an archive.

Espejo (1980) uses the model to diagnose organizational problems in the structure of a manufacturing company 43. Further work undertaken by Espejo relates mainly to the introduction of Beer's ideas in MIS design and will be discussed in that section.

Gomez (1977, 1978) presents a VSM-based methodology for problem-solving in Management ^{44 45} and Public Administration ⁴⁶.

Gomez (1982) combines the VSM with Checkland's "root definitions" to provide a problem-solving methodology in a publishing company. ⁴⁷

Ganete and Criggs (1977) have undertaken and presented an organizational analysis, employing VSM, of the Fisheries and Marine Service of the Federal Government of Canada ⁴⁸. The same project is discussed in a paper of Baker, Elias and Griggs (1978) ⁴⁹.

Karlin (1977) has shown the application of Beer's work through graphics. ⁵⁰

Carhart, Slagle and White (1977) have undertaken a modelling of the U.S. Federal Trade Commission employing comparatively, a traditional management model and VSM, and stating the advantages of the latter. ⁵¹

Tripp and Rainey (1983, 1986) ^{52 55} and Tripp, Pearson and Rainey (1983, 1986) ^{53 54} have employed VSM in their studies of the U.S. Air Force Logistics Command.

Britton and Callion (1985) have used VSM in assessing the deficiencies of the trade training network in New Zealand. ⁵⁶

4.3.2.3. VSM and the Design of Management Information Systems

Beer's model assists the design of MIS, as it pays attention to the communication links and the flow of information within the organization and between the organization and the environment. The proposition for the design of a Management Information System based on cybernetic principles underlies Beer's design for Allende's Government in Chile. Beer's concern was designing a comprehensive regulatory system for the Chilean economy. His conception was not of a management information system for top decision-makers, but a comprehensive design of information flows, communication channels and transducers for the multiple layers of management in that complex situation.

Detailed descriptions of this design are provided by Beer ^{57 58}, Schwember ⁵⁹ and Espejo ⁶⁰. Here, the main features will be outlined.

Real Time Information

According to Beer, even in the world's most advanced countries, economic data arrive very late, nine months late in average, before the total picture is seen.

Thus, most economic decisions are taken out of phase with economic reality. The advanced countries spend a great deal of money in trying to offset the errors thereby induced: they engage in econometric studies aimed at projecting data -not indeed into the future- but only into the present. It is perfectly possible, these days, to capture data at source in real time, and to process them instantly. ⁶¹

The time-scale of managerial problems is one of the most vital parameters involved. Thus, a management science that ignores the fact is not a science at all. ⁶²

The idea of real-time information had been strongly questioned, even before the Chilean experience, most characteristically by Dearden ^{63 64 65}. Jankowicz ⁶⁶, studying an alternative issue of management control, where the manager is fed information direct from the input and analysing the time delays inherent in such a system, points out that inevitably decisions will be delayed and perfect control is not possible.

However, Beer has shown with his work that it is feasible to design and construct a system providing real-time information. On the other hand, real-time control is related with the time-lag mediating between the reception of information and the decision-taking. Obviously, this phase is associated with human skills and cannot be guaranteed by any artificial system.

Central to the idea of real-time information is, according to Beer ⁶⁷, the concept of Cyberfilter, which is taken to mean the use of Bayesian statistical theory, according to the Harrison-Stevens protocol ^{68 69}, to examine streams of data flowing within the enterprise for any alerting signal that might enable a manager to take action to avert trouble before it results in damage to the enterprise. In this sense, cyberfilter breaks the time barrier. It aims not at remedial action after the trouble has manifested itself, but rather just before the trouble occurs.

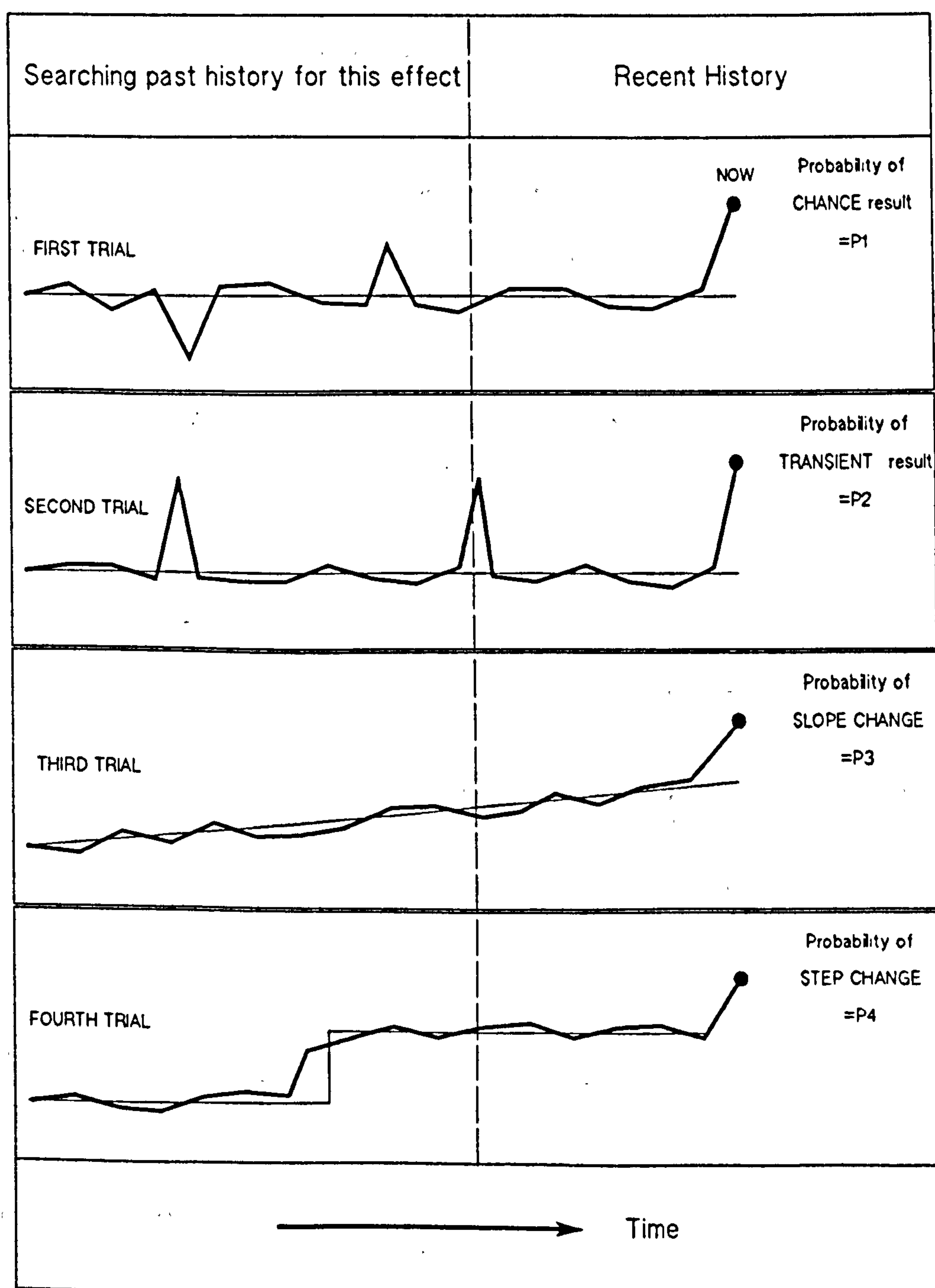


Figure 11: The Cyberfilter: Assessing the Probability of Four Effects

The Harrison-Stevens protocol was conceived as a tool for short-term forecasting. In cyberfilter it is used to recognise the likelihood of significant changes in the behaviour of streams of data. For each new datum added to a time series, four probabilities are computed. These probabilities are whether the new datum implies a chance variation, a transient, a slop change or a step change in the behaviour of the measured variable.

If there is a high probability that the new datum may imply step or slope changes the exception reports are transmitted to the relevant managers. Chance variations and transients are filtered away. This notion entails the surveillance of data streams on real time. The solution is not to wait for the periodic report which indicates that trouble exists and has existed for however long it took to prepare the periodic report.

According to Espejo ⁷⁰, two problems in the typical enterprise make difficult the implementation of the cyberfilter.

The first is that data are collected and processed by epochs, not continuously. *"We know the state of affairs daily, weekly, monthly, quarterly, yearly, but not in continuum. Nor is it reasonable to expect that any enterprise would convert its data capture and data processing to a real time format. The costs would be prohibitive"*.

The second problem is that within the existing epochal data capture, processing and reporting system, most attempts to invigilate the data streams demand expensive equipment to convert the existing protocol into a Harrison-Stevens protocol. The best way of developing cyberfilter is by the use of micro-computers. However, there is a severe problem at the interface between the established system with its periodic reporting and the micro-computer which seeks to operation in real time.

The solution to the second problem is to de-couple the two systems, the existing and the projected, by the creation of indices.

Creation of Indices

According to Espejo and Watt (1979) ⁷¹, Beer's design is very powerful as long as it is understood how to design meaningful indices. In Beer's framework, they are the elementary bricks supporting the building of information for organizational management. They have the meaning of physiological measures like the body temperature or the blood pressure; they have a profound systemic meaning.

Beer's indices are measures of performance relevant to any organizational operation. Figure 12 provides a diagrammatical definition of these indices.

What is done today, the **actuality**, is compared with what could have been done, considering present level of resources and operational constraints, if everything had been optimally organized, i.e., the **capability**. This gives the so-called index of **productivity**.

By removing constraints and allocating resources, a better value than capability should be achieved. This is **potentiality**. The index of latency is a measure of possible organizational development, considering resources that are present but not yet active.

Finally, the index of **peformance** integrates present behaviour with future possibilities. ⁷²

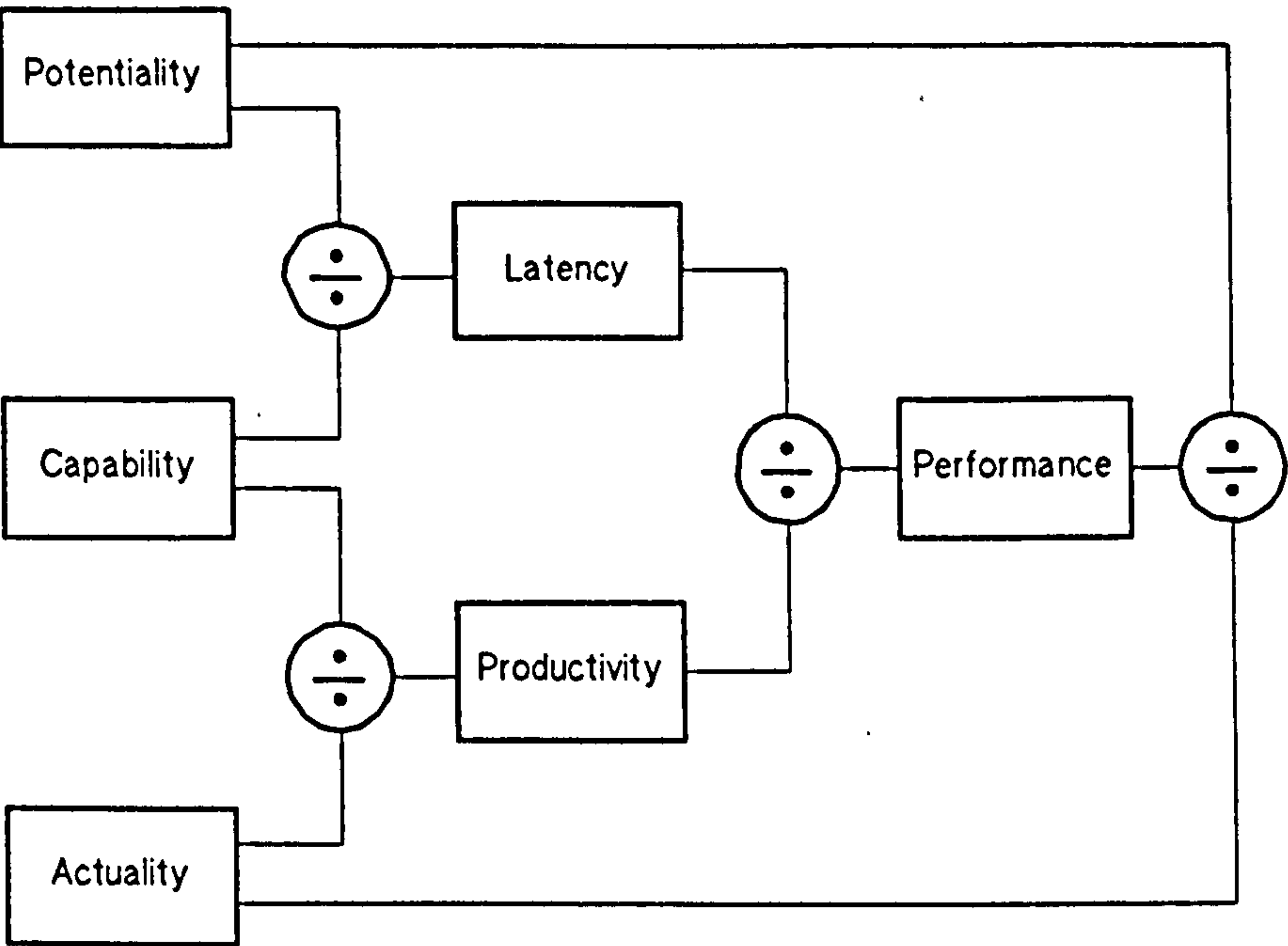


Figure 12: Beer's Indices for Performance Measurement

The notion of **capability** as a "systemic" concept is central to the definition of indices. While **potentiality** is basically a normative value, and **actuality** is a fluctuating value, **capability** is a measure of the present organizational resources. Its value can only be defined once it is understood the way other systemic activities affect the particular activity being measured.

Thus, the life of a system may be realized, in respect to the indices above, as a continuous process of adjustment to **potentiality**, as *Figure 13* illustrates.

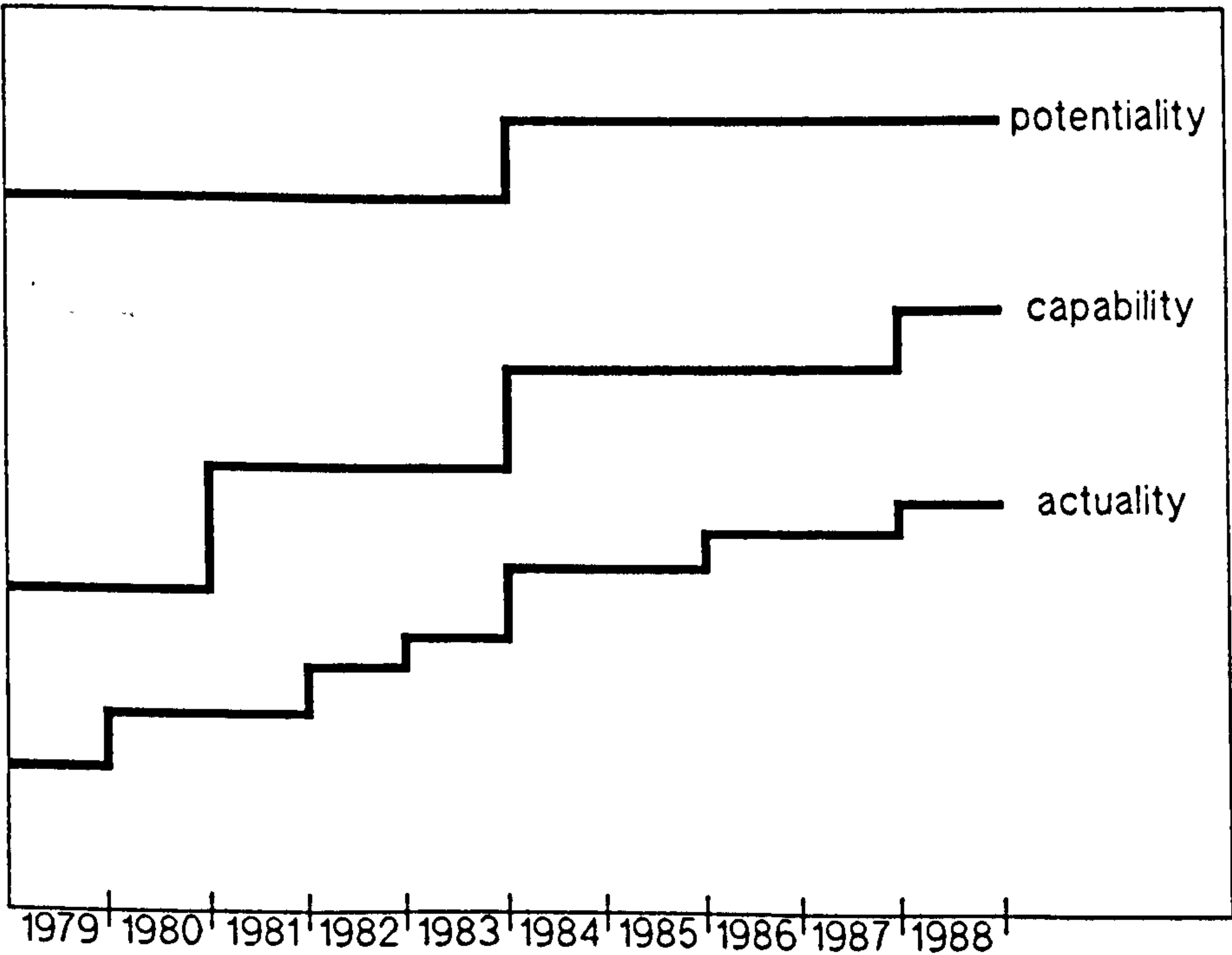


Figure 13: The Continuous Process of Systemic Adjustment

According to Beer, there can be no argument about the numbers used to measure actuality. However, there will be severe arguments about the other two sets of numbers. By means of operational research, agreement may be gained that the numbers used are sensible. What matters is that capability and potentiality measures, though somewhat arbitrarily fixed, cannot then be arbitrarily changed. Hence, although the absolute values of the productivity and latency indices provide only approximate assessments, movements of these indices over time provide the information really needed. 73

The VSM as the Basis of the Cybernetic MIS

Beer's model of the viable system is employed for the definition of the recursive structure of the organization under concern.

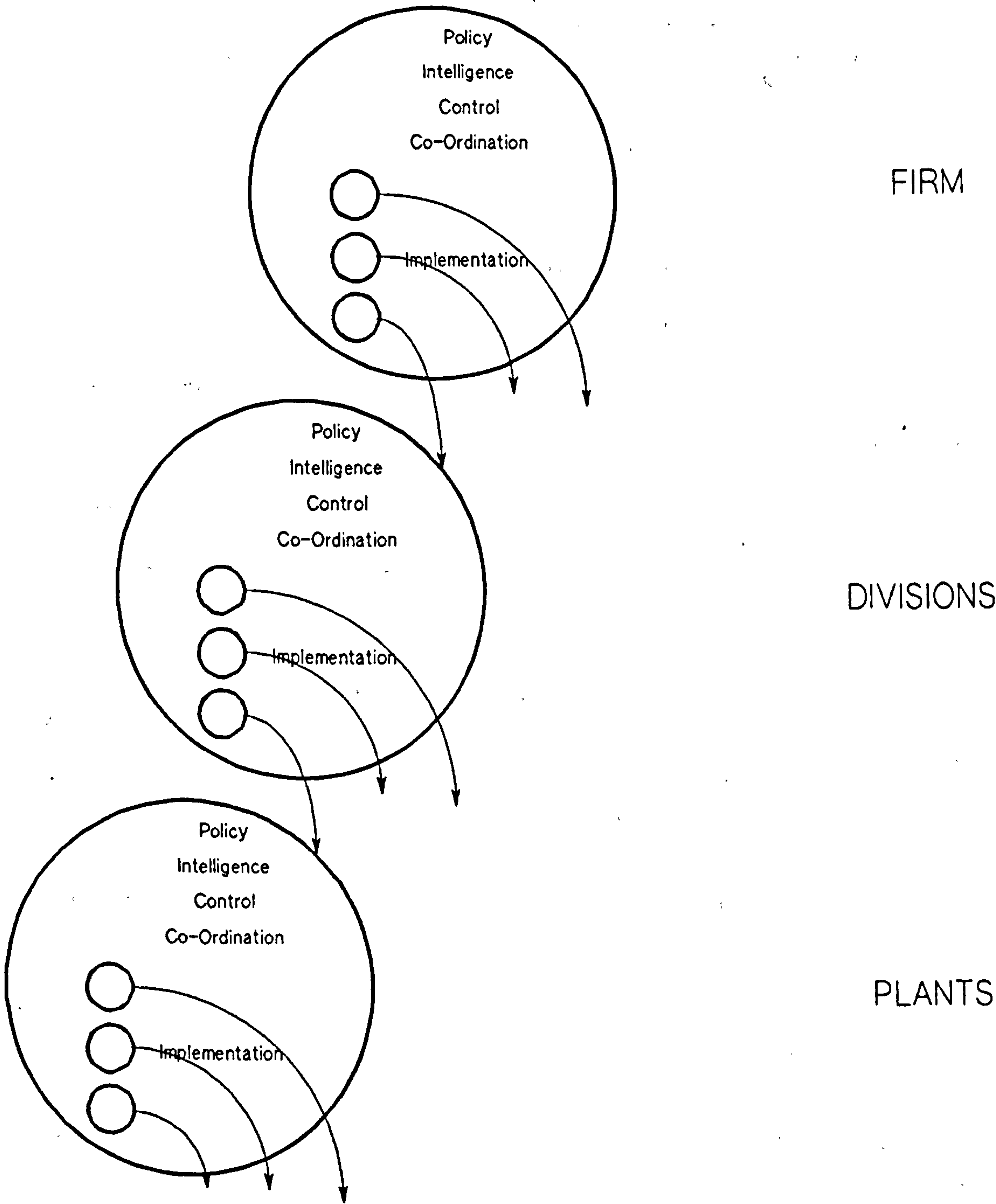


Figure 14: Organizational Modelling

For instance, for a firm a first level of recursion may be defined by the divisions, "doing" what the firm is all about. Within each division there may be several plants, defining the second level of recursion. Within each plant there are several sections "doing" what the plant is supposed to do. The breakdown is done as many times, as necessary for design purposes, as *Figure 14* illustrates.

Operational modelling at each level of recursion is then undertaken, focusing on the different processes producing organizational output. These models are expressed by "*quantified flowcharts*", and their usefulness depends upon the definition of indices that give true measures of internal activities. ⁷⁴

4.4. CRITIQUE TO BEER'S MODEL

"Those who have been induced by their culture to act to further its survival through design must accept the fact that they are altering the conditions under which men live and, hence, engaging in the control of human behaviour. Good government is as much a matter of the control of human behaviour as bad..."

Prof. Skinner: "Beyond Freedom and Dignity"

The heading of this section, as extracted by Adams' (1973) critique to the Chilean experiment ⁷⁵, summarizes the fundamental opposition to Beer's model. Apparently this opposition is based on philosophical grounds and is the first to be discussed.

4.4.1. "Neutral" Science and Social Systems

As Athanasiou (1979) ⁷⁶ points, we know from Beer's post-Chile writings that he left the Cybersyn project a good deal less naive politically than he began it. "*Prior to Chile we were confronted with a man who seemed somewhat unaware of the true nature of the 'social meta-systems' that dominate our society, and who clearly thought that the revolution he desired could be made by enlightened scientists and technologists*" ⁷⁷. After Chile we hear no more the confident assertion that the problems which face humanity "*are not in essence economic or political problems at all; they are cybernetic problems*" ⁷⁸. He is no longer so naive. In 1974 we hear instead that "*science and technology are driven forward towards a society of conspicuous consumption, since this is the only development that our economic machinery can countenance*" ⁷⁹.

A detailed discussion of the issue of Beer's "*political naivety*" goes far beyond the scope of this thesis. The task is further complicated by the fact that the development of Beer's thinking over the years makes the job of citing in his work statements favouring this or the other point of view easy, but, nevertheless, morally unjustifiable. Beer is well aware of this accusation and has tried to defend himself. His post-Chile work has demonstrated a political awareness well above of that of the average practising manager or consultant. ^{80 81}

Literature on Beer's work returns again and again to this starting point, namely the attempt to implement formal systems models or cybernetic models directly in social systems.

According to Thomas (1980), to try to conceptualize and actually build social cybernetic control systems is in fact dangerous as well as being virtually impossible.

It is dangerous because the requirement for a pre-determined goal cannot be met without assuming that it is possible to find an agreed definition of the "general good", unless the application is to limited areas with existing unitary power structures and to cases where the people being controlled take a purely instrumental attitude towards their participation.

It is virtually impossible, because it requires knowledge of the transfer function, i.e. the mechanisms by which the control "levers" have their effect. *"Unfortunately -or perhaps fortunately- a purposeful system will not remain passive in the face of attempts to control it. Individuals are able to choose a variety of reactions to the attempt to control behaviour".* 82

On the same grounds, Ulrich (1981) argues that the cybernetic systems concept, despite its grasp of the idea of intrinsic control, appears to be inadequate to social systems design, for it is still oriented towards a merely extrinsic concept of motivation. The fact that such a system may be given some built-in choice is largely irrelevant, because such choice is exercised merely in reaction to externally determined inputs (namely, purposes "given" to the system, and environmental "perturbations" to be eliminated). 83

4.4.2. Organic Systems and Social Systems

Gharajedaghi and Ackoff (1984), advocating the need for a new systems model, have postulated that, traditionally, in efforts to acquire information, knowledge and understanding of social systems, two types of model have been used: mechanistic and organismic.

Mechanistically modelled organizations, manifested by adherents to the so-called classical or traditional school of management, are structured hierarchically and are centrally controlled by a completely autonomous authority. Such an authority can affect any part of the system without being affected by any of them. This separates the ultimate authority from the system, making that authority an external controller.

Organismically modelled organizations (and they take Beer's work to be characteristic of this type of modelling) try to exercise control by specifying desired outputs, leaving the selection of means to the parts (management by objectives). The environment and organizational performance are kept under surveillance to determine whether they are behaving as expected. Thus, management engages in feedback control, which facilitates both learning and adaptation. However, they argue, to treat an organization or other type of social system as an organism is to fail to recognize the way in which these differ significantly. In contrast to an organism, which cannot change its structure more than a limited amount and still survive, a social system has almost complete control over its structure. Furthermore, an effective social system requires agreement among its parts and between its parts and the whole. It requires consensus; an organism does not. 84

A similar criticism to the analogy between mechanisms/organisms and organizations has been expressed by Checkland (1980): *"Any enterprise set up to carry out some purposeful activity may in part be regarded as a machine. But since its components can attribute meaning to their situation, it will have to be regarded as many other things as well: social grouping, appreciative system, power struggle".* 85

Rivett (1977) states, that Beer's model fails to understand human reaction and the way humans behave. *"It is not sufficient to draw all these diagrams showing feedback loops,*

algedonic loops, esoteric boxes, polystable systemic levels and metasystemic levels, and assume that the people who occupy these esoteric boxes and so on are going to behave in the way which the diagrams assume. Professor Beer has in the past, rightly, been scornful of management's assumption that people in organizations behave as organization charts indicate. But is there any reason to suppose that if we take the new systems for communication and control that are proposed, then these will be the way that groups of people will behave or even should behave ?" 86

4.4.3. Cybernetics and Organization theory

Morgan (1982) identifies a major conflict between the epistemology which underwrites cybernetics and the epistemology of goal-oriented rationality that provides the basis for much of organization theory.

Organization theory provides an inadequate basis for understanding the nature of evolved contexts, and, as a perspective for guiding management and human action, can actually disrupt and destroy the relationships which give meaningful form to the context within which that action is set. The insights of cybernetics challenge the premises and utility of goal-oriented rationality as a mode of understanding and as an effective technology of action.

However, used as a technique, cybernetics facilitates the design of systems which use the principle of negative feedback as a basis for self-regulation and control. To the extent that such systems are geared to the achievement of predetermined ends, then cybernetics is used as an instrument of goal-seeking activity, and as such contributes to the pathological consequences which such purposive modes of action may generate for the wider system. 87

Arguing this point Jackson (1985) assumes the emphasis on stability at the expense of change to be a characteristic of the early period of the development of cybernetics. *"At that time, the excitement generated by the discovery of the negative feedback process as an ubiquitous mechanism of control, meant that interest centred on deviation-counteracting systems" 88*. Adopting Maruyama's (1968) distinction between 'first' and 'second cybernetics' 89, he sees no reason why cybernetics could not deal with structure elaboration and change as successfully as it has dealt with system maintenance.

4.4.4. Conclusion

The adequacy of the framework for organizational study and design offered by Beer in terms of the model of any viable system (VSM) has to be examined at three levels:

4.4.4.1. The Model as a Tool for Organizational Diagnosis

This is the most obvious and justifiable use of the model. Many researchers have reported on the model's diagnostic power. Britton and McCallion (1985) find the model *"an extremely powerful diagnostic and predictive tool for analyzing deficiencies in organizations and inter-organizational networks" 90*. Mitchell (1977) accepts that Beer's model offers a large number of powerful hypotheses about communication and control in social organizations, offering very interesting possibilities for further investigation, though the propositions are short of a well-integrated theory 91.

4.4.4.2. The Model as a Theory of Organizational Design

Mitchell's argument on the absence of a well-integrated theory takes us to the second level of examination. Can Beer's model develop as a framework for Organizational Theory ?

It seems to be early yet to predict, though many scientists have reported on the independent validation of the model ⁹².

There seems to be to a great extent lack of communication between researchers in various schools of thought in the field of Organizational science. Attempts to bridge these gaps appear in the literature at an increasing rate:

Mitchell (1977) wonders why Beer being so well known for his scholarliness, his scientific zeal, his political commitment and his concentrated focus on the major problems of our time has so little been used.

Clemson (1977) assigns this limited use not to lack of interest or appreciation but to the lack of an adequate language to discuss complex, dynamic processes in general or in the abstract. ⁹³

Espejo (1987) believes that there is a group of scientists whose formalised conceptions appear equivalent to Ashby's Law, but who have failed to recognise the universal significance of requisite variety. He reports this to be the case, among others, of Simon in the field of human information processing, Galbraith in organizational design and Weinberg in systems theory. ⁹⁴

Tomlinson (1987) states that Beer's concept of the "Brain of the Firm" is a seminal concept, which is increasingly making its impact on the understanding of what are the important structural elements in a progressive organization, and thus how improvement can be achieved. ⁹⁵

4.4.4.3. The Model and the Design of Information and Control Systems

Probably this is the area mostly requiring further development before any concrete conclusions concerning the usefulness of the model can be drawn.

Besides the fact that operational problems have yet to be resolved, e.g., an agreed upon methodology for defining 'molecular' indices of performance out of 'quantified' flow charts, there always remains the problem of model's misuse. Ulrich (1981) argues that it is enough for the model to be at fault if it provides tools which are capable of being misused and are likely, therefore, to be misused. For him, design tools must be so constructed that they are impossible to subvert for authoritarian usage. ⁹⁶

4.5. SYNOPSIS

The main assumption underlying Beer's model is that there are invariances in the behaviour of all viable systems. Any viable system contains and is contained in a viable system (principle of recursion).

Any viable system has to achieve requisite variety with the complex environment with which it is faced. The variety engineering strategies must be designed to fulfil two requirements:

that the organization should have the best model of the environment relevant to its purposes; and

that the organization's structure and information flows should reflect the nature of that environment, so that the organization is responsive to it.

Beer's model of any viable system (VSM) consists of five sub-systems/elements, the existence and proper functioning of each of which is a necessary and sufficient condition for viability and effectiveness.

The five sub-systems may be labelled:

- (1) implementation,
- (2) co-ordination,
- (3) control,
- (4) intelligence, and
- (5) policy.

The model may be used either for

the design of new organizational systems, or for

the diagnosis of deficiencies in existing organizational structures, or

as a part of the design of management information systems.

A number of theoretical issues related with the model still remain unresolved. These issues, reflecting contemporary lack of consensus in the fields of Management Science, Organizational Design and Systems Theory, limit at the moment the validity of the model to a powerful diagnostic tool.

This thesis will make use of the diagnostic power of the model, placing it, at the same time, under a further test of theoretical validity.

4.6. FOOTNOTES

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33. *"In Chile, problems were encountered in regulating the social economy because the 'allocation system' and the 'people system' were not initially seen as independent viable systems"* (S.Beer, 1981: pages 322-329).
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35. S.Beer, 1984: page 18.
36. M.C.Jackson, 1985: page 46.
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38. S.Beer, 1984: page 18.
39. S.Beer, 1984: pages 18-19.
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CHAPTER 5

THE RAILWAY ENTERPRISE

5.1. INTRODUCTION

A railway produces the availability of transportation of people and freight between distinct geographical points. From this point of view, railways do not differ from other modes of land, air or sea transport. What makes a railway company unique in a national context, in most countries of the world, is that the same enterprise undertakes various kinds of transportation, each with its own characteristics and market. Thus, the types of railway services offered may be:

- **Freight transportation services**, varying from services to large customers, probably owning their own wagon fleet, or specific loads, to transportation of small items such as parcels.

- **Passenger transportation services**, which may be either high-speed and quality interurban services, or frequent commuter services facilitating the flows to and from the centres of conurbations, or even rural services, providing a transport connection to isolated populations.

Each of the above types of railway services requires a specific treatment. On the other hand, each of these types is confronted with different aspects of competition.

In the case of freight transport, for bulk commodities, the main competitors may be (according to the historical development of the modes of transport in a country, the physical layout, etc.) sea transport, road transport and pipelines. For other commodities, competition arrives either from road transport companies, or from the development of road transport fleets owned by the manufacturing companies.

Similarly, concerning passenger transport, competition in interurban transport comes primarily from aeroplane and motor-car, and, to a lesser extent, dependent on national peculiarities, from the development of interurban bus transport. In suburban or rural transport, usually there is no alternative to rail transport other than the motor-car.

The production of rail services demands the day-to-day maintenance of the availability of several subsystems, most significant amongst which are:

- **The traction sub-system**, both in the form of the tractive power, i.e. the locomotives, including the provision for energy, either being fustile fuel (notably diesel oil) or requiring the operation and maintenance of energy production and transmission installations (electrification) and the coaches or wagons receiving the passengers or goods to be transported.

- **The permanent way sub-system**, including both buildings and mechanical equipment through which traffic is transferred to and from the railway system and the track, the '*iron road*' on which trains move, including subgrade and technical works such as bridges, tunnels, supportive walls, etc.

The signalling and telecommunications sub-system, through which traffic is scheduled and controlled, aiming at permitting the optimum utilization of the other resources, under a strict regime of safety in operations.

This holistic nature of a railway system, with the geographical extent, the multiplicity of products and the requirement for the co-ordination of several sub-systems makes it unique. No other transport undertaking engages in so many types of activity, having, at the same time, the obligation to develop and maintain its infrastructure. A successful railway, therefore, provides a paradigm of the feasibility of a planned and co-ordinated series of activities, with consequences beyond the narrow topic of transportation, contrasting individualistic options, common in contemporary society.

The same holistic nature makes railway a first candidate for the introduction and application of cybernetic principles. Besides the various applications of cybernetics in technology (shared by the railway and other technological products), there seems to be a belief in the feasibility of running the enterprise cybernetically ¹. Wyckoff (1976) has noted this characteristic, though he mainly realises it as a negative feature of increasing centralization. ²

Three major themes concerning railway enterprises have to be examined, before a framework for railway management control can be developed in the next chapter. These themes relate to:

- the ownership of the railway enterprise,
- the objectives of the railway enterprise, and
- the external control over the railway enterprise.

5.2. OWNERSHIP OF THE RAILWAY ENTERPRISE

Most railways in the world are ran by state-owned enterprises. According to Nove (1973), there could be two types of answer to the question why should anything be nationalized ³. The first concerns ideology and the class war. The other economy and/or social efficiency.

This distinction is not very clear to the extent that the latter type of answer is included (or, at least, should be included) in the former. Throughout this thesis, the second type of answer is examined, with the belief that, thus, the clarification of the practical consequences of the first type is facilitated. This limitation is additionally justified by the fact that, in western societies, the greatest part of nationalizations did not take place under the influence of ideological terms, but rather under considerations of economic and social efficiency ⁴.

5.2.1. The Need for a Regulated Environment

The present historical period is characterised by an attempt to revitalise the 'liberal' model of economic development, both in ideological, political and financial terms. The consequences of this model on the companies of the transport sector could in general be described as a move towards the abolition of regulations and limitations (deregulation). This move, implying increased competition and transport activities governed by market laws, is usually accompanied by the privatisation of large state-owned transport enterprises (e.g., British Airways).

However, though there is this tendency to adopt the 'liberal' (in contrast to the Keynesian) model of development in western societies nowadays, very little has been said

about deregulating railway transport. The only experience comes from recent policies in the United States ⁵, but refers to a specific environment, characterised by the existence of a multitude of competing railway companies. Furthermore, in this environment, deregulation refers only to freight traffic (which is by and large the main traffic of American railroads) and, though it is very early to make predictions, it seems that will lead to:

- Further mergers ⁶, potentially facilitating monopoly conditions.
- A rationalization of the size of the network, with the abandonment of multiple connections between terminal points.

On the other hand, a number of important issues remain unresolved with deregulation legislation, most important of which are:

- how high a rate level should be allowed;
- to what extent should new firms (rail or nonrail) be allowed to enter the most lucrative markets of coal transport;
- what will taxation and subsidy policies towards railways and competing modes be;
- how will institutional problems as merger policies, labour practices, etc., be tackled;
- which way will external issues, as energy conservation, environmental protection and national defense, be considered. ⁷

In financial terms, state regulation of private business activities (extreme case of which is the nationalisation) is justified in case of the existence of a natural monopoly.

According to Baumol (1982), when it is easy to enter or to exit a market, even a natural monopoly has the characteristics of a competitive market, minimising thus the need for state control. Baumol calls this kind of monopoly a 'contestable' monopoly. ⁸

Adopting this view, Keeler (1983) argues, that if railway was a contestable monopoly, the function of its regulation could be simplified, because the market would be able to undertake a great part (if not all) of the task of achieving efficient pricing and resource allocation to the industry. However, he insists, railway industry is not a contestable monopoly. Entry to the market entails a long and tedious process of bying up parcels of land. Engineering and building a railway line also require considerable time and expense. Exit is also difficult, largely because of public regulatory policies, but also because of heavy sunk costs, often financed with debt, incurred to serve a specific market, without opportunity to transfer them to other markets easily. "While bridges, ballast, rails, and ties can be moved from one route to another, they can be moved only at great expense" ⁹. Hence a need to regulate railway activities. Alternative options of regulation exist or are proposed, belonging generally in one of the following categories:

5.2.1.1. Nationalisation of the Infrastructure: Public Track System

Wyckoff (1973) has proposed for the case of US rail system that the federal government should undertake a project to purchase major segments of railway track and right of way, for the purpose of developing a modern, high-speed rail system for public use. ¹⁰

The private railways would be allowed to continue to own and operate any of their private tracks. They would also be responsible for development of classification yards and track connecting their own lines with the federal track system.

Operations on the Public Track System would be in conformance with federal operating regulations. Traffic control through signalling systems would be provided by federal traffic controllers, in a role similar to that of the air traffic controllers.

Charges for the use of this track system would be made on a user-tax basis, shifting fixed costs of railroading into variable costs, more like the cost structure of the motor carriers. ¹¹

The main objections to this proposal arrived from the railway companies themselves. The Association of American Railroads ¹² argued that the federal ownership of the tracks:

- (1) Complicates the problem of optimizing track construction and maintenance standards, the result being some increase in the overall cost of rail transportation.
- (2) Presents problems in train control and operations, problems that will necessarily increase the cost associated with the installation and operation of train control systems and additional trackwork.
- (3) Presents special difficulties in terminal design and operations, which will further increase both capital and operating costs.
- (4) Generally insures an increase in the cost of providing railroad fixed plant, because of the intrusion both of politics and of bureaucratic inefficiencies into management decisions.
- (5) Generally politicizes decisions on:
 - Fixed plant improvement and maintenance.
 - Abandonment of uneconomic and redundant rail lines.
 - Railroad operating rights.
 - Use of terminals.
 - Level crossing elimination.
 - Railroad labour contracts.
- (6) Opens up the use of railroad fixed plant to private and restricted-commodity carriers, who will enter into rail operations under the guise of providing 'competition' for existing common carrier railroad operating companies. These new carriers will skim the cream (heavy, long-haul, base-load traffic) off the railroad common carrier market, all to the direct benefit of the largest industrial corporations. ¹³

5.2.1.2. Private Railway Companies - State Regulation

This regime characterised the period from the introduction of railway services till, approximately, the World War II. It was also retained in the USA until recently (deregulation) and is still in use in a few other countries, in several forms ¹⁴.

According to Keeler (1983) ¹⁵, much of the important regulation affecting railways today originates in mediæval British common law, subject to which were the railways, as common carriers. At that time, stagecoach, and later canal and turnpike, operators were given operating franchises, called certificates of public convenience and necessity. These franchises, issued by the government, initially reflected widespread economic cartelization practiced through the system of mediæval guilds. But the notion of common carriage, and of certificates granting firms franchises for common carriage, survived even as guilds disappeared.

Reasons explaining the continued government controls of transportation through the 16th, 17th and 18th centuries in England and then in the United States were:

Travelling through dangerous areas. The government felt that in return for franchise protection and the profits that afforded, transportation companies should be ready to bear the risks involved and assume liability for losses and damages.

Need to maintain a regularly scheduled and reliable transportation. This need was so important, that required the protection of legal sanction beyond what the marketplace might supply.

Power to acquire a right-of-way. The carrier required powers over others, not usually needed by commercial firms, in order to force, with a reasonable compensation, owners of land along its right-of-way to surrender the land.

The notion, therefore, behind common carriage was that the government would grant the carrier certain powers and privileges, and, in return, the carrier was expected to assume certain obligations, i.e. that:

- The carrier may not refuse to serve.
- The carrier must serve at reasonable price.
- The carrier must serve all equally.
- The carrier is responsible for the safe delivery of the goods or persons committed to its care.

Another aspect of public policy towards railways, consistent with the notion that firms were granted considerable privileges for which they in turn had responsibilities, was that of subsidisation.

Furthermore, the pricing behaviour of the railways during the middle and late 19th century made consistent control of rail rates politically more and more imperative. On monopoly routes, rates tended to stay extremely high by comparison. The railways disliked the rate wars and attempted to form cartels and collude on services and rates to prevent them. Shippers on monopoly routes also disliked the structure of rates, because they found themselves paying rates far higher than those charged on competitive routes, for equivalent services.

These occurrences made it evident that state regulation of railway fares and services would be necessary. Thus, both the British Canals and Railways Act of 1854 and the US Interstate Commerce Act of 1887 attempted to make explicit and achieve consistent enforcement of a number of legal principles already embedded in common law. This legislation was revised in the following period, both in United States and Britain. However, the basic characteristic, i.e., the state regulation, was always, to the one or the other extent, retained.

Very broadly, the relative historical phases of railway regulation, both in United States and Britain, are:

United States 16

The Commerce Act of 1887 established the Interstate Commerce Commission, to rule upon the law. By 1910, the ICC had in actuality all the powers the 1887 act intended it to have, and it used these powers in a politically effective way.

The policies resulting from the 1887 act and its pre-World War I amendments worked well politically as long as the railway industry had a virtual monopoly. But with the advent of highway, barge and air transportation, regulation designed to function under a rail monopoly had to adapt. The story of regulatory policies from 1920 to the present indicates continuous and generally inadequate attempts to do so.

During World War I, the federal government took over the operation of the railways. When it was over, Congress worked out legislation returning the industry to private ownership. The Transportation Act of 1920 not only did this, but it also amended the 1887 act to broaden the ICC's powers significantly:

It allowed the ICC to set minimum rates.

It transferred the control of entry into and exit from rail routes from the states to the Interstate Commerce Commission.

It gave the ICC the right to promote mergers among railways.

It provided for direct subsidies in the form of guaranteed loans to weaker railways, if indirect or cross-subsidies were found to be inadequate for continued operation.

As truck competition increased with the development of a national road system in the 1920s and 1930s, the railways claimed for placing the trucking industry under the same regulation they were subject to. This resulted in the Motor Carrier Act of 1935, which gave the ICC control of truck rates and entry.

The ICC's power was increased by the Transportation Act of 1940, which brought certain barge transportation under the control of ICC regulation. It also made some changes in rate regulation:

In a case in which a carrier proposed a rate reduction the act placed the burden of proof that such a rate was 'reasonable' for the carrier.

The act also gave to the ICC the duty to pursue regulatory policies that would create a national transportation system adequate to the needs of commerce, defense and the postal system and that would bring about 'sound economic conditions' among the carriers.

It also stated that these conditions were not to be used by the ICC to keep the rates of one mode high to protect the traffic of another.

Because of the considerable relative advantage of truck transportation over rail after World War II, the railways found themselves losing more and more of their high-value traffic. They tried to reduce rates to counter the better truck service and the lower barge rates, but, frequently, the ICC blocked railway rate cuts, on the grounds that they were 'unreasonable'. The pressure from railways resulted in the Transportation Act of 1958, which was geared in several ways towards making ICC regulation both more supportive of competition and more favourable to the railways.

It stated that rates of a carrier shall not be held up to a particular level to protect the traffic of any other mode of transportation.

It allowed for guaranteed loans to railways, to help rebuild their plant and equipment.

It brought the power to grant discontinuance of passenger trains under the ICC, from the states where it was previously.

In the late 1960s and early 1970s the railways were relieved from both passenger service and minimum-rate regulation.

Passenger service was for the most part taken over by Amtrak. Although railways had to pay significant amounts to turn service over to Amtrak and although Amtrak probably does not fully compensate railways for all services used, it offered most railways eventual relief from almost all their passenger burdens.

Relief from rates came from inflation. Since the consumer price index rose by nearly 50 % between 1967 and 1974 and fuel costs by much more than that, the railways could over that period easily achieve any effective rate cuts they might want simply by failing to raise rates. Thus in the 1970s suddenly the important constraint was not minimum rates, but ICC controls on maximum rates.

At the same time in the 1970s the financial situation of many railways deteriorated. It had become evident that more legislation was urgently needed, which started with the formation of Amtrak in 1971 and continued with the Regional Rail Reorganization (3R) Act of 1973, the Railroad Revitalization and Regulatory Reform (4R) Act of 1976, and the Staggers Rail Act of 1980.

The Regional Rail Reorganization Act of 1973 established an agency, the Railway Association, to plan the reorganisation and transition to public ownership of railways in the Northeast. Based on economic and social criteria, it was to determine what parts of the northeastern rail system were worth keeping, and to recommend how much money was required, both to operate the system in the near future and to revitalize it. Thus, the publicly owned corporation Conrail was formed, from the consolidation of the Penn Central and several other bankrupt companies in the Northeast.

By 1976 it was evident that the railway problem went well beyond the Northeast, thus the Railroad Revitalization and Regulatory Reform Act was passed, aiming at:

providing government subsidies to money-losing branch lines, grants for the rehabilitation of main lines for financially weak companies, and guaranteed loans.

reforming regulative legislation towards deregulation, as already stated.

Great Britain 17

As stated previously, in Great Britain, regulation of charges began with the fixing of maximum rates in the enabling Acts, but gradually became more comprehensive and uniform as a result of the anti-discriminatory Railway and Canal Traffic Act of 1854 and the appointment of a Railway Commission to implement it in 1873. Regulation finally culminated in the years 1888-1893 with the drawing up of a standard freight classification and of the fixing of schedules of maximum charges for each type of traffic. The primary criterion for charging was the value of the goods transported, not the cost of transporting them.

Effective machinery for the supervision of rates and facilities came into being in 1888, when the Railway Commission gave way to the Railway and Canal Commission, with extended powers to deal with complaints and decide whether charges and services were reasonable.

The Railway and Canal Traffic Act of 1894 had the effect of freezing freight charges at the existing levels, for it placed on the companies the onus of justifying any increases before the Commissioners.

As time went on, the railways acquired other obligations of a social-service nature. The Act of 1844 had required the provision of one service a day on each line on which passengers were carried at a fare of a 0.41 p per mile, but this obligation was ended when the Cheap Trains Act of 1883 placed on the companies a general obligation to provide workmen's tickets at reduced rates, in order to encourage workmen to move from congested areas to more salubrious neighbourhoods further from their place of work.

Rate control was only one and perhaps not the most important control of railway autonomy. By the time that road competition became significant in the 1920s, the railways had the following legal requirements, from which their rivals were free:

- to publish their fares and charges,
- to carry all goods under their statutory conditions - often loosely called the 'common carrier obligation',
- to afford 'reasonable facilities',
- to afford facilities for the through conveyance of traffic,
- to show no undue preference,
- to provide facilities for workmen and members of the armed forces at reduced rates,
- to submit statutory regulation of wages and conditions of service,
- to submit accounts and returns in the prescribed form.

During the World War I, railways were centrally run by the Railway Executive Committee, comprising the managers of the ten largest companies. Thus, railwaymen and politicians were convinced that considerable economies of scale were available through further amalgamation. Immediately after the war, as the nationalization of the system had been rejected, the 1921 Railway Act brought into existence four new groupings out of the 120 separate companies.

When railways were faced with road competition in the 1920s, their reaction was largely defensive. Capital was short, since the companies in the inter-war period never managed to earn the 'standard revenue' which the new pricing structure had been expected to achieve, and there was consequently little investment. Changes in the pricing structure under the 1921 Act merely produced still more millions of 'exceptional' rate reductions, to compete with road hauliers.

Responses of the railways to road competition were:

- To buy into road operations. The railways were by far the biggest road hauliers and bus operators by the outbreak of World War II.
- To appeal for their road competitors to be given similar legal obligations. This question was examined by the Royal Commission on Transport, 1928-1930. The result was the Road Traffic Act of 1930, which created a bus licensing system, and the Road and Rail Traffic Act of 1933, which created a goods haulage licensing system. However, both of these acts did little to improve the position of the railways.

During the World War II, the railways, already suffering from net disinvestment in the inter-war period, were strained to the utmost by the war effort. Although they performed extremely well, both financially and in amounts carried, their physical condition was very poor by 1945, and it was clear that large amounts of money needed to be spent on modernisation. The only obvious source of this finance was the State itself. For this

reason, nationalization might have been necessary whatever the Government, but the election of a Labour Government made it certain.

5.2.1.3. State-Owned Railway Enterprises

Under conditions similar to those mentioned above, most countries in the world have arrived to the model of a state-owned railway enterprise. In the case of European countries (both East and West) there is usually one public enterprise operating over the national network. However, in some cases there may be as well small local enterprises, private or public.

This type of state-owned, nationwide railway enterprise will be examined in this thesis. Here belong Greek Railways, but also every other railway enterprise in the European Community. 18

5.2.2. Inherent Disadvantages of State Ownership

As already shown, state ownership is the extreme case of regulation. Assuming that principle reason (or one of the principle) of the state ownership of enterprises is that thus they operate more efficiently respectively to what Nove (1973) calls "*public interest under nationalization*", obviously, unless the term "*public interest*" has some meaning, there really is little point in state ownership of railways. The meaning, if any, surely relates to possible conflict between profitability and some apparently desirable act or omission. Because if the question was purely one of private profitability, any individual or firm could produce railway services and there would be no problem and economic case for state ownership. Therefore, the analysis has to investigate the existence of substantial financial or social externalities stemming from railway operations, and to prove that under these externalities the pursuit of private profitability becomes a misleading criterion. This analysis has to be performed very carefully and honestly, because state ownership is not recommended from the point of business activity. Some of the disadvantages of state ownership, compared to private ownership under commercial criteria, are presented below.

5.2.2.1. Monopolistic Implications on Market

Nove (1973) argues that a public monopoly, if told to operate "commercially", will tend to behave in exactly the same way as a private monopoly. Indeed, it can be argued that it would be worse. The reason is that a private monopoly is generally supervised by some sort of regulating body, to prevent abuse of its position. In some instances, there are imposed statutory duties. If the monopoly is based on legal enactment, it is considered normal to bind it with various conditions. Private monopolies, which are not based on law of franchise, are always conscious of being monopolists on sufferance, since failure to give some minimum satisfaction to customers could lead to the invasion of their "territory" by a competitor.

By contrast, a public "commercial" monopoly is subjected to few constraints. It is told to make money (or, at least, not to lose money), and the state deliberately refrains from interfering with its day-to-day operations. It must therefore be expected to behave as a private unsupervised monopolist would, if in addition he was protected by law from competition. 19

5.2.2.2. Public Managers Have Difficulties in Operating "Commercially"

Sutherland (1978) argues that while the majority of decisions undertaken within the private sector legitimately involve alternatives with clearly specified outcomes (being

matters mainly of precisely defined or even numericalized quantities), many decisions that must be made by public administrators, operating even at the lower levels of the enterprise, involve "value" issues and have distinct policy and sociopolitical implications. Most managers within the private sector -except for those operating at the highest levels- are shielded from such considerations by the "umbrella of certainty" under which they operate. Thus, they may behave as if the system of phenomena with which they deal are effectively deterministic, whereas virtually all problems emerging within the confines of public enterprise may involve elements of uncertainty that are largely "external" to the normal business decision-maker. ²⁰

Because public enterprise so often deals with issues involving the public welfare, the common good, the dignity of human beings, or other such elusive criteria, the public manager must treat the consumer of his product as a "client" per se, with all the ambiguity and ethical responsibility that that entails. On the other hand, the business manager is largely freed from any fiduciary responsibility towards the consumer, and in many cases, the link between the operating manager and the consumer may be a long and indirect one. In short, the business decision-maker more or less legitimately can consider only the welfare of his own firm, whereas the public manager (for admittedly political as well as philosophical reasons) must have a bifold calculus, which involves client as well as organizational welfare. ²¹

5.2.2.3. Antithesis Between Organization and Evaluation

Grubb (1977) states that perhaps the major constraint on evaluation is that programmes are conducted by organizations. Indeed, organization and evaluation may be antithetical. Organizations usually stand for stability, the status quo; evaluation seeks change. Organizations inculcate loyalty and commitment, evaluation is scrutiny and skepticism. Being evaluated, particularly with the prospect that the judgement of the evaluation will be disseminated to a large audience, is a threatening experience. ²³

Pavlidou (1978) argues that the aim of the public enterprise is to control the environment by affecting it in such a way as to make it correspond to the image that the enterprise has internally formulated of this environment. Therefore, serving society is one of the means of controlling it, since service is not readily provided according to the desires or demands of the environment, but according to patterns that are intelligible to the enterprise, i.e., match its internal representation of the environment. To the degree that the desires and demands of the environment are compatible with the patterns of the enterprise, the output responses satisfy these needs and grant the service. To the degree that they are not compatible, needs are not readily satisfied. The reason given for this denial of service is that regulations do not provide for such arrangements, or that such arrangements are not consistent with the functions of the public enterprise, or that they are not for the best interests of the society. In other words, a public enterprise behaves in such a way as to satisfy to the greatest possible extent its conception of the environment. Is thus capable of self-stabilization. ²⁴

5.2.2.4. Absence of Clear Goals to Illustrate Performance

According to McLoughlin (1978), not only must the public manager operate his enterprise to be productive and effective; he must do so in a manner that is politically rational, i.e., in a way that takes into account the political realities. The literature on public administration emphasizes the importance of clear goals. Yet most public programmes are the results of unstable conditions that come together as the result of a political understanding, often one achieved at the expense of raising the goals to a high enough level of abstraction, that all parties can agree. The net result is vague goals and a programme that might lose its support if the manager tried to get all parties to agree

on concrete, operational goals. Thus, public managers may have to be prepared to live with vague goals and the potential for lost efficiency that they imply. ²⁵

De Neufville and Stafford (1971) argue that since total social welfare is almost certainly not a simple sum of the utilities of individuals, and since, unfortunately, an optimal distribution of society's output cannot be defined on any theoretical grounds, but rather on ethical or moral grounds, the overall determination of what kind of objective function is appropriate for society and for a public system must therefore always remain somewhat vague. ²⁶

5.2.2.5. Influence of Political Considerations

The Chicago School of Economics which has provided the theoretical basis of neo-liberalism, presents a theory of regulation according to which economic efficiency is not the primary task of the regulator and, consequently, a valid theory of regulation has to go beyond the theory of public interest. ^{27 28 29}

According to Stigler (1971), there is a market for regulation through the political process, and for those ready to pay for it, the political system is ready to supply it. Stigler noted, for example, that the suppliers of goods and services should have an incentive to purchase regulation, because regulation can be used to block entry and raise prices, and hence profits and factors payments. Given these considerations, it is little wonder that regulators generally failed to pursue public interest goals such as overall economic efficiency.

Extending the work of Stigler and Posner, Peltzman (1976) presented a general, formalized theory of regulation, according to which the regulator maximizes a political support function, for which prices and service levels for different services and users are arguments. According to Peltzman, a dollar's worth of subsidy money directed to any user or factor should generate the same amount of political support on the margin. ³⁰

Besides the fact that railways need a regulated environment (as shown in section 5.2.1), one has to admit the influence of political considerations as regards decisions concerning public enterprises.

5.3. THE OBJECTIVES OF THE RAILWAY ENTERPRISE

Gray (1984) summarizes in the following list government's non-commercial objectives in establishing and maintaining public enterprises. ³¹

a. Economic stabilization

- (1) Control of inflation;
- (2) Food security; and
- (3) Dampening economic downturns, with special reference to surges in unemployment.

b. Economic growth

- (1) Expanding absolute levels of investment, output, exports, income, and employment; and
- (2) Accelerating industrialization.

c. Income redistribution

- (1) Promotion of small-scale producers through credit;
- (2) Other approaches to vertical redistribution of income; and
- (3) Geographical redistribution (promoting regional equity).

d. Localization/Indigenization

- (1) Supply sources;
- (2) Asset ownership and control;
- (3) Jobs; and
- (4) National policymaking.

e. Miscellaneous objectives.

This thesis will not examine whether the objectives mentioned (in their totality, or some of them) are facilitated by the existence and operation of public enterprises, because this problem relates to wider sociopolitical issues and is tackled, in each case, according to these issues. On the contrary, what should be mentioned is that every government, as far as it doesn't decide to privatise a public enterprise, will use it in order to pursue a set of these non-commercial objectives.

It should, therefore, be expected that the formulation of the objectives of a state-owned railway enterprise would refer to its two principle characteristics:

To its nature as a state-owned enterprise, i.e., instrument in government's hands for the pursuit of non-commercial objectives.

To its nature as a public interest enterprise, aiming at producing railway services and offering them to the public under the optimum combination of quality and price characteristics.

Unfortunately, literature on public enterprises doubts strongly the feasibility of definition of such objectives via an explicit governmental formulation. According to Bryatt (1984), overall control of nationalised industries is concerned with three main objectives:

- (1) Ensuring that nationalised industries conform to macro-economic policy objectives; in particular that they do not pre-empt too much of the nation's savings and investment.
- (2) Ensuring that nationalised industries contribute to the efficient allocation of resources; in particular that their pricing policies are properly related to their costs and that they earn an adequate return on investment.
- (3) Ensuring that nationalised industries are internally efficient, and provide adequate services while keeping their costs low.

These objectives are obviously linked. What constitutes the "correct" allocation of investment resources to nationalised industries depends on the return achieved, which in turn depends on prices and costs. In principle it is possible to have a set of instruments which can be used to pursue these objectives in a coherent and consistent way. But, in practice, differing emphasis has been placed on the macro-economic, resource allocation and internal efficiency objectives at different periods of time. 32

Thus, due to the governmental vagueness in formulating objectives for the railway enterprise, the enterprise itself constructs a set of objectives to pursue.

Duval (1982) states that the two principle objectives of French Railways (SNCF) are: ³³

to offer the best service to national, regional and local communities, to improve the conditions of work, and to progress the human quality of those who constitute the enterprise;

to have strict and challenging management on commercial basis.

Hausler (1982) notes, referring to German Federal Railway (DB), that the statutory directive *"DB is responsible for managing its elements as a commercial undertaking, with the aim of the best transport service according to business principles in such a way, that the proceeds cover the expenditure including the necessary replacements"* led to the formulation of the following company objective:

Effective safeguarding of the future of the DB as a transport undertaking:

by limitation of the federal contributions to a proportion justifiable from the aspect of the whole national economy; and

by stabilization and improvement of the financial results. ³⁴

Lapsley (1983) argues that BR's wider statutory obligation, *"to provide railway services ... and to have due regard ... to efficiency, economy and safety of operation"* (Section 3, Transport Act, 1962), is virtually a verbatim repeat of that contained in the 1947 Act. Beyond this, BR has lacked an explicit statement from government on its non-financial objectives, which can readily be translated into measurable variables, to facilitate the assessment of its non-financial performance. ³⁵

Finally, Holtgreffe (1982), recording the experience of the Dutch Railway (NS), states that phrases on company objectives are generally expressed in vague terms. The intentions to strive to continuity, to optimally use limited government funds, to offer the customers a fair level of service and to perform an adequate social function, cannot be tested by the company's annual results. Clear and measurable objectives are necessary. ³⁶

The examples above are compatible to McLoughlin's (1978) argument on absence of clear objectives in a public enterprise. Therefore, is there a contradiction between railway reality and the, according to Morasky (1977), need to formulate clear objectives ?

*"... If we assume that some social systems are created by man for specific reasons or purposes, then it follows that planning and creating those social systems implies a measure of control. Evaluation and control exist in superordinate-subordinate relationships which are facilitated by goals... In the absence of goals, evaluation criteria and, therefore, control depend on value structures which, in turn, are often idiosyncratic, subject to thresholds and unpredictably dynamic in nature".*³⁷

Goals are manifest statements describing the specific state a receiving system should obtain by a specified time. Goals facilitate two functions of organizations or systems: evaluation of programme effectiveness relative to receiving systems and control over system behaviour. In order to provide such facilitation, goals must exhibit four characteristics. Goals must:

- (1) be manifest statements;
- (2) be specific enough to permit objective interpretation;
- (3) focus on the receiving system; and
- (4) specify a time dimension.

Each characteristic is necessary for the existence of a goal. Statement purporting to describe system direction which do not exhibit all four characteristics should be viewed as directional statements with limited function. A system operating with such statements should be viewed as moving towards some target(s). Evaluation and control of target-oriented systems should be viewed as based on implicit value structures, not on goals (Morasky, 1977).

A comparison between the above, according to Morasky definition of goals (or objectives) and the state requirements from a public railway enterprise indicates that, in reality, objectives or goals of this kind do not exist. These characteristics of objectives, however useful in the context of a conceptual framework, are more a reference for analytical purposes than necessary conditions to define a system. In fact for a given system, the problem might be to elucidate the underlying operational objectives.

When studying systems (and a railway enterprise is a complex social system), a distinction is made between system objectives and purposes³⁸. While objectives are formally defined tasks that the system should accomplish, the subjective interpretation of these objectives defines the purposes of the system. The nature of the system is a consequence of objectives; however, its boundaries are a function of the specific purposes that individuals, e.g. policy-makers or analysts, may ascribe to that system. Thus, according to Pierick (1982), *"the operational position as regards the production of the railways has not changed in the 150 years of its existence and even today can still be described by the following target function: the transport offer, within the limits of a marketable price, must be adjusted to the demand in such a way, that as few as possible of the wishes of the market remain unfulfilled"*.³⁹

It follows from the continual change, that this problem cannot be solved once; it has to be solved every time, continuously. Thus, the fulfillment of the above mentioned target function becomes a problem of adjustment.

5.4. THE EXTERNAL CONTROL OVER THE RAILWAY ENTERPRISE

To the degree that railway literature doubts the feasibility of existence of explicit and quantified goals or objectives for the railway enterprise, there should some other means, governing the resource bargain between the state-owner and the railway enterprise.

5.4.1. Financial Criteria

Financial control is the most widespread of the above mentioned means. According to Heald (1980), there has been a proliferation of systems of financial control over public enterprises without regard to the interrelationship between these systems and the pricing and investment rules. Examining five of these parameters, elements of a state system for the control of public enterprises, i.e., financial targets, self-financing, cash limits, accounting policies and capital structure, he argues: ⁴⁰

- (1) **Financial targets** have been much less popular with economists than with politicians, civil servants or the nationalised industries themselves, for the following reasons:

Financial targets themselves provide no guarantee of allocative efficiency, which, indeed, they may obstruct.

Financial targets may distort investment decisions.

Public enterprises view financial targets first and foremost as pricing criteria.

The usual responses of public enterprises to failures to meet the financial targets have been applications for price increases.

- (2) As regards **self-financing**, a target rate of self-financing might encourage the adoption of relatively unprofitable projects, whereas the profits could be more productively invested elsewhere. On the other hand, a deliberately higher level of self-financing than would emerge from allocatively efficient pricing and investment policies is the equivalent of an indirect tax on consumers of the good. When the purpose is to finance investment, this means that today's consumers are subsidising future consumers. This raises issues of intergenerational equity.
- (3) When a **cash limit** system is introduced to reinforce the existing system of public expenditure control, a cash limit is set for each nationalised industry's external financing requirements from all sources (i.e., loans, public dividend capital, and grants) for the current financial year. The rigid application of the cash limit system, under which any increase in the cash limit requires Ministerial agreement and an announcement to Parliament, has shortened the time-horizon of financial control over nationalised industries. It has raised the 'political' costs for the industries of external finance.
- (4) Besides the way in which net assets employed may be reduced by accounting policies which do not capitalise interest on plant under construction or adopt too short lives for depreciation purposes, significant is the issue of supplementary depreciation. Sometimes it is urged that supplementary depreciation should be charged to cover the divergence between replacement and historic cost, and premature obsolescence. However, when large price increases send the nationalised industries into profitability, it is difficult to resist the view that the major purpose of charging supplementary depreciation is to reduce the reported profit, both to avoid criticism of 'large' profits and to justify applications for price increases.
- (5) Unlikely privately-owned firms, nationalised industries are predominantly debt-financed. This has a number of important implications. First, as interest payments on debt capital are deductible from taxable profits, the corporation tax liabilities of nationalised industries have been negligible. Second, interest must be paid every year, regardless of trading performance. This contrasts with the position of equity-financed private firms which may reduce dividend payments in years of comparatively low profitability. Especially in a nationalised industry markedly influenced by the economic cycle, the financial structure will exacerbate fluctuations in reported profits.

The importance of financial criteria as key indicators which influence railway policy has been examined by Lapsley (1983).

He establishes this importance by reference to significant landmarks in the corporate existence of British Rail ⁴¹. He tackles the criticism directed to the most recent document on UK railway policy, the Serpell Report (1983) ⁴², on the grounds that financial criteria were paramount and, consequently, that they were too narrow to provide an effective basis for making decisions regarding the future of BR. This concern arises from the viewpoint that such criteria ignore the existence of considerable social benefits which stem from the continued operation of BR, in its present form.

Indeed, there is evidence which suggests that social costs (of noise, of inflicting serious injury and loss of life, and of using excessive quantities of scarce energy resources) of railway operations are slight. It is also arguable (although not uncontested) that the existence of the rail network is a major social benefit, which maintains transport links with outlying regions of the economy, reduces congestion on roads, provides employment opportunities, and represents a strategic investment which preserves society's choice of transport modes for present, and future, generations.

However, Lapsley (1983) argues that much of the hostile reaction to Serpell is misguided, for two reasons:

- (1) As he shows, throughout the life of British Rail, governments of different political complexions might have made political statements to the contrary, but they all responded to financial or accounting information as a key indicator in initiating policy changes. Therefore, much of the criticism of the Serpell Report by politicians is unfounded.
- (2) He shows, that the reason for this reliance on accounting or financial criteria (regardless of the political party in power) is basically one of default. Thus, financial objectives (and results) have retained this key role because of both government inaction on radical transport policies and intractable measurement problems in the development of information of more relevance to the formulation and execution of railway policy.

Given these circumstances, the remedy to redress the balance in the means by which railway policies implemented, might, according to Lapsley, appear to be self-evident. Thus, if policy-makers paid similar attention to the wider aims of transport policy as they do to financial aims, it might be argued that this issue would be satisfactorily resolved.

5.4.2. Non-Financial Criteria

Lapsley (1983) concludes that there are numerous reasons for reliance on financial measures. Thus, while financial measures do not reflect the social benefits of the railway, they have other attributes which might be expected to promote their use. i.e., they are readily available, easily verifiable, and widely used in both the private and the public sectors of the economy. The most evident means of improving financial measures would be a cost-benefit analysis of railway's operations. However, to date, the technique of cost-benefit analysis has been confined to project appraisal. The extrapolation of such techniques to the measurement of the social benefits of an entire industry, such as the railways, presents formidable difficulties.

Given such difficulties and given the necessity of subsidising railways, pressures arise to regulate the subsidy by the use of non-financial indicators of productive efficiency. Productive efficiency has been broadly defined as the minimal use of physical inputs to achieve a given level of production or service. Therefore, this concept has an apparent direct relevance to the problem of ensuring efficiency in, and providing

management objectives for, subsidised railway services. A wider interest in the concept has arisen because of serious doubts expressed in the literature over a fundamental assumption of economic theory, i.e., that firms organise themselves as efficiently as possible, such that their costs are minimised. A critical influence on the challenging of this assumption has been that of Leibenstein (1966). He argued that many firms do not operate at, or near, their production possibility frontier, but at some lower level of output. He attributed this to absence of pressures to be efficient. Leibenstein focused primarily on the use of (and not the prices paid for) production inputs and the pressures (internal and external) on management to organise efficiently. He designated the avoidance of such waste as '*X-efficiency*'. 43

Lapsley (1984) argues that such ideas have gained support in the literature and as a part of government policy towards the state industries. However, reservations can be expressed, over:

- (1) its applicability to railways;
- (2) the quality of empirical evidence in support of X-efficiency; and
- (3) whether it is possible to construct an operational measure of X-efficiency for railway operations 44.

Productive efficiency of a railway, though it is practically not feasible to be calculated by means of an algorithm, may be estimated by the use of partial indicators, referring either to the inputs or to the outputs of railway operations.

Table 2, as provided by Lapsley (1984), shows the performance indicators published by BR, in line with Government recommendations.

These indicators reflect both inputs (labour and capital) and outputs ('quality of service'). As regards labour inputs, Lapsley (1984) argues that indicators (15), (16), (19) and (20) are so crude as measures of labour inputs required for a given level of service, that their use by a regulatory authority would be likely to result in the employment of arbitrary standards. Furthermore, as a consequence of specifying what constitutes an efficient use of labour, the regulatory authority is drawn into the details of operational management. This would represent a radical change of emphasis in existing formal relationships between railways and governments. However, if this change of emphasis were pursued, the degree of detail and direction required in decisions on the best use of labour would be such, that there would be a virtual takeover of management's function by the regulatory authority. This outcome would also apply to capital inputs, as discussed below.

As regards capital inputs, the non-financial indicators in Table 2 highlight the load factor [(12) and (18)] and the use of the rail network (21). These are of crucial importance in determining the efficiency of a railway. However, Lapsley argues, the improved regulation of the railways cannot be achieved by simply linking a financial objective to specified levels of load factors and/or the use of rail network in a fashion which eliminates productive inefficiencies. The major difficulty in such an exercise is the specification of 'acceptable levels' of efficiency of capital inputs, as expressed by non-financial indicators (12), (18), and (21). There are several ways in which such 'acceptable levels' of efficiency might be determined:

- (a) Railway management might specify its view on attainable levels for these indicators;

F i n a n c i a l I n d i c a t o r s	P a s s e n g e r	<p>(1). Average fare per passenger mile.</p> <p>(2). PSO 'contract' payment per passenger mile.</p> <p>(3). PSO 'contract payments as a percentage of GDP at factor cost.</p> <p>(4). Passenger business direct costs per loaded passenger train mile.</p> <p>(5). Revenue per #1 000 of paybill costs (rail and rail workshops).</p>
	F r e i g h t	<p>(6). Freight revenue per wagon.</p> <p>(7). Train running and terminal costs per loaded train-mile.</p> <p>(8). Revenue per #1 000 of paybill costs (rail and rail workshops).</p>
	P e W r a m. y	<p>(9). Track maintenance costs per track mile.</p> <p>(10). Signalling renewal and maintenance costs per track mile.</p> <p>(11). Total administration costs per loaded train mile.</p>
N o n f i n a n c i a l I n d i c a t o r s	P a s s e n g e r	<p>(12). Passenger miles per loaded passenger train mile.</p> <p>(13). Passenger trains arriving on time, or less than 5 mins late (% of total passenger trains).</p> <p>(14). Passenger trains cancelled as a percentage of current timetable services.</p> <p>(15). Loaded train miles per train crew member (i.e., freight and passenger).</p> <p>(16). Passenger miles per member of staff employed (rail and rail workshops).</p>
	F r e i g h t	<p>(17). Average wagon load (all traffic, including Freightliner and NCL).</p> <p>(18). Net tonne-miles per loaded freight train-mile.</p> <p>(19). Loaded train-miles per train crew member (i.e., freight and passenger).</p> <p>(20). Net tonne-miles per member of staff employed (rail and rail workshops).</p>
	P.W.	<p>(21). Loaded train miles per route mile.</p>

Table 2: BR Performance Indicators

- (b) Reference might be made to comparable ratios for other railways; and
- (c) Existing indicators might be supplemented with additional information on railway operations.

Lapsley argues that none of these ways is without its defects.

Table 3 provides output indicators advocated by Baumol (1975) ⁴⁵ for Amtrak in the USA ⁴⁶. In this framework, quality of service has two components: passenger comfort and the timeliness of services provided. Two factors in this table require further explanation:

Marginal incentive 'bonuses' refers to 'bonus' subsidy payments of fixed amounts for every percentage point by which a given railroad exceeds its 'base standard' of timeliness. This base standard is a specified percentage of trains which arrive on time.

The **'excess delay parameter'** refers to an allowance for delays in journey times. Specifically, a train is defined to have arrived at its final destination on schedule, if it has fallen behind no more than five minutes for every hundred miles it has travelled, with a maximum tolerance of 30 minutes, no matter what distance it has covered.

There are two criticisms which might be made against the usefulness of the Amtrak 'quality of service' indicators. In the first place, a major reservation expressed regarding the partial measures of productive efficiency discussed in the previous part, also applies to these indicators. Specifically, the setting of standards always carries the potential cost of built-in organisational slack. Therefore, criticism is relevant to:

- (1) establishing a base standard for timeliness;
- (2) the 'excess delay' tolerance parameter;
- (3) scheduled trip times and R , the rate for the train; and
- (4) the level of fleet required to meet peaks in demand.

Lapsley argues that indeed, US railroads regulated by this scheme have built-in organisational slack. Thus, an investigation revealed that no railroads responded to the 'schedule improvement' incentive and that incentives were predominantly paid for schedule adherence ⁴⁷. This report found that railroads modified schedules to make them easier to observe. Thus, as punctuality was only measured in terms of final destination, railroads inserted 'slack' in the schedules approaching that destination, such that trains could arrive 'on time'. Indeed, Amtrak's average speed fell from 51.5 mph in 1971 to just over 45 mph in 1977.

A second, potentially more important, matter is the extent to which such indicators can meaningfully be used as a basis of subsidy payment. This is particularly because of the extent to which such subsidy payment is contingent upon factors beyond the control of railway management. This varies from the frequency with which trains are cleaned, which is controllable, to the effects of adverse weather conditions. A further aspect of this issue of the degree of influence which management can exert is the state of equipment used. This could significantly influence both the degree of passenger comfort and the timeliness of services provided. Therefore, the size of subsidy might depend upon the 'quality of service' but the 'quality of service' depends upon the size of the subsidy. Indeed, this type of interdependence is highly likely to arise where the subsidy received for such services is a major source of their finance.

Quality of Service	Indicator	Basis of Subsidy Payment or Deduction
Passenger comfort	1. Carriage cleanliness	The cost of cleaning a carriage.
	2. Equipment operability	Required attributes: (i). One carriage for a complete journey without breakdown. (ii). Temperature t within range: <div>$\begin{matrix} & 0 & & 0 \\ 62 & > & t & > & 82 \\ & = & & = & \end{matrix}$</div> (iii). Sufficient light for reading.
Timeliness of services provided	1. Schedule adherence	(i). Base standard for timeliness. (ii). Marginal incentive 'bonuses'
	2. Excessive delay	(Actual time of trip - scheduled time - 'excess delay' tolerance parameter).
	3. Schedule improvement	$= T \times \frac{M}{Sch.T} \times R, \text{ where:}$ T = no. of trips for train whose schedule is improved. M = no. of minutes eliminated from schedule. Sch.T = scheduled trip time in mins. R = rate for the train (as specified for given routes).
	4. Equipment availability	A target for the number of spare locomotives and carriages required to maintain scheduled services.

Table 3: Amtrak 'Quality of Service' Indicators

Concluding, there is potential for the use of a regulating policy by the use of non-financial indicators derived from notions of productive efficiency. However, it must be stressed that a policy of making subsidy payments contingent upon specified levels of non-financial indicators would entail a radical change in the relationship of railway to its regulatory authority. Thus, if this policy is to be effective, the regulators will become deeply involved in the details of operational management. Paradoxically, this course of action might serve to further undermine the very financial criteria which are the source of difficulty, as it would then become increasingly difficult to isolate the effects of managerial and regulatory influences on reported financial results. 48

5.4.3. Abandonement of Criteria ?

Davies and McInnes (1982) argue, that since there is no danger for bankruptcy or takeover for any of the nationalised industries and as many of them operate in monopoly or near monopoly situations alternative mechanisms must be developed to control their activities and to make them accountable for their performance. Assessing the present framework of controls, they conclude that it does not provide a satisfactory foundation for a rigorous system of accountability. For those industries in monopoly or near monopoly situations they recommend that financial targets and the measurement of income be abandoned. To achieve an improvement in accountability and control they propose consideration to be given to the publication of cash flow information and to the extension of the audit function. Information would of course still be required about each industry's economic resources and obligations at the end of the financial year, to give an indication of the ability of the industry to continue to provide services 49.

Discussing the case of non-financial criteria they state: *"It appears that little thought has been given to the possible conflicts that can arise between performance measured by various indicators and a broad concept of social interest. For example, it might be more desirable to operate a railway line with unreliable rolling stock that is subject to delays than close the line altogether, even though this is likely to lead to deterioration of measured performance in terms of the numbers of trains arriving on time"*.

5.5. SYNOPSIS

Three major themes concerning railway enterprises and related to management control are:

- (1) the ownership of the railway enterprise;
- (2) the objectives of the railway enterprise; and
- (3) the external control over the railway enterprise.

Public ownership of railways, discussed in this thesis, is the extreme case of state regulation. However, some kind of regulated environment is required by the railways, due to the very characteristics of the industry.

There are inherent disadvantages under state ownership related to:

- (1). monopolistic implications on market;
- (2). inability of public managers to operate "commercially";
- (3). the antithesis between evaluation and organization;
- (4). the absence of clear goals to illustrate performance; and
- (5). the influence of political considerations.

The state-owner does not provide the railway enterprise with a set of clear objectives. Therefore, the enterprise seeks by itself its objectives, trying to adapt to the demand in such a way, that as few as possible of the wishes of the market remain unfulfilled. Thus, the realisation of this target becomes a problem of continuous adjustment.

State exercises its control over the railways by means of financial criteria of performance. Literature doubts the rationality of such criteria.

Non-financial criteria have been proposed, as a solution to the evaluation of the social benefit of railway operations. It has been argued that this kind of criteria

- (1) are inadequate, and
- (2) might lead to reverse results.

The set of characteristics discussed in this chapter will be considered:

- (1) in designing a framework for railway management control, and
- (2) in designing the case-study, both in its descriptive and survey form.

5.6. FOOTNOTES

1. *"...Only the total conception of the railway as a comprehensive system, in which all sub-systems and elements are mutually dependent, brings with it the possibility of wanting to explore these dependences in their conformity with a natural law and to bring them together to a systematic regulation in Norbert Wiener's sense".* (K.Pierick, 1982: "Electroning Data Processing Models for the Support of the Production of Modern Railway Undertakings", *Rail International*, May, pp.75-78).
2. *"...I have found a profound belief in Norbert-Wiener-like cybernetics in more than one railway executive".* (D.Wyckoff, 1976: *Railroad Management*, Lexington Books, Lexington, Massachusetts, page 7).
3. A.Nove, 1973: *Efficiency Criteria for Nationalised Industries* (Allen and Unwin, London).
4. According to Short (1984), the main factors which contributed in the development of substantial public enterprise sectors in a large number of countries are:

First, socialist policies have been of some significance in several countries and the dominant factor in a few, for example Burma and Tanzania. In this group of countries, government intervention in public enterprise operations is often particularly great, especially in pursuit of non-commercial objectives.

Second, historical and other political factors have resulted in substantial extensions in public ownership. Many public enterprises were established as a result of the political upheavals of World War II as, for example, in France and Korea. Others were set up following the financial collapse of large private companies, as, for example, in Argentina and the United Kingdom, or were established to reduce foreign ownership of industry, especially of former colonial powers, as, for example, in Egypt and Indonesia. In principle, these enterprises could eventually have been sold to the private sector. However, in practice, there have been few instances of public enterprises being returned to private ownership, at least not on a large

scale, with the exception of the denationalization program in Chile in mid-1970s (which followed the abolition of Allende's government by the military dictatorship) and the privatisation program of the present British government.

Third, the pursuit of economic objectives has been a major reason for the establishment of public enterprises. Probably the most fundamental, and certainly the most widespread, objective in this respect has been the promotion of allocative efficiency. Certain industries where economies of scale or externalities are important are almost universally operated by public enterprises, because of the failure of private markets to satisfy the conditions for an optimum allocation of resources.

(R.P.Short, 1984: "The Role of Public Enterprises: An International Statistical Comparison", in R.H.Floyd, C.S.Gray, and R.P.Short, 1984: *Public Enterprise in Mixed Economies: Some Macroeconomic Aspects* (International Monetary Fund, Washington, D.C.), pp.110-196.

5. The Railway Revitalization and Regulatory Reform (4R) Act of 1976 and, mainly, the Staggers Rail Act of 1980, which provided the legislation for the deregulation of the US Rail Industry are discussed by T.E.Keeler (1983, *Railroads, Freight and Public Policy*, The Brookings Institution, Washington, D.C.).
6. R.G.Harris and C.Grimm, 1985: "Revitalisation of the US Freight Industry: an Organisational Perspective", in K.J.Button and D.E.Pitfield (eds.): *International Railway Economics: Studies in Management and Efficiency* (Gower, Aldershot), pp.49-84.
7. T.E.Keeler, 1983: *Railroads, Freight, and Public Policy* (The Brookings Institution, Washington, D.C.): Chapter Five: Regulatory Reform and Its Consequences.
8. W.J.Baumol and J.C.Panzar, 1982: *Contestable Markets and the Theory of Industry Structure* (Harcourt Brace Jovanovich, New York).
9. T.E.Keeler, 1983: page 48.
10. D.D.Wyckoff, 1973 : "Public Tracks, Private Users", *Transportation and Distribution Management*, April, pp.38-40.
11. This proposition refers to the specific US case, where there operate 68 Class I plus several hundred smaller railway companies (D.D.Wyckoff, 1976: *Railroad Management*, Lexington Books, Lexington, Massachusetts, page 20. The number is much smaller now, because of continuing bankruptcies and mergers taking place). Though this proposition has been expressed as an alternative to the otherwise unavoidable nationalisation of the US rail industry it has a theoretical value, especially when considering development under the 'liberal' paradigm.
12. D.D.Wyckoff; 1976: pages 132-133.
13. Association of American Railroads, 1974: "Government Ownership of Railroad Fixed Plant", Working Memorandum, 74-10, October 22, pp.4-6.
14. For example, in Canada operate mainly two companies: the privately- owned Canadian Pacific (CP), introduced in 1885, and the state-owned Canadian National (CN), formed in 1923, when the government took over and consolidated the operations of several failing railway companies. In Australia operate seven public or private railway enterprises, etc.

15. T.E.Keeler, 1983: Chapter Two: A Capsule History of Railroad Regulation (pages 19-42).
16. As provided by T.E.Keeler, 1983.
17. As provided by A.W.J.Thomson and L.C.Hunter, 1973: *The Nationalized Transport Industries* (Heinemann, London), pages 125-130.
18. All railway enterprises in the European Community are state-owned. However, the details of state-ownership vary, from fully state-owned (Great Britain-BR, Denmark-DSB, Portugal-CP), to autonomous, non-incorporated state properties (Federal Republic of Germany-DB), independent state-owned companies (Italy-FS, Greece-OSE-CH, Netherlands-NS, Belgium-SNCB, Spain-RENFE, Ireland-IE), and mixed companies where the State holds the majority of shares (France-SNCF).
19. A.Nove, 1973: page 19.
20. J.W.Sutherland, 1978: "Accountability in Public Enterprise", in J.W.Sutherland (ed.): *Management Handbook for Public Administrators* (Van Nostrand Reinhold, New York), pp.689-719.
21. Heald (1980: "The Economic and Financial Control of UK Nationalized Industries", *The Economic Journal*, Vol.90, June, pp.243-265) questions the assumption implicit in most of public enterprise literature, that the public managers are social welfare maximisers, i.e., that they are presumed to act altruistically, in the sense that their utility depends solely on, and increases with, social welfare. He argues, that in devising a state control system over the public enterprises, it is important to consider what the objectives of the public managers actually are. Since the control system must give appropriate incentives to efficiency at the enterprise level, the Gravelle and Katz (1976) ²² reformulation of the previous assumption has to be adopted, i.e., that the public managers are "semi-altruistic", in the sense that their utility depends upon both social welfare and (inversely) upon the amount of effort they devote to the enterprise. Thus, they may fail to minimise the costs of the public enterprise or tho choose wrong output level, adding to the debate on the desirability of financial targets in assessing the performance of public enterprises.
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24. M.Pavlidou, 1978: "Dynamic Control of Hierarchic Public Systems", in G.Klir (ed.): *Applied General Systems Research: Recent Developments and Trends* (Plenum Press, New York), pp.811-819.
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27. G.J.Stigler, 1971: "The Theory of Economic Regulation", *Bell Journal of Economics*, Vol.2, Spring, pp.3-21.

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30. S.Peltzman, 1976: "Towards a More General Theory of Regulation", *The Journal of Law and Economics*, Vol.19, No.2, August, pp.211-240.
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32. I.C.R.Bryatt, 1984: "The Framework of Government Control", in J.G.Smith (ed.): *Strategic Planning in Nationalised Industries* (Macmillan Press, London), pp.67-87.
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39. K.Pierick, 1982.
40. D.A.Heald, 1980: "The Economic and Financial Control of the UK Nationalized Industries", *The Economic Journal*, vol.90, June, pp.243-265.
41. I.Lapsley, 1983: "The Influence of Financial Measures on UK Railway Policy", *Journal of Public Policy*, vol.3, no.3, pp.285-300.
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CHAPTER 6

RAILWAY MANAGEMENT CONTROL

6.1. INTRODUCTION

Railway enterprises are complex social systems. Management control in such enterprises has to be conceived under a cybernetic model, since, in any case, neither top management nor intermediate managerial levels have the ability to possess detailed knowledge of complex operations performed over an extended geographical area.

This chapter attempts to outline the characteristics of a cybernetic model for the management control in railway enterprises. The following issues are, in turn, discussed:

- (1) the analysis of railway activities;
- (2) the planning process in the railway enterprise; and
- (3) the organizational structure of the railway enterprise.

The framework resulting from this analysis will be used in the remainder of the thesis as a basis for the examination and diagnosis of a real-life situation, i.e., that of the Greek Railways.

6.2. ANALYSIS OF RAILWAY ACTIVITIES

A railway enterprise may be conceived in Beer's terms as a viable system embedded in a wider system, i.e., the national transport system, and consisting, in turn, of viable systems, doing what the enterprise is supposed to do. Four principle systems ONE may be identified within any railway enterprise:

6.2.1. System ONE: Operations

The Operations System (sometimes referred to as the Transportation System) contains all the activities directly concerned with the transportation of people and goods between points of the railway network. Two distinct sub-systems may be identified within System ONE Operations: train operations and terminal operations.

Sub-system Train Operations consists of movements of trains, engaged in transporting the traffic between origins and destinations. The following distinct activities may be distinguished within this sub-system:

Train Preparation, i.e., train composition, cleaning, servicing, inspection and fuelling (for non-electric trains). All these activities are standard, repetitive day-to-day activities and take place in railway depots, except for the composition of freight trains, which may take place in marshalling yards.

Train Driving. Technology-in-use requires the existence of a person responsible for directing the train during all its movements. The degree of discretion allowed to the train driver varies between networks, depending on the degree of development of communication systems, traffic control systems and train automation.

Train Crewing. Certain duties on a moving train have to be performed by personnel other than the train driver. These include ticket inspection (sometimes and ticket issuing), train guarding, passenger information, etc. The number of the crew of a train varies with the type of train and the technology in use, and may consist of train guards, conductors, sleeping car attendants, and catering services personnel. The crew of a train reports to the train inspector.

Sub-system Terminal Operations, includes the following operations associated with the functioning of a railway:

Traffic Controlling: Usually a railway line is either double (one track for each direction of movement) or single. In both cases there is a need to control movements of trains over the line, since various types of trains are simultaneously travelling, hence there is a need for overtakings etc., either prescribed in the schedule, or resulting from delays, emergencies etc. The job of traffic controlling has traditionally been that of the stationmasters. Gradually, due to innovations in communications and control systems, the concept of central traffic control (CTC) has developed and been implemented in the form of operations rooms, having control over an extended part of the line, minimising thus the need for traffic to be controlled by local stationmasters. Nevertheless, in most railways, CTC has been introduced only to main lines. Thus, in a number of cases, stationmasters still have the duty of traffic controlling.

Clerical Operations: Include a number of terminal operations concerning booking and consigning, inspection and collection of tickets, sheeting and securing, freight parcels charging and documentation and public information.

Loading/Unloading: Concerns all operations by means of which freight/parcels are loaded and unloaded to the trains. Apparently, the complexity and sophistication of this sub-system is a function of the type and quantity of freight transported and the technological innovation adopted. Thus, within this sub-system may be identified automated parcel sorting systems, container depots, etc.

Marshalling and Shunting: This sub-system is concerned with classification or re-classification of wagons into freight trains or with the classifications of passenger trains at the origin depot.

6.2.2. System ONE: Traction and Rolling Stock

Trains consist of locomotives and passenger coaches or freight wagons. Due to the strict safety regime in railway operations, railway equipment is inspected/examined in predetermined intervals. Usually, inspection and light repairs take place at the depots. General repairs, damages, etc. are the duty of railway workshops. Therefore, two main sub-systems may be identified within System ONE Traction and Rolling Stock: **Rolling Stock Maintenance and Rolling Stock Repair.** The distinction of duties between these two

Type of Rolling Stock	kind of inspection or repair	frequency	duration of repair/maintenance	location	responsible department
locos ¹	safety control	every 48 hours	6-8 hours	loco's station	Operations
	preventive maintenance	every four weeks	two days	workshop	Rolling Stock
	A.B.	every 10 000 miles	two days	workshop	Rolling Stock
	C	every 3rd A.B.	two days	workshop	Rolling Stock
	E	every 6th A.B.	two days	workshop	Rolling Stock
	F	every 120 000 miles	three days	workshop	Rolling Stock
	H	every 360 000 miles	three days	workshop	Rolling Stock
	K	every 600 000 miles		workshop	Rolling Stock
	L	every 1 200 000 miles		workshop	Rolling Stock
coaches ²	cleaning	every day	1-2 hours	depot	Operations
	A.B.	every 48 hours	4-6 hours	depot	Operations
	C	every month	one day	depot	Operations
	D	every six months	1-2 days	depot	Operations
	E	every two years		workshop	Rolling Stock
	J	every 120 000 miles		workshop	Rolling Stock
	General Repair	every thirty months		workshop	Rolling Stock
wagons ³	D	every six months	1-2 days	depot	Operations
	General Repair	every six years		workshop	Rolling Stock

1: Locomotives type GM 01.

2: Coaches type Mk III.

3: Wagons bogie flat type.

Table 4: Rolling Stock Periodic Maintenance/Repair.

sub-systems is not always very clear. *Table 4* provides a way in which this distinction has been implemented in the case of Irish Railways (IE) ¹. Three types of rolling stock are shown (01 General Motors locomotives, Mk III BREL passenger coaches, and bogie flat freight wagons), though the same procedure applies to the whole fleet.

The way of dealing with the complexity of the System ONE Traction and Rolling Stock defines, to a large extent, the successful operation of a railway. Thus, inevitably, day-to-day routine rolling stock duties and light repairs have to be seen as belonging to the System ONE Operations. The duty of System ONE Rolling Stock is to receive, at predetermined intervals, rolling stock from Operations for periodical maintenance/repair and to return this rolling stock to Operations at predetermined times. In *Table 4*, the last column illustrates this distinction.

Concluding, Two main sub-systems may be identified within System ONE Traction and Rolling Stock:

Sub-system Rolling Stock Maintenance, containing frequent periodic maintenance and light repair duties, taking place at depots and locos' stations. This sub-system may be further broken down into:

Locomotives Maintenance,

Coaches Maintenance, and

Wagons Maintenance.

Sub-system Rolling Stock Repair, concerned with heavy repairs, refurbishment, and damage recoveries, taking place at depots, similarly broken down to:

Locomotives Repair,

Coaches Repair, and

Wagons Repair.

6.2.3. System ONE: Permanent Way and Installations

Three main sub-systems may be distinguished within System ONE Permanent Way and Installations:

Sub-system Track consists of the "iron-road" on which trains are moving. Railway track consists of ballast, sleepers, rails switches, and connections between rails and between rails and sleepers.

Sub-system Technical Works contains all works summing up to track's infrastructure and consists of bridges, tunnels, supportive walls, earthworks, track drainage, sea protection works, etc.

Sub-system Buildings and Installations has the provision for terminals, freight depots, stores and all kinds of buildings of the railway system.

Main purpose of the Permanent Way and Installations System is to maintain the infrastructure, enabling thus the movement of trains and people and the successful completion of railway operations.

The magnitude of civil engineering construction/maintenance work required for the fulfillment of the tasks of this system varies from network to network, and relates to:

the physical layout and the infrastructure technical works associated. A mountainous line proceeding over bridges and supportive walls and under tunnels usually has increased maintenance requirements than a line on even ground.

the climate and associated snowfall, rainfall and temperature variations, all of which exert various kinds of tensions both to the infrastructure and the track itself.

the quality of construction/maintenance work of past periods. When, in the past, capital shortages or poor technology have accumulated problems, maintenance requirements in the present are much severe.

the volume of traffic over the line. The more a line is used, the more frequently it has to be maintained.

This thesis will adopt a further sub-division of the three sub-systems comprising the Permanent Way and Installations System ONE. Each of them will be conceived as consisting of two sub-subsystems: One concerned with routine maintenance and the other with new constructions. The division applies to all networks, even when, in some of them, the construction phase has terminated. Some kinds of construction projects are always developing, either they relate to construction of new lines, doubling of existing lines, or, more frequently, installations construction projects such as new terminals, buildings, etc. Thus:

Sub-system Track consists of:

Track Maintenance, i.e., periodic repair of the line infrastructure to meet predetermined standards. Usually this kind of work in all networks is undertaken by railway staff. Patrol gangers are inspecting the line daily (walking a distance of approximately 10 km), locate problems, and mobile gangs undertake maintenance work. Usually, track geometry and standards are recorded periodically by track recording cars, providing thus the fundamental information on which track maintenance is planned on an annual basis. An extended maintenance project over a segment of line including all or some of works related to rails replacement, sleepers replacement, ties replacement, ballast renewal, and continuous welding constitutes a renewal project. Usually, renewal projects aim at upgrading a set of track characteristics (e.g., journey speed, axle load). Therefore a track renewal project is a kind of new track construction project.

New Track Construction is either the building of a completely new track, or the substantial improvement of an existing track by extended renewal works. Construction/renewal projects require a much different organization from that of the routine maintenance, mainly in that they cannot be undertaken by local mobile gangs, since they require a quite detailed plan and specific skills. A construction/renewal work may be viewed as an autonomous civil engineering project, which may be undertaken either by the railway itself or by a constructions company.

In the same way, subsystem technical works may be subdivided in two parts:

Technical works maintenance, i.e., minor scale maintenance works on bridges (notably iron bridges), tunnels, track drainage, retaining walls, fences,

etc., undertaken by railway staff, either on a pre-planned basis, or as occurring from adverse climatic, etc. conditions.

Technical Works Construction, which again are major civil engineering projects, associated with the construction of a new line (i.e., new bridges, tunnels, etc), or with the substantial upgrading of an existing line. Usually such projects are sub-contracted to third parties.

Finally, sub-system **Buildings and Installations**, consists of:

Buildings and Installations Maintenance. Though this kind of work is quite simple (redecorating, painting, furniture renewal, central heating installation, gardening, etc.), the problem is caused by the fact that, again, it extends over the multiplicity of a railway's buildings and installations in a whole country. Usually routine works are undertaken by railway staff, whereas major, specific, or urgent works are being subcontracted.

Buildings and Installations Construction refers to big projects such as a new passenger terminal, a new freight depot, marshalling yard, maintenance depot, etc. Almost always this work is the job of specialised construction companies.

6.2.4. System ONE: Signalling and Telecommunications

The more modernised a network, the more it relies on sophisticated signalling and telecommunications systems. Hence a need to distinguish a separate system ONE, concerned only with the installation and maintenance of such systems, because, obviously, their operation is part of the duties of other systems, notably System ONE Operations. Four subsystems of this kind will be distinguished in this thesis: the signalling system, the communications system, the central traffic control systems and the level crossings guarding systems. Each of them will again be seen as consisting of two parts: an installation sub-system and a maintenance sub-system.

The basic purposes of a railway signalling system are:

- (1) to keep a safe distance between trains following each other on the same line;
- (2) to cross trains safely at junctions; and
- (3) to regulate trains to meet service requirements.

Two basic types of signalling systems are in use:

Mechanical signalling systems, where points and signals are operated by rods and signal wires from a lever frame. The levers are mechanically interlocked with each other in the frame, to prevent conflicting moves being made.

Electromechanical signalling systems, where the signalman operates a lever frame as before, but some, or all, of the signals and points may be electrically operated. The mechanical locking is still retained.

A third type, i.e., the power signalling system, which is still electric but all points and signals are controlled electrically from a control panel, there being no mechanical connections between the cabin control centre and the ground equipment is examined separately (Central Traffic Control System).

Sub-system Signalling System Installation refers to the introduction of electromechanical signalling over a segment of line, which was previously controlled by mechanical signalling or lacked any kind of conventional signalling.

Sub-system Signalling System Maintenance refers to day-to-day maintenance of the elements of installed mechanical or electromechanical signalling systems.

The **Telecommunications System** consists of all those systems permitting the transmission of verbal or typed information between points of the network. Such systems may be:

radiotelephones, facilitating the communication between train drivers and the traffic controlling staff.

conventional telephones; frequently, a railway network possesses its own telecommunications system, developing parallel to the railway line.

modern telecommunications systems, such as telex, facsimile, computer networks, etc.

Again, the **Telecommunications Systems Installation** subsystem is concerned with the selection, the acquisition and the installation of the proper system, whereas the **Telecommunications Systems Maintenance** sub-system is concerned with day-to-day maintenance.

The **Central Traffic Control (CTC)** system has been distinguished, in this study, from conventional signalling systems, because:

- (1) It is becoming more and more common throughout the world.
- (2) It leads to a radical change in conventional division of tasks among the railway labour.

It basically means that large areas of track are controlled from one control centre. In the control room, the signalman has a panel which shows the running lines and loops. the system is completely track circuited throughout. These track circuits are indicated on the panel, as well as signals and points. The signalman sets a route for a train instead of changing points and clearing signals.

The **Level Crossings Guarding System** consists of all mechanical, electromechanical or electrical equipment employed at manned or unmanned level crossings, in order to guarantee a safe separation of road and railway traffic.

The proper functioning of all systems mentioned is a prerequisite for a proper functioning of the railway enterprise as a system. Employing the division of tasks, outlined in this part of the thesis, *Figure 15* may be drawn, which illustrates the unfolding of systemic complexity of the railway enterprise into recursive levels.

6.3. THE PLANNING PROCESS IN THE RAILWAY ENTERPRISE

From the very beginning of this thesis, the strong relationship between planning and control has been stressed. In Koontz's words, control is the reverse side of the coin of planning. One cannot control what has not been planned. Especially in the railways, present-day decisions have consequences until a distant future. Decisions about the

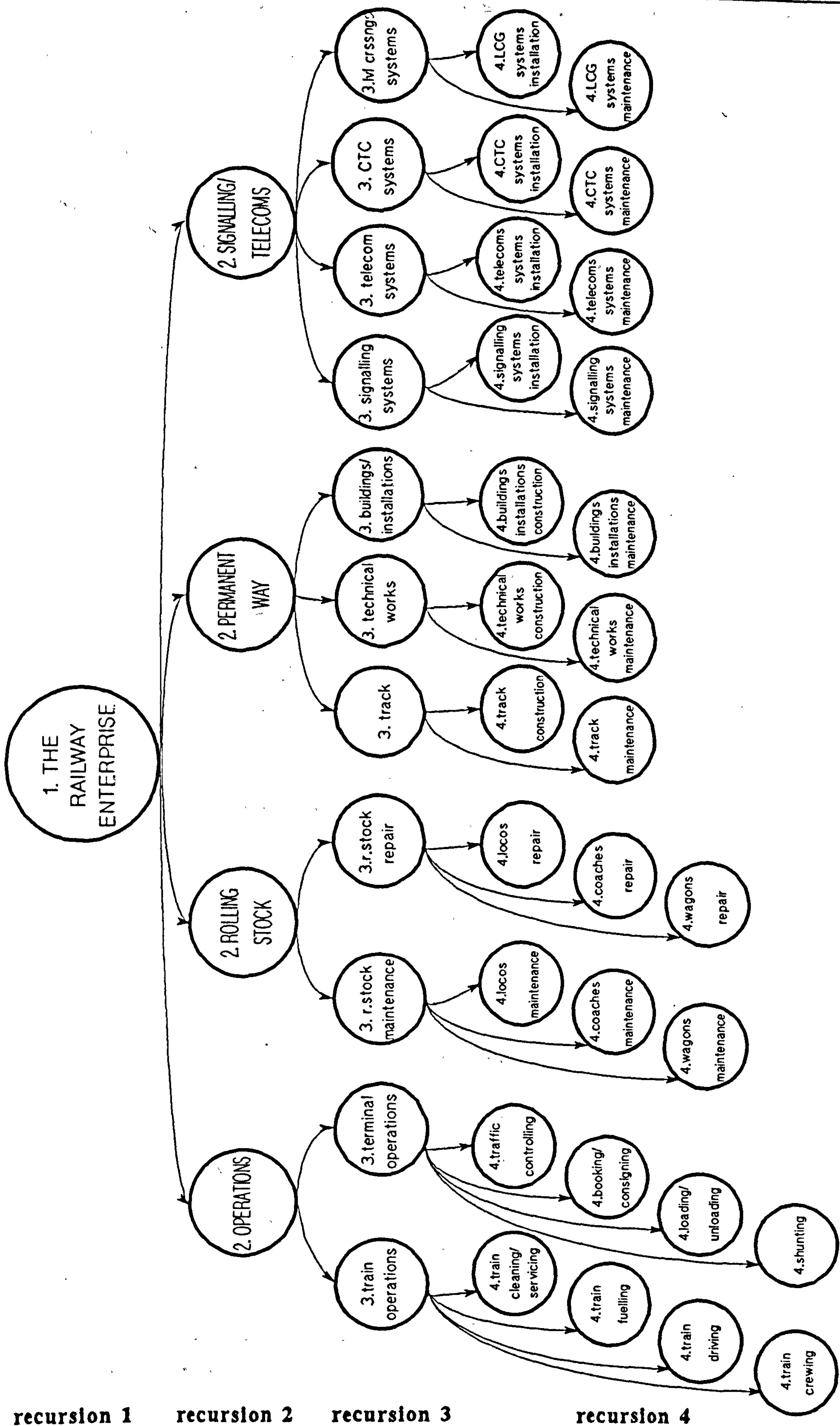


Figure 15: Unfolding Systemic Complexity of the Railway Enterprise

infrastructure influence the position of the railways in the next decades or even the next century. Today's new rolling stock will still be used in the first years of the next millenium. The present composition of staff and the number of employees determines the production possibilities in future years. Beer defines planning as the 'glue' of organizational cohesion ². He makes two points:

- (1) Planning is a continuous process. The continuity arises from the constant readjustment of rational expectations against shifting scenarios.
- (2) The only planners are managers, namely those people who are entitled to commit resources.

In *Chapter 5*, Beer's indices of systemic capacity were illustrated, namely actuality (what we are doing now, with existing resources and constraints), capability (what we could do now, under existing resources and constraints, by organizing optimally), and potentiality (what we ought to be doing by developing our resources). These indices were used to provide three indices of performance, i.e., productivity, latency and overall performance. Beer uses the same capacity indices to define three stages of planning ³. Planning on the basis of actuality he calls programming. This is simply a programme because it accepts the inevitable shortcomings of the situation, and does not admit that anything can imminently be done about them. Planning on the basis of capability he calls planning by objectives. A move to genuine planning requires the setting of new objectives and the attempt to achieve them. This is the strategic planning level. Planning on the basis of potentiality he calls normative planning. Normative planning sets potentiality as its target and incurs major risks and penalties, although it also offers major and perhaps decisive benefits.

Long-term planning in a state-owned railway enterprise, when it is not merely fiction (i.e., maps full of railway lines and high-speed futuristic trains), becomes a very dangerous exercise, since it has to rely on external (mainly governmental) funding, which not only is not guaranteed, but might eliminate in the middle of a major project. On the other hand, rapidly changing environment poses the requirement of a relevant adjustment of the services offered. This continuous adjustment is not a simple exercise for a system so complex as a nationwide railway, but, nevertheless, is a condition for viability in the long run.

6.3.1. Preparing Alternative Scenarios for Future Development

Since the environment is rapidly changing, the railway enterprise must possess a planning tool, producing alternative organizational futures corresponding to alternative values of environmental parametres. The more realistic the model, the better prognostications it will make. An example of a corporate model of this kind used by the Dutch Railways has been provided by Holtgreffe (1982) ⁴. The model was abandoned in the 1970's for producing, according to top management, irrelevant results. At a time when the company's deficit was 200 million guilders, the model forecasted for the year 1981 a deficit of 691 million. The actual deficit in 1981 turned out to be 1 017 million. Holtgreffe draws some conclusions from the sad destiny of this promising tool:

the construction of a model is not the exclusive job of a mathematical researcher; things go wrong when the "black box" produces unexpected and unpleasant results, while the users, i.e., top management, have no idea of how these results have been produced;

the logic of a model has to be accepted by the managers and staff of the company.

These assumptions are frequently met in corporate modelling literature 5 6 7.

6.3.2. Setting Operational Objectives

Planning should be environment-oriented and should set clear objectives in respect with:

Sectors of transport market which the enterprise decides to enter or to maintain its presence.

Features of services to be offered.

This is stressed because the commercial dimension is not always taken very seriously in a state-owned enterprise. The very strong technological characteristics of a railway company further relegate commercial initiatives in favour of technological development. Thus, it is quite easy for a technical project to become an end in itself, while it should only be a means for the pursuit of a commercial or social (but quantitative in financial terms) set of objectives.

6.3.3. Participative Planning

The two previous conditions can only be satisfied when planning in a railway is viewed neither as an authoritarian activity nor as a formal once-a-year exercise. The totality of the enterprise should get involved in the continuous corporate planning process. Several examples of how this is implemented in a railway enterprise may be cited in literature 8 9 10 11.

6.4. ORGANIZATIONAL STRUCTURE OF THE RAILWAY ENTERPRISE

In general, there are two basic variations of railway organization:

extreme functional (departmental) organization, and

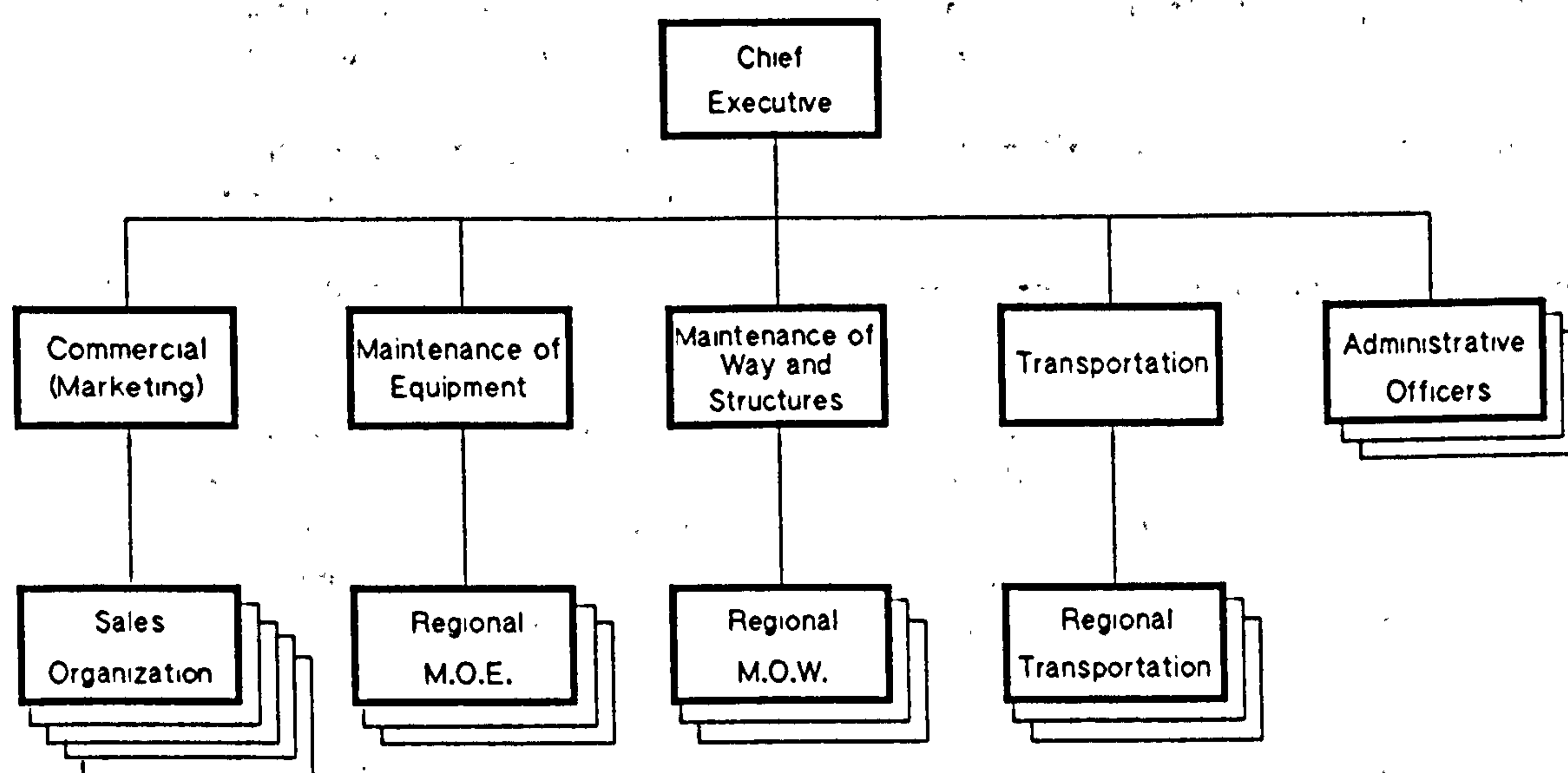
functional, regionalized within operations, organization.

Figure 16 depicts these forms, referred to by Wyckoff as Type I and Type II.

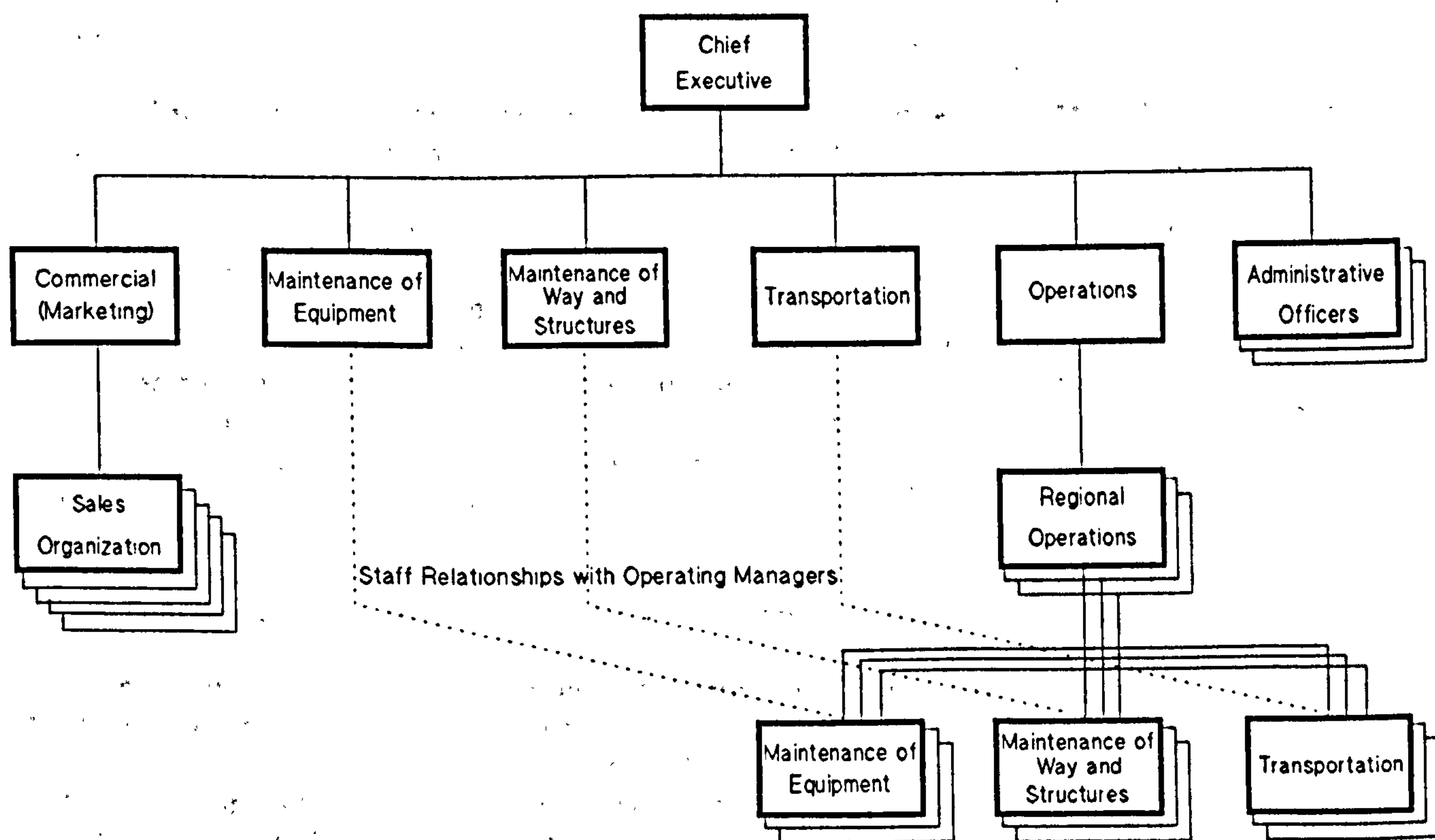
The Type I organization is basically a strict departmental structure, where line authority flows from the chief officer of a functional department directly to the field group, without significant integration with other departments at less than the executive level.

The Type II organization integrates all operating departments on a regional (or geographical divisional) basis. Under such an organization, the regional maintenance of way officer is responsible to the regional operations officer for repair of track and structures, but receives staff direction in matters pertaining to standards and practices from the chief officer of maintenance of way and structures. 12

There may also be cases of hybrid organizations, in which some operating functions are regionalized (or divisionalized) and other functions retain the departmental relationship more typical of the Type I organization.



Type I: Extreme Functional (Departmental) Organization



Type II: Functional, Regionalized within Operations, Organization

Figure 16: Basic Variations of Railway Organizations

The differences between Type I and Type II structures are not as great as might be imagined, since:

they both center around the level and degree of integration or differentiation of only the operating functions of the company.

they both result to a natural tendency for operating and commercial or marketing functions to be isolated from each other.

Wyckoff (1976) shows that the development of railway organization has been determined by the environment and strategies of early railway companies.

When the present form of railway organization evolved, the companies were considerably smaller in size, faced less intermodal competition, had fewer technological innovations (particularly in the communications area), and had been less exposed to diverse, alternative forms of organization. The main task of the railroad was operation. The primary task of the commercial function was to determine "what the traffic would bear".

As intermodal competition developed, it became increasingly more necessary to refine and modify the product to fit the marketplace better. However, the commercial function, which has tended to be subordinate to the operating function in seniority and social ranking, was given the task of primarily selling what operations elected to produce. Of course, this was partially justified by the massive investment and momentum of the physical plant and operations of a railway. It was also believed that since the "sale" was often made at a point other than where the operations were performed, there was good cause for these functions to be separated organizationally as well as geographically.

As railway industry entered the twentieth century, the now familiar patterns of large organizations in maturing industries began to appear. Railway organizations became massive, and management became diffused among an army of individuals of lesser ability at the lower levels of the bureaucratic structures. As employment levelled and opportunities for rapid promotion dwindled, a system of advancement by seniority developed. Initiative and vigour were replaced by on-the-job apprentice-master training, greater security in rules, and patience. Because of the large-system nature of railways, the input of one person in the system was difficult to identify with a discrete and recognizable output. But breaking a rule, or acting in way that is outside the social constraints could be immediately spotted and punished. Also, as traditions of functional organizations continued over the years in increasingly larger firms, the likelihood of a young manager gaining or holding a meaningful appreciation or sympathy for the viewpoint or problems of the other functional groups was small. Functional specialization, not general management across functional lines, was desired, and its development was rewarded by promotion.

Concurrent with the solidification of the functional organization, there has been a tendency towards an increasing degree of control to be exercised by central organizations. This tendency has been strongly reinforced by improved rapid communications and the computer. Throughout the world, railways were among the earliest users of nearly every communication and data processing innovation. This was encouraged by the geographic dispersion of operations and the volume of transactions. However, the adoption of these innovations, instead of leading to a greater independence of the decentralised local operating and commercial units, has resulted to the opposite, mainly for two reasons, according to Wyckoff:

- (1) Railways are highly systemic, and there is a great temptation to seek system optimization through centralisation of control under a "master-mind" organization; and

(2) A marked distrust of field managers by many railway executives exists, stemming from a basic insecurity among the executives, who remember the sense of hopelessness they felt as junior managers relative to the massiveness of the system.

Thus, the traditions of a period when control of operations was the primary task of management, when commercial functions were of secondary significance, are still powerful. The solidification of values and employee development produce managers, who are ill-prepared for integrative management, either by personality or by training.

Wyckoff concludes that this situation has discouraged control or incentive systems, which attempt to identify the revenues and costs of specific activities as profit centres at a level below that of the firm itself, familiar in many other industries. He considers the following scenarios as alternative probable courses of action:

- (1) Decentralising the organizations of existing railways around profit centres.
- (2) Reconfiguring existing railways into smaller companies that can be effectively managed by existing organizations and managers, by breaking up present railways or by separating track ownership and operating companies.
- (3) Minimising local operating and commercial functions by developing railways as wholesalers of intercity transportation, abdicating local operations to other institutions.
- (4) Minimising need for local management of operating functions by accelerated development of and investment in communications and data processing innovations.
- (5) Restructuring railway properties so as to submerge the intense local operations problems of short-haul operations into railways with predominantly more of the easily managed and profitable long-haul operations.
- (6) Accepting existing management organizations and "forcing" integrative behaviour by means other than decentralised profit centres.

Referring to the case of privately-owned American railroads, Wyckoff finds any of the propositions above as preferable to the nationalization of railroads, mainly because nationalization reinforces management organization and behaviour of the past: *"In the large nationalized railroads I have studied, centralised, functional organizations have been retained and even strengthened to ill-effect"* 13.

In a western-european state-owned-railway context, most of Wyckoff's propositions are being implemented by British Rail. However, it seems that there will be no opportunity to be judged in a nationalized industry environment, as they are strongly related to British government's denationalization programme, which has already involved:

privatisation of Sealink and other BR subsidiaries,

privatisation of BREL, and

moves towards privatisation of intercity sector and other profitable parts of the rail business.

Irrespectively to the future of this privatisation project, BR's organizational innovations have provided a new perspective to the state-owned railway enterprise, a key element in which is the identification of business sectors within the company and the

attempt to allocate costs of rail operations to each sector. Detailed descriptions of both this organizational change and the methodology of cost allocation have been provided elsewhere 14 15 16. In summary, in addition to the traditional regional (five regions) and functional (operations, civil, mechanical and electrical, and signalling engineering, finance, personnel, etc.) organisation of the enterprise, five business sectors have been identified, each with its own sector director who holds full delegated responsibility from the chief executive for his own bottom line result. Two of these sectors are social (London commuter, provincial) and three commercial (intercity passenger, freight, parcels). Sectors' costing is made by employing the rule of primer user for every railway route. Thus, clear commercial objectives are set for the commercial sectors, whereas the exact cost of social services offered may be isolated and more precisely identified, returning to the government (where it naturally belongs) the responsibility for decisions regarding social policy.

6.5. MANAGEMENT CONTROL IN A RAILWAY ENTERPRISE

Having discussed the recursive structure, the planning process and the organization of the railway enterprise, management control may now be conceived in terms of managerial cybernetics. The principle Systems ONE of the enterprise have already been identified. Obviously, some variations of this general structure may exist from country to country (notably the amalgamation of systems ONE operations and signalling and telecommunications) which will not be considered in the developing general model. On the other hand, the two principle organizational variations discussed will be considered, since they define whether the identified systems ONE belong to the first or second levels of recursion.

6.5.1. The Impact of Organization Structure on Management Control

Figure 17 depicts the railway organization labelled as Type I in terms of Beer's model of the viable system.

In a Type I organization, the first level of recursion consists of the four systems ONE as already described, namely:

- operations,
- rolling stock,
- permanent way and installations, and
- signalling and telecommunications.

Each system ONE is managed by a functional manager with delegated responsibility for this function over the totality of the network. Co-ordination of various systems ONE is achieved via the corporate system TWO, which may be summarised as the company's information centre. Management of each system ONE is engaged both in setting functional norms, standards and programmes, and in monitoring sub-systemic performance through a functional regulatory centre.

System THREE controls operating performance on the basis of information it receives from system TWO, relating to achieved values of indices in respect with preset tasks, during the periodical resource allocation process.

An example of the functioning of a such system has been offered by the Dutch Railways 17 18 19. A monthly bulletin is published giving the relevant quantified data (financial and non-financial) for past, present and future operations, on a yearly basis, providing information about:

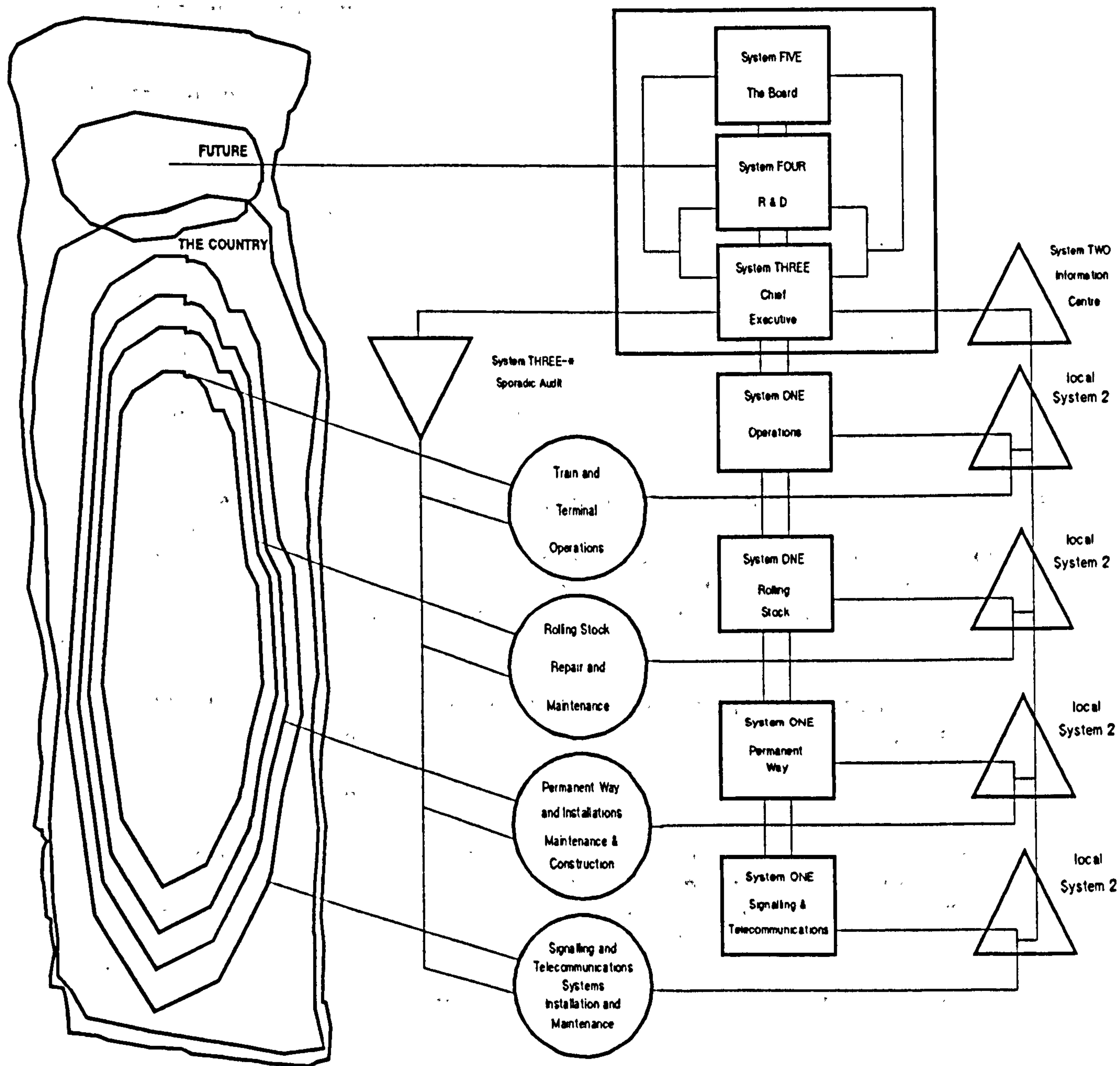


Figure 17: VSM of Type I Railway Enterprise

(1) Production:

passenger traffic, and
freight traffic,

(2) Sales:

pasenger traffic, and
freight traffic,

(3) Main supporting systems:

Personnel,
Infrastructure,
Rolling Stock, and
Finance.

(4) Environment:

subsidiary companies,
relationship with the state,
general economic development, and
miscellaneous.

This bulletin, extending over 40 pages, is reduced to a one-page-per-month exception reporting, covering 40 identified control points. Not all of these 40 points give rise to exception-reporting every month. Reported are those which tend to move (in a favourable or unfavourable way) outside predetermined ranges. Tieleman (1975) offers some rules for the functioning of Corporate System TWO (i.e., Information Manager), which are very closely to managerial cybernetic concepts:

- (1) A MIS for control collects much information especially from other information systems. Hence the need for a very good liaison between the MIS manager (corporate System TWO) and the managers of the different logistic information systems (local systems TWO).
- (2) Once a MIS for control is in operation, company officers should be prevented from sending periodical control information to top management directly (system THREE overloading). They should forward such information via the MIS (system THREE monitors performance through system TWO).
- (3) A MIS for control should produce a complete but not too detailed survey of current company operations (information filtration).
- (4) Top management should always maintain a dialogue with the MIS manager about those topics considered relevant to the management process (information relevance). The information manager must, accordingly, adapt continuously the contents of the MIS output. If he fails to do so, MIS is of no use to the management any more.
- (5) If one or more processes regarded as vital for the functioning of the company in its environment give continuously rise to exception-reporting, the standards should be altered. The information manager must continuously ensure that the company standards remain consinstent despite the modification carried out (systemic regulation).

(6) The original sources of information remain responsible for this information.

Since, as already mentioned, in this type of organisation there is both a natural tendency for operating and commercial departments to be isolated from each other, and for focusing only on the operating functions of the company, organizational integration, at a level lower than that of the chief executive may be achieved by a matrix structure. *Figure 18* illustrates such a matrix organization, at corporate level, as adopted by Dutch Railways (NS). The horizontal organization extends to long- and short-term planning, automation and information issues and cuts across the formal vertical functional organization. Similar structures are employed at lower levels.

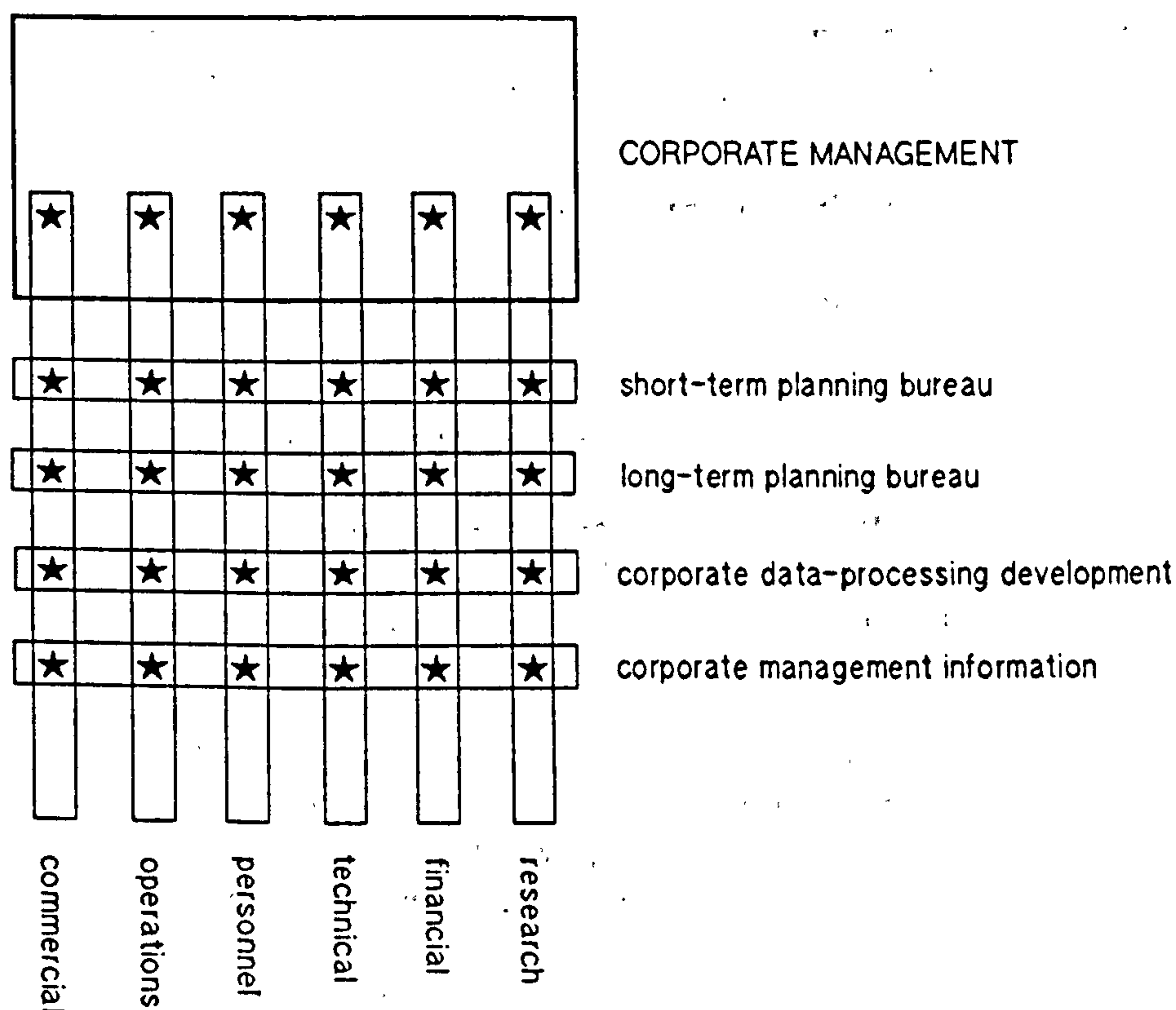


Figure 18: Matrix Organization at Corporate Level

Type I functional organization (with or without matrix integration) is achieved when relatively small enterprises, or enterprises operating within small and homogenous countries are concerned. In the example mentioned, Holland is a very small, densely populated and homogenous country. The railway is by and large a passenger transport railway. Passenger services aim at providing a hourly linkage between any two major cities within the country. The situation is much more complex in the case of multi-product and large railway enterprises. In this case a sort of Type II organization is adopted, to allow for local (regional) co-ordination and control of functional activities. The introduction of an intermediate level of recursion (i.e., regional management) between corporate level and functions seems to be inevitable, to allow for a management control process closer to the location of operations.

Regional structure, besides facilitating control of operations, may produce a lot of problems as far as there is no clear definition of the status of the regional management. When conceived as a first level of recursion, that is regional management is a system ONE, a viable system in its own right in the geographical area it covers, it follows that the dichotomy between centralization-autonomy has to be resolved in a way which passes to the regions managerial accountability for a lot of issues and minimises headquarters function to a role assuring corporate identity. The degree to which this may, at first, be achieved, relates to the characteristics of the rail product within a certain enterprise. When there is a natural separation between regions and not substantial inter-regional transactions in terms of traffic, regional management can be held accountable for results of operations, hence its system ONE status has to be recognised and reinforced. *Figure 19* illustrates this case in terms of Beer's VSM.

However, in nationwide railway companies, usually principle type of traffic is passenger and freight intercity traffic; that is, a train originates in one region and terminates to another, probably crossing some more regions. Hence a difficulty to allocate profits and costs of railway operations among regions. In this case, either a set of algorithms for intra-regional cost-profit allocation is developed (however arbitrary this set might be in complex rail operations), or regional management loses its system ONE status and becomes a local coordinating unit.

In any case, either in the nationwide enterprise or in the regionalised, the actual implementation of railway operations is achieved through the functioning of the four systems ONE mentioned, i.e., operations, rolling stock, permanent way, and signalling and telecommunications.

6.5.2. A Framework for Management Control

Having identified the systems ONE of the enterprise, either in the first level of recursion (Type I enterprise) or in the second (Type II), management control in terms of Beer's model of the viable system requires the identification and the proper functioning of the rest four systems comprising the VSM. The physical location of these systems may be identified in terms of accountability for certain managerial activities within the company's structure. For the purposes of this thesis, a list of managerial activities has been constructed and used in the survey. The list is displayed in the Survey Questionnaire (*Appendix C*). Thus, both at corporate level, and within the management of each functional system ONE, four sets of activities may be identified:

6.5.2.1. Research and Development

Research and Development activities, comprise a continuous scanning of the environment of the enterprise (or the respective functional system ONE), in order to identify opportunities and threats.

At corporate level these activities involve monitoring international trends in the development of the railway and other modes of transport, monitoring trends in national development, monitoring relationships with the State and other stakeholders and preparing alternative scenarios for future development, related to alternative directions of the overall development of the country.

At functional level, R&D activities focus mainly on monitoring trends in technological innovations and are balanced with functional operations by the preparation of functional plans, further intergrating within the overall corporate plan. The commercial sector of the enterprise is engaged, at this stage, with the monitoring of financial activities in various sectors of the national economy, activities and methods employed by competitors

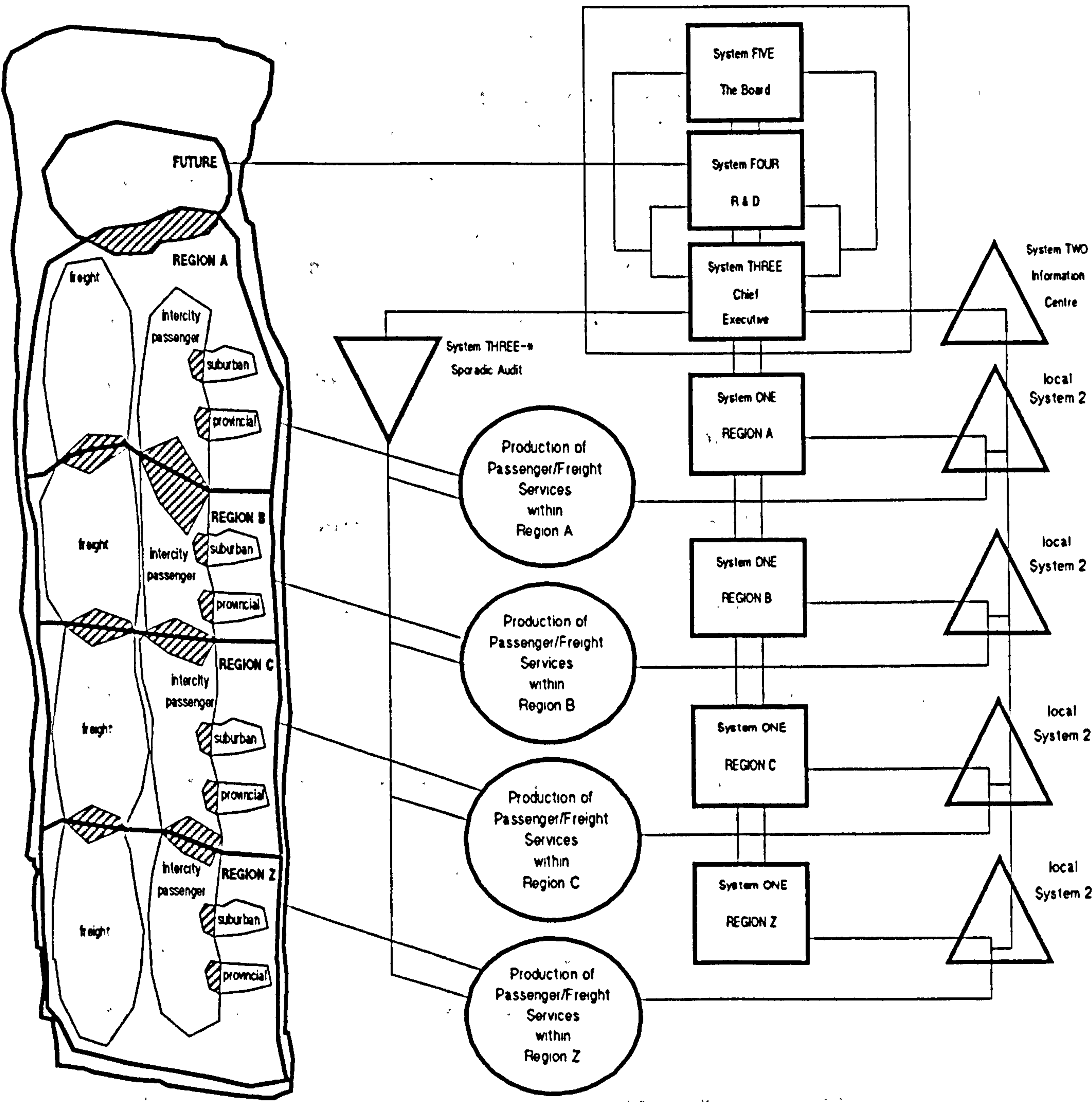


Figure 19: VSM of Type II Railway Enterprise

within the transport business and with the identification of alternative possible means of increasing traffic volume and market share of the enterprise, producing, simultaneously, favourable financial results. Apparently, the conclusions of the marketing function should serve as a basis for the assessment of any corporate or functional plans; however, this is not the usual case in a state-owned railway enterprise.

6.5.2.2. Planning and Organizing

Planning-Organizing activities at corporate level consist of:

Identification of sectors of transport market which the enterprise decides to enter, as deriving from the adopted general direction for the development of the company.

Identification of the characteristics of services to be offered.

Identification of required investment, in order to succeed in entering the desired market sectors and in offering the planned railway services.

Identification of required organizational change.

Similarly, the Operations System ONE Planning-Organizing stage is characterised by the:

Identification of requirements in new railway installations, or modification/extension of existing.

Identification of requirements in new rolling stock, or modification/refurbishment of existing.

Identification of requirements in line's capacity configuration (single/double, type of signalling, central traffic control).

Identification of requirements in technical configuration of the track (required axle loads, journey speeds).

Definition of passenger services characteristics (first/standard class, couchettes/sleeping cars, buffet services, comfort/cleanliness requirements).

Definition of freight services characteristics (block trains, containerization, combined transport, 'door-to-door' services).

Finally, Planning-Organizing at Functional Level involves:

Issuing of methods and rules defining the maintenance/repair regime for rolling stock, permanent way, installations, signalling and telecommunications.

Preparation of technical and economic studies for certain functional projects, related to the overall development strategy (e.g., requirements in rolling stock repair/maintenance installations and equipment, civil engineering studies, selection of signalling, telecommunications, etc. systems, installation studies, etc.)

Identification of requirements in materials, spare parts and equipment for the fulfillment of functional operations.

6.5.2.3. Annual Programming/Budgeting

Annual Programming/Budgeting activities involve, at **Corporate Level**, the preparation of the Annual Budget and the Annual Investment Programme. Since the principle source of income for a railway company is the one resulting from the selling of the services, annual budget is related with the **Railway Operations System** by means of:

The railway traffic forecasts, reflected in the service timetable, which makes provision for available capacity and principle features of services (journey times, frequency, connectivity, etc.)

The pricing policy implemented, including both marketing activities for commercial services and identification and state subsidy compensation for social services.

Since the activities of the three Supporting systems (i.e., rolling stock, permanent way, and signalling/telecommunications) may be viewed as inputs to the Operations system, the latter should define at this stage a set of requirements from the supporting functions, aiming at permitting the offering of the prescribed services. Such requirements might be:

From the **Rolling Stock** sub-system: Rolling stock availability, operationality, cleanliness, comfort, etc. requirements.

From the **Permanent Way and Installations** sub-system: Track availability, track quality and terminals and installations operationality requirements.

From the **Signalling/Telecommunications** sub-system: Operationality of the specific systems within this sub-system (signalling, telecommunications, CTC, level crossings guarding).

Functional systems, at the annual programming/budgeting stage, are expected to prepare (preferably in an integrated within the company manner):

Their annual functional maintenance/repair programmes with associated expenses and aimed results.

Their annual investment programmes with associated completion times and cash-flow.

Their annual materials/spare parts/equipment purchase programmes.

6.5.2.4. Performance Monitoring

The fourth set of activities identified is the set of **Performance Monitoring** activities. Five principle areas of performance monitoring may be identified at corporate level:

Commercial Performance monitoring, i.e., monitoring the development of the traffic volume achieved and the market share gained within the market sectors of interest.

Financial Performance monitoring, i.e., monitoring the development of the annual budget which involves:

- revenue monitoring,
- expenditure control, and
- cash-flow control.

Investment Programme development monitoring, involving:

- monitoring the rate of completion of investment programmes, and
- monitoring the rate of absorption of investment funds.

Enterprise-Personnel Relationship development monitoring, associated with:

- monitoring the relations with the trade unions, and
- monitoring employees morale by adopting some kind of appropriate index (e.g., absenteeism).

Monitoring Relationship with the State, which is a continuous informal activity, involving:

- Informing the enterprise on state's requirements from the railways.
- Informing the state on conditions for the fulfillment of these requirements.
- Informing the state on the company's performance.
- Negotiating with the state the funding of investment plans.
- Negotiating the general features of the annual budget.

Similar performance monitoring activities associated with operational performance, financial results, personnel morale, etc., should develop at functional level. These activities are reported at the relevant parts of the Survey Questionnaire.

6.6. SYNOPSIS

Four system ONE elements, doing what the company is supposed to may be identified within the railway enterprise:

Railway Operations,
Rolling Stock,
Permanent Way and Installations, and
Signalling and Telecommunications.

At subsequent levels of recursion these systems may be viewed as consisting of further sub-systems and sub-subsystems.

Management control of the railway enterprise under a managerial cybernetics modelling requires the recognition of the VSM status of the mentioned elements. This status usually is not reflected in the formal organizations of the railways, which tend to view the enterprise as a sum of technical functions, either coordinated and controlled at the very top of the enterprise (Type I), or through regional management with unclear bottom line responsibilities (Type II).

The examination of the managerial status either at corporate or at functional or subsystemic levels may be attempted via the search for accountability for activities belonging in general in one of the following sets:

Research and Development activities,
Planning/Organizing activities,
Annual Programming activities, and
Performance monitoring activities.

The full set of these activities is displayed in the Survey Questionnaire (*Appendix C*) and constitutes the basis for the identification of the actual VSM in the case-study enterprise.

6.7. FOOTNOTES

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CHAPTER 7

CASE STUDY BACKGROUND

7.1. INTRODUCTION

Chapter 7 is the first part of the research implementation. Theory on management control, public enterprise and railways previously developed is combined with information concerning an actual organization, Greek Railways, to provide a clear picture of what is in a real situation the railway management control problem. Since the emerging picture will inevitably be subjective, as it reflects the author's perception of the reality, a survey within the case-study will further be undertaken, in which acting managers of the enterprise will be requested to express their opinions on railway management control issues. Thus, *Chapter 7* may be seen as a connective chapter, between the framework developed, and the survey which follows.

The chapter develops in five parts, each of which is, in turn, concerned with:

- (1) A very brief description of the history of the enterprise;
- (2) Its principle characteristics;
- (3) The ownership and external control over the enterprise;
- (4) The performance of the enterprise; and
- (5) The organizational structure of the enterprise.

7.2. A BRIEF HISTORY OF THE GREEK RAILWAYS ORGANIZATION

Railway history in Greece starts with the publication of the Law TZ/28.12.1855, concerning the establishing of the "*Athens to Piraeus Railway*", and the opening of this line 14 years later (17 February 1869). Provided that, at that time, a big part of mainland Greece was under Ottoman occupation, the formation of a nationwide network was not feasible. Thus, a standard gauge (1435 mm), single-tracked line from Piraeus/Athens to the then border (Papapouli, north of Larissa) was built (350 km long), together with a 20 km branch to Khalkis, on the island of Euboea. (Law YMST/20.07.1881, construction 1889-1909). This network was operated by a state-owned company under the name Greek State Railways (SEK). ¹

During the same period, the private Thessaly Railways was formed and operated on a 160 km narrow gauge (1000 mm) single-tracked line, connecting the principal towns of Greece's biggest plain, Thessaly, with the main line (at Paleofarsalos) and with the city and port of Volos (Law AMH/22.06.1882, construction 1881-1896).

Further still during the last part of the 19th century, the private Athens-Piraeus-Peloponnese Railways (SPAP) started operating on a network constructed in South mainland Greece, the Peloponnese. This network, 800 km approximately long, starts from Athens and, after crossing the Corinth Canal and reaching the city of Corinth, diverges. One branch follows the north and, then, the west coastline, via Patras; the

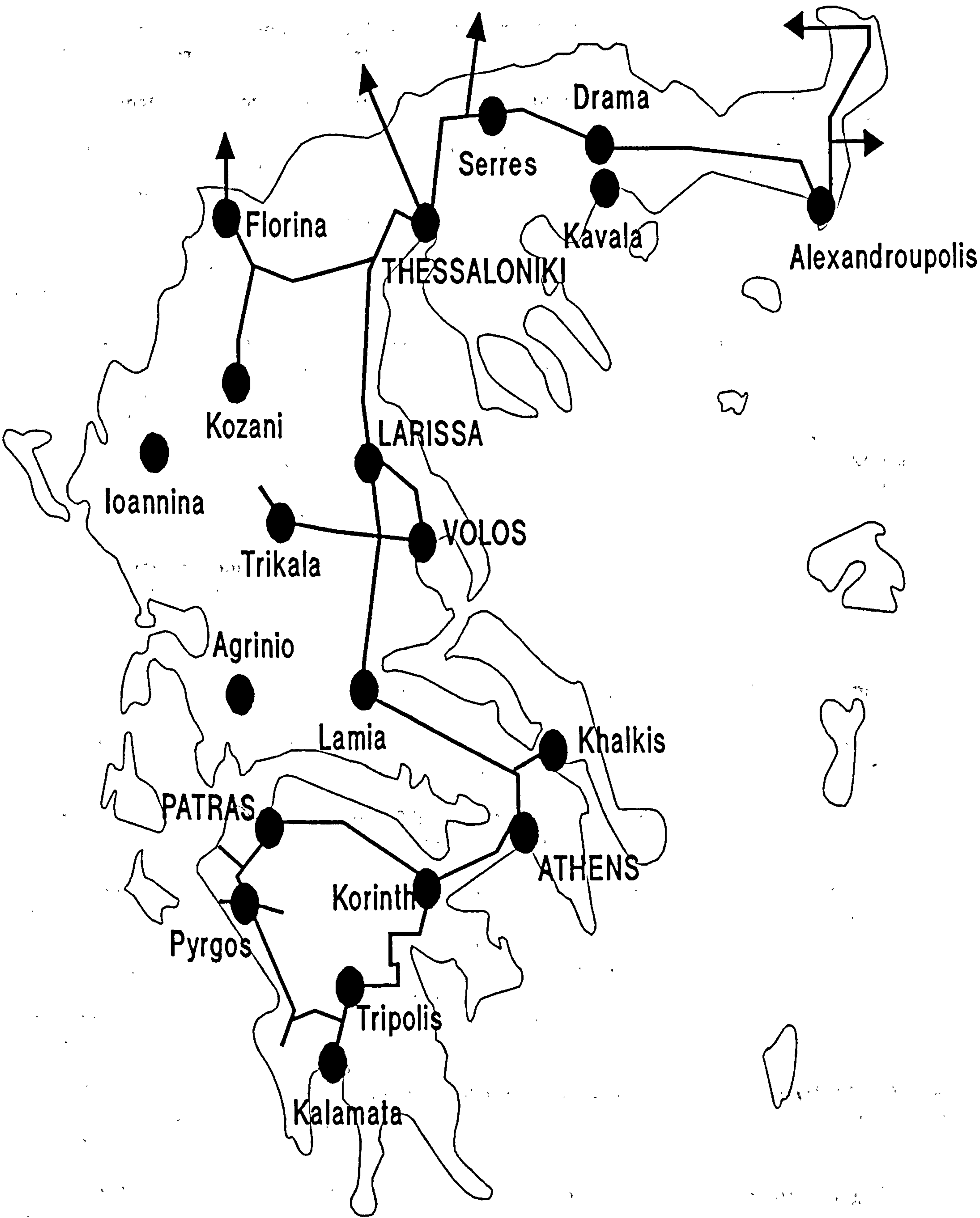


Figure 20: The Greek Railway Network

other proceeds mainland south, via Argos and Tripolis. The branches merge at Zevgholatio, near the south-coast city of Kalamata (Law AMS/22.06.1882, construction 1882-1902). ²

The formation of a nationwide rail network was interrupted by the Balkan Wars (1912-1916), by the end of which, when a further part of the Greek territory was liberated (forming the contemporary Greek State, with the exception of the Dodhekanese Islands which entered after World War II), the Athens-Larissa-Papapouli railway was connected with the part of the Ottoman Railways' network, which had been constructed in the liberated lands. The first train from Athens to Thessaloniki ran on March 1918.

The network of the 1920's remains almost unchanged (*Figure 20*). Besides the physical and financial constraints, historical conditions obstructed further expansion.:

Soon after Balkan Wars, World War I started. By the end of this war, Greece participated with her western allies in the Middle East military operations, forced by the will to liberate further Greek populations, living by the West (Aegean) coast of Asia Minor. The operations ended in a disaster (1922). At the time when Kemal Attaturk was fighting against both the European allies and the Ottoman monarchy to form the first Turkish Republic, 1 500 000 Greeks from Asia Minor, Black Sea and Constantinople had to abandon their homes and to follow to the west the defeated Greek army.

This enormous number of refugees, 20 % of Greece's population at that time, helped to reshape the country drastically. A significant development and industrialisation was achieved during the period which starts soon after the "*Asia Minor Catastrophe*" and ends with the outbreak of World War II.

The end of World War II, which, nevertheless, ruined almost the whole of Europe, was not followed by peacetime in Greece. The evacuation of the country from the allied German, Italian and Bulgarian forces was to be followed by the British military involvement (1944-1946) and the Greek civil war (1946-1949).

In 1935, SEK, Thessaly Railway (STh) and other small companies to the north of Athens merged into one company, SEK, administered directly as a government department.

During the early 1950's, the totally destroyed railway network had to be rebuilt. A Railway Reconstruction Committee (SAS) was set up to decide on its future (May 1945). Several options were discussed. ³ Modernisation thoughts were expressed, which could be financed by funds of the Marshall Plan. Finally, under the influence of political, military and financial interests, only the restoration of the existing network to its pre-war condition was decided. On the other hand, a lot of investment was made on roads, ports, and airports. It was the era of the automobile and the aeroplane.

In September 1962 SEK took over the 'Athens-Piraeus-Peloponnese Railways' (SPAP), the 'North-West Greece Railway (SVDE)' and the 'Pyrgos-Katakolon Railway' (SPYK), which had already come under state control (Law 4246/1962).

In September 1970 (Law 674/19.09.1970) SEK becomes "*an organization operating for the public interest, accordingly to the rules of private economy, in the form of a company having managerial and financial autonomy*". The new name of the enterprise is OSE, standing for '*Hellenic Railways Organization*'. Today, OSE is the only operating railway in the country, apart from the Athens-Piraeus urban electric railway (ISAP). It is an autonomous public enterprise, run by a Board. Till recently (1983) the members of the Board were appointed by Government. Since 1983, under the legislation for the Socialization of the Public Enterprises, the following innovations were introduced:

- (1) Employees representation in the Board of the Railways. Three of the nine members of the Board are elected by the personnel through a general election.
- (2) Social Control of the activities of the enterprise. The same legislation makes provision for a Social Control Representative Assembly (ASKE), consisting, in the case of OSE ⁴, of 27 members, 9 of which are appointed by the government, 9 by interested parties (chambers of commerce, local governments, export organizations, technical chamber, trade unions confederation, etc.) and 9 are elected by the railway employees.
- (3) Decentralised social control. In addition to ASKE, a regional assembly for social control (PESKE) is set up in each of the nine major regions of the country (provided railway network exists within the region), with similar duties to ASKE at regional level.

Experience from the short life of these innovations has shown that, in the case of the Railways, these bodies have not exploited the rights stated in the legislation, partly due to government intervention and partly due to their strongly political character.

7.3. CHARACTERISTICS OF THE GREEK RAILWAY

7.3.1. The Layout of Rail Connections

Greek Railways offer passenger and freight transportation services. Trains, in general, originate from two focal points: Athens, the capital, and Thessaloniki, the second biggest city of the country, in North Greece.

Standard-gauge passenger trains departing from Athens every day and arriving in Thessaloniki,

either terminate,

or are directed to the Greek-Yugoslavian border (Idomeni/Gevgelija), from where Yugoslavian (and then Austrian, German or Italian) locomotives take them to Western Europe (Akropolis Express to Munich, Hellas Express to Dortmund, and Venezia Express to Venice; the train to Venice conveys up to Belgrade coaches to Wien and Budapest),

or are directed eastwards, either to the north-eastern point of the network (Ormenion), or to Turkey. At Strymon, coaches are taken to the Greek-Bulgarian border (Promachon/Kulata) and from there to Sofia, Bucharest, and Moscow.

Narrow-gauge passenger trains depart from Athens (Peloponnese) railway station towards Korinth. Half of them continue westwards to Patras and then south to Pyrgos and Kalamata. The rest travel mainland from Korinth to Argos and Tripolis and terminate also at Kalamata.

Local trains travel daily from Athens to Inoi and from there on the branch line to Khalkis.

Local trains travel on parts of the network or branch lines. *Figure 21* provides a picture of daily journeys of passenger trains over the network of the Greek Railways.

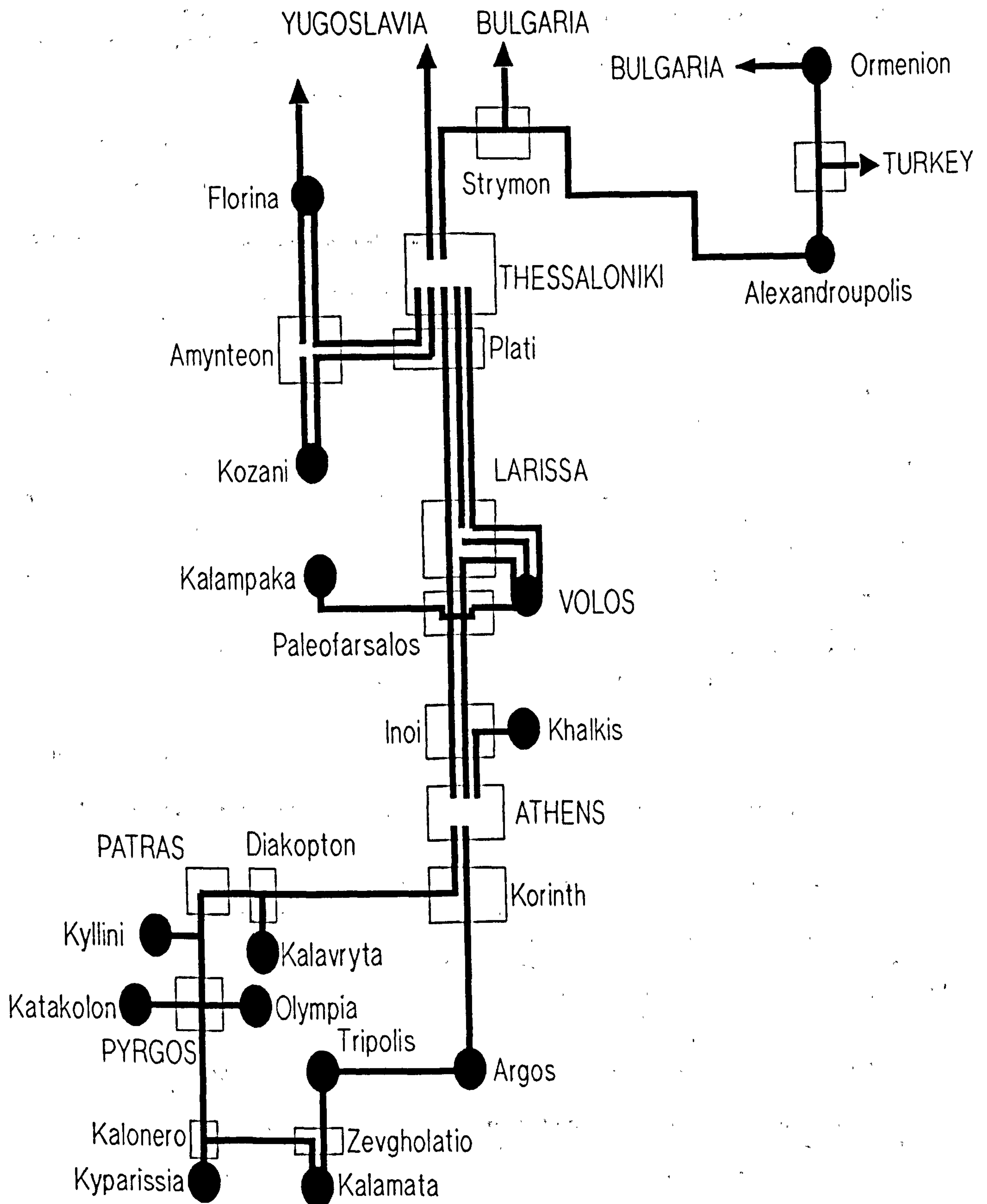


Figure 21: Greek Railways: The Layout of Passenger Services

A number of freight trains travel mainly between Piraeus/Athens, Thessaloniki and the Greek/Yugoslavian border, providing thus a transport link, via Yugoslavia, with the European Community, which is by and large the main origin/destination of the Greek import/export trade. Gradually, the importance of the Yugoslavian route as a link between Greece and the Community tends to become smaller, as the port of Patras (in the Peloponnese) and the frequent ferry service to Italy (Brindisi, Bari, and Ancona) develops. However, in any case, the way through Yugoslavia will always be the only land connection, for both railway and the automobile.

7.3.2. Characteristics of Services Offered

The quality of railway services has been seriously influenced by the condition of the network, which, till recently, could be described as completely outdated. Indeed, it was only during the 1970's that, as a consequence of the oil crisis, the growth of pollution and congestion problems, and the very poor condition of the railways, a rail modernisation plan was introduced. The plan refers mainly to the updating of the 'axis' of the network, the 600 km long Athens- Thessaloniki-Yugoslavian border main line, and includes track renewal, construction of a second track, electrification, and central traffic control, to allow for speeds of the range of 200 km/h ⁵. Further plans refer to the modernisation of part of the Peloponnese narrow-gauge network, namely the construction of a high speed standard-gauge line between Athens and Patras (the third biggest city of the country), and, with partial financing from Community funds, the construction of a direct west-east rail link from the port of Igoumenitsa in North-West Greece (opposite to the island of Corfu) to the port of Volos on the Aegean coast. A rail freight ferry service is being introduced from the port of Volos to the port of Lattakia in Syria. Therefore, there is an obvious will within the community for the construction of an integrated link for freight transport between Europe and the Middle East, by employing two ferry services (Italy-Greece, Greece-Syria) and the greek railway network.

Principle causes of the poor quality of services offered are:

- (1) the single track which, in relation with developing infrastructure projects accounts for delays and deviations from the schedule.
- (2) the maintenance standards of the rolling stock, related both to the outdated and poorly organised maintenance installations (depots, workshops) and to the extreme multiplicity of employed equipment, defined by external conditions. Almost every kind of rolling stock may be identified within the Greek Railways: American, Canadian, Japanese and Romanian locomotives; Hungarian, German and Italian dmu's. Romanian, East German coaches, etc. Bear in mind that:

there is no railway equipment constructing company based in Greece; and

a big part of national agricultural production is directed to Eastern Europe. Until recently this international trade was balanced with the clearing method. I.e., agricultural products were exchanged for technological equipment, notably railway equipment, power generators, etc.

7.3.3. The Rolling Stock of the Greek Railways

Rolling stock repair and maintenance work is undertaken by the network's workshops and depots. Heavy repair and maintenance work is undertaken by the network's principle workshop in Piraeus (EP), which serves standarg gauge trains originating from Athens and the biggest number of Peloponnese narrow-gauge rolling stock. A second major workshop in Thessaloniki (ETh) serves the Thessaloniki originating local trains to North-West and

North-East Greece. Finally, a small workshop at Volos (EV) is engaged with duties concerning the narrow-gauge Thessaly line trains.

Light repair and day-to-day maintenance and servicing is undertaken by the network's three principle depots:

Aghios Ioannis depot (MAI) near Piraeus serves the Athens originating standard-gauge trains.

Piraeus depot (MPR) serves the Athens originating Peloponnese network trains.

Thessaloniki depot (MTh) serves the Thessaloniki originating trains.

A few more local depots have responsibilities over branch-line trains maintenance and servicing, as well as local coaches or wagons periodic inspection, and are situated at Lianokladi (ML), Larissa (MLr), Drama (MD) and Alexandroupolis (MA) for the standard-gauge line, and Diakopton (MD), Patras (MP), Kalamata (MK) and Volos (MV) for the two narrow-gauge parts of the network.

Tables 5-7 provide the numbers and types of the rolling stock of the Greek Railway, as well as the average out of service percentage due to breakdowns for the year 1984. Though in some instances this percentage is artificial, in the sense that certain types of rolling stock have become obsolete but still appear in official tables, the poor production of the Rolling Stock maintenance/repair system is quite apparent.

Type	serial no.	construction	year	HP	units	% out of service
standard gauge						
KRUPP V60	A.100	FR GERMANY	1963	650	30	33.0
ALCO	A.200	USA	1963	1 050	8	31.2
ALCO	A.300	USA	1964	1 950	8	45.0
ALCO	A.320	USA	1966	2 150	6	46.7
ALSTHOM	A.350	FRANCE	1967	2 400	26	62.7
SIEMENS	A.400	FR GERMANY	1966	2 000	10	94.0
FAUR	A.150	ROMANIA	1973	700	12	100.0
FAUR	A.170	ROMANIA	1979	750	7	84.7
MLW	A.450	CANADA	1974	2 700	20	32.6
MLW	A.500	CANADA	1975	3 600	10	46.0
GENERAL ELECTRIC	A.220	USA	1974	1 050	13	80.0
ELECTROPUTTERE	A.550	ROMANIA	1982	3 600	10	41.0
GANZ-MAVAG	A.250	HUNGARY	1983	1 800	11	22.7
1 000 mm gauge						
ALCO	9.100	USA	1965	1 350	12	31.6
ALSTHOM	9.200	FRANCE	1967	1 600	10	56.0
MITSUBISHI	9.400	JAPAN	1967	640	20	24.5

Table 5: Greek Railways, 1984: Diesel and Diesel Electric Locomotives

T y p e	serial no.	construction	year	HP	units	% out of service
standard gauge						
FIAT	11-26	ITALY	1949	450	15	70.0
FIAT	27-36	ITALY	1957	590	8	33.7
FERROSTAHL	71-90	FR GERMANY	1962	600	18	60.0
GANZ-MAVAG	91-101	HUNGARY	1976	1 140	11	61.8
1 000 mm gauge						
BREDA	2500	ITALY	1952	390	13	83.0
MAN	2100	FR GERMANY	1937	210	6	70.0
MAN	4200	FR GERMANY	1937	420	7	91.4
DE DIETRICH	6400	FRANCE	1952	640	13	50.0
ESSLINGEN	6000	FR GERMANY	1959	1 000	7	45.7
GANZ-MAVAG	6450	HUNGARY	1977	1 140	4	45.0
GANZ-MAVAG		HUNGARY	1985		10	
750 mm gauge						
BILLARD	3000	FRANCE	1959	350	3	25.0
DE CAUVILLE	3000	FRANCE	1967	500	3	25.0

Table 6: Greek Railways, 1984: Diesel Multiple Units

T y p e	standard gauge	1 000 mm gauge
Passenger Coaches	326	143
Buffet Cars	6	5
Post	120	56
Wagons	8 909	1 687
Service cars	229	30

Table 7: Greek Railways, 1984: Coaches and Wagons

7.3.4. Track Maintenance in the Greek Railways

Table 8 provides lengths of railway line (in km) per regional department in terms of track gauge. Railway line consists of a single track, with the exception of three double-track segments (Athens-Inoi 61 km and Plati-Thessaloniki 36 km on the standard-gauge network, Athens-Eleusis 27 km on the Peloponnese network). Recently (1988), as a part of the modernisation project a further segment of second line, 95 km long (Inoi-Tithorea) has been opened to traffic, whereas another part of double line (Domokos-Larissa, 61 km) is near completion. In the Athens-Thessaloniki line, the construction of the second track is being accompanied with the upgrading of the existing one (heavy rails, concrete sleepers, continuous welding, elimination of level crossings, local alignments). Further, a major part of the Thessaloniki- Alexandroupolis north-east line has been upgraded. A project for the conversion of the narrow gauge-line Thessaly line to a standard gauge one is under development, aiming at a second north-south link after the construction of the Kalampaka-Kozani connecting line.

track gauge	Athens Region (DPA)	Thessaloniki Region (DPTh)	Peloponnese Region (DPP)	Total
standard gauge (1 440 mm)	585	980	-	1 565
narrow gauge (1 000 mm)	162	-	730	892
narrow gauge (750 mm)	-	-	22	22
t o t a l (km)	747	980	752	2 479

Table 8: Greek Railways, 1984: Length of network in km.

Track maintenance in Greek Railways is the responsibility of area engineer units (TM.GR). Under an organizational structure comprising of three regions (mentioned in the previous table), within each region a chief civil engineer (YGR) is reported by area engineers (four for each of the Athens and Thessaloniki regions, and three for the Peloponnese). The elementary track maintenance unit is the mobile gang. Each gang is responsible for a segment of line (approx. 10 km in double- and 20 km in single-lines). A track maintenance foreman has responsibility for a wider area within the area unit. Foremen report to the area engineer. An illustration of this organization is provided in Table 9, which refers to the structure of the First Permanent Way Area Unit of the Athens Region (DPA/A'TM.GR). The responsibilities of this unit, as shown in the table, extend over 153 km of the main line track, i.e., from the port of Piraeus (km 0.000) to km 153.000.

railway station	distance from origin (km)	mobile gang		staff composition chf dep wrk	foreman's base and responsi- bility	area enginner's (TM.GR) base and responsi- bility
		base	responsible between km			
----- Piraeus	0.734	-----	-----0.000--	=====	===0.000=	===0.000==
Aghios Ioannis	4.107	*		1 2 13		
----- Athens	10.290	*	-----5.000--	-----	*	*
----- Acharnae	21.021	*	-----14.000--	-----		
=====		=====	===25.000==	=====	==25.000=	
Oeon	33.485	*		1 2 11		
----- Afidnae	40.048	*	---36.000--	-----		
----- Sfendhali	50.878	*	---46.000--	-----	*	
----- Avlon	59.215	*	---55.000--	-----		
=====		=====	===65.000==	=====	==65.000=	
Oenoi	71.394	*		1 2 9	*	
----- Tanagra	75.248	*	---75.000--	-----		
=====		=====	===93.000==	=====	==93.000=	
Thevae	100.448	*		1 2 11	*	
----- Aliartos	121.085	*	--113.000--	-----		
----- Levadia	141.947	*	--133.000--	-----		
=====		=====	==153.000==	=====	=153.000=	=153.000==
Tithorea	153.260	*		1 2 12		

Table 9: Greek Railways: The Structure of a Typical Permanent Way Area Unit.

The line is patrolled by patrol gangers. Track geometry and standards are recorded periodically by track recording cars. Under the modernisation plan a substantial number of track renewal/maintenance mechanical equipment was purchased (ballast cleaners, ballast regulators, tampers, etc.). The introduction of this equipment in day-to-day track maintenance duties will, inevitably, require major changes both in the organization and the skills of the track maintenance staff.

Buildings and Installations maintenance within each area unit is undertaken by the unit's building maintenance group, consisting of a small number of skilled workers of various specialisations and reporting to the buildings maintenance foreman. Larger building maintenance or construction projects are subcontracted.

Finally, within a region, an Iron Constructions Unit (TMK) is responsible for:

- the maintenance of iron bridges, which are quite numerous;

- the maintenance and construction of track switches, level crossings fences, etc.;
- and

- the maintenance of the track maintenance/renewal mechanical equipment.

Construction jobs are undertaken at two shops. The Athens shop serves both Athens and Peloponnese region, whereas the Thessaloniki shop serves the local region.

On-site maintenance is undertaken by mobile gangs.

7.3.5. Signalling and Telecommunications

The narrow-gauge part of the network lacks any kind of conventional signalling. Traffic is controlled by radiotelephones, and, provided that the line is single, crossings take place at manned stations. A project for the installation of an electromechanical signalling system in the Athens-Patras part of the Peloponnese network is under way.

Standard-gauge lines employ a mechanical signalling system. Modernization plan involves also modernization of signalling. Plans for Central Traffic Control systems have been adopted for the main line, whereas the first CTC system, controlling traffic on the Tithorea-Domokos single-tracked segment of the main line (121 km), which will still remain single-tracked after the completion of this phase of modernization due to very difficult terrain, is already operating.

In addition to making use of the national telecommunications network, Greek Railways possess their own telecommunication lines, running parallel to the track. Modernisation of this system is also under way on the main line and the Athens to Patras line.

The responsibility for the maintenance of signalling and telecommunications systems, as well as of electrical installations and level crossings guarding systems rests within Signalling, Electrical and Telecommunications Units (TTHE). Till recently, these regional units were contained within the regional structure, the head electrical engineer of the unit reporting to the head of the regional department. Since 1987, a vertical organization has been employed, these three units reporting now to the signalling, electrical and telecommunications division (YSTHE), which formerly was a headquarters unit.

7.3.6. Railway Operations

Responsibility for both transportation and commercial activities lies, according to the formal organizational structure, within the regions. A regional division of operations (YEK), headed by a transportation engineer, manages a structure consisting of:

- (1) Area inspectors (EPITH), each of which is broadly responsible for commercial activities and terminal operations over an area broadly coinciding with that covered by the Permanent Way Area Engineer (TM.GR).
- (2) The Train Crews Control Central Office (KGPA).

The area inspector (EPITH) supervises the activities of stationmasters, travel offices, and freight depot masters. The crews control central office (KGPA) controls and co-ordinates crew utilization through local crew offices (GPA).

A major characteristic of terminal operations in the Greek Railways is the disproportional number of manned stations respectively to the traffic they handle. This relates to the characteristics of the network already described, i.e., to the single track and the inadequate signalling, which place the traffic controlling duty to local stationmasters. It also relates to the population distribution within the country, where, in a total population of approx. 10 000 000, half of it is living either in the Athens (4 000 000) or the Thessaloniki (1 000 000) metropolitan areas, whereas only three more cities have a population in excess of 100 000 (Patras, Larissa, Volos).

A second characteristic is the large number of level crossings, which imposes to the railway both direct (manning requirements) and indirect costs (accidents in unmanned level crossings).

Overall, the function of the operations system of the organization may be viewed as purely technical. No commercial activities are undertaken within this structure. Although the formal organization assigns this duty here, it is difficult to believe that local stationmasters have either the skills or the time to act as local agents of the railway company.

7.4. OWNERSHIP AND CONTROL OF GREEK RAILWAYS

Until September 1962 two railway enterprises existed in Greece:

The Greek State Railways (SEK), operating on the standard gauge network and the narrow gauge network of the former Thessaly railways (ThS). This enterprise was ran as government department, directly subordinate to the Minister of Transport.

The conglomerate of the former distinct private companies Athens-Piraeus-Peloponnese Railway (SPAP), Northwest Greece Railway (SVDE) and Pyrgos-Katakolon Railway (SPYK), operating as a private company, independent from SEK. This independence was reinforced by the physical and operational (different gauges) separation of the two networks.

In September 1962, under the 4246 Law, the two companies merged into one, with the status and the name of Greek State Railways (SEK). This company changed its status (from government department to autonomous public enterprise) and its name to Greek Railways Organization (OSE) in 1970, forming what is the contemporary under study company.

OSE, as an enterprise, belongs 100 % to the Greek State. The president, vice-president and four more of the nine members of the Board are appointed by the Government.

Like most railway enterprises, OSE lacks a precise definition of objectives from the state-owner's point of view. External control over the enterprise is attempted mainly by financial control. Since the enterprise's financial results produce continuously a deficit, and since the investment plans draw heavily on state support, government's financial control has gradually extended to such operational issues as personnel recruitment, personnel salaries, pricing policy, purchase of equipment and materials, etc. To be precise, rather than recording a move towards the direction of increased state intervention, one could identify the absence of a move towards the implementation of the legislation which produced an autonomous enterprise (OSE) in the place of a government department (SEK). Thus, in practice, not much has changed since the pre-1970 period, though official records indicate the contrary.

7.5. THE PERFORMANCE OF THE ENTERPRISE

Table 10 provides a picture of the 12 networks within the European Community, as emerging from International Union of Railways (UIC) data, for the year 1985. Since comparisons cannot readily be made by the use of the information in this table, *Table 11* produces comparable indices. Thus, as may be seen, though OSE has one of the lowest ratios of number of personnel per km of railway line (which, at first might be seen as justifying frequent requests for permission to employ additional staff), at the same time OSE has very low productivity indices, both in terms of production per employee and in terms of production per km of railway line. Though productivity is strongly related to technology-in-use as well (which cannot be revealed by these indices), the poor performance of the company is quite clear, especially in comparison with networks of similar population densities and size.

Poor performance of the under study company is reflected in its market share, both in the passenger and the freight traffic businesses. *Figures 22* and *23* display the market shares of selected European Railways for the year 1983 (data from European Conference of Ministers of Transport). The share of the Greek Railways (4% in passenger and 8% in freight transport respectively) is probably the lowest in Europe. Besides organizational characteristics leading to poor performance, the following notes should be made, to provide for a more clear picture:

- (1) Traditionally, freight in Greece has been the duty of sea transport. Recall that a large number of ships carry the Greek flag, which by the way, is not an opportunity flag, in that almost all of these ships belong to Greeks.
- (2) As a result of the geographical position of the country, transit traffic is almost negligible.
- (3) The majority of substantial industrial units are located either next to a port (i.e., bauxite mines, aluminium, cement factories) or next to production (coal mines adjacent to electricity production units).
- (4) Greek Railways do not operate any urban or suburban passenger services, which, in most cases, account for a large part of the reported performance statistics.

Figure 24 shows the development of the traffic transported by Greek Railways during a period of 15 years (1970-1985). After a period of continuous decline, traffic volume has

started increasing slightly since 1985 but, nevertheless, it still fluctuates around the values of early 1970's. Considering that during these 15 years overall traffic has substantially increased (e.g., the numbers of cars in operation in 1970 and 1978 were 226 893 and 744 692 respectively, i.e. 3 282 % increase in eight years), the market share of Greek Railways is steadily decreasing.

Table 12 displays the annual deficit of the company expressed in both current and constant prices (base year 1977). The difficult financial position of the company is clear. However, no conclusions concerning financial performance can be drawn, since the railway holds the government partly responsible for these financial results, for not complying to the articles of the existing financial agreement (i.e., not paying interest payments, not subsidising financially non-viable lines, enforcing unfavourable pricing policy, etc.)

Finally, *Table 13* shows the numbers of personnel employed between years 1978 and 1985. Considering that in years 1984-1985 1 859 people were employed in order to cover needs arising from the five-day week implementation and that, in the same years, staff employed in modernization projects and salaried against investment budgets has been included (which was not the case till 1983), no significant changes are recorded. On the other hand, the large number of seasonal staff exerts a pressure (requiring a permanent job), which in Greece is usually resolved in periods immediately prior to general elections; i.e., every party in power exchanges political support with a permanent job, validating the conclusions made in *Chapter 5* (influence of political considerations) and recycling the problem of preferability between social ease (judged in this case by the rate of unemployment) and public enterprise's performance.

RAILWAY	COUNTRY	Area (km ²)	Popltn (mln)	Characteristics		Railway Traffic			
				Length (km)	Personnel	Passengers (million)	Passenger-km (million)	Tonnes (million)	Tonne-km (million)
BR	Great Britain	244 046	56 760	16 670	171 400	689.4	30 800	138.4	16 565
CFL	Luxemburg	2 586	360	270	3 785	10.6	224	14.6	543
CH-OSE	Greece	131 944	9 970	2 461	14 596	11.7	1 950	4.1	689
CIE	Ireland	70 283	3 540	1 944	5 000	21.7	1 075	3.1	574
CP	Portugal	92 082	10 290	3 603	21 433	224.5	5 803	5.3	1 328
DB	F R Germany	248 577	61 050	27 490	272 790	1 023.0	41 397	277.2	9 581
DSB	Denmark	43 069	5 120	2 471	21 437	144.3	4 536	7.4	1 791
FS	Italy	301 225	57 220	16 088	214 947	397.0	40 500	51.7	17 476
NS	Holland	40 844	14 560	2 817	27 474	210.5	8 919	19.1	3 107
RENFE	Spain	504 782	38 760	12 721	66 509	193.4	15 646	29.4	11 077
SNCB	Belgium	30 513	9 910	3 618	55 193	139.1	6 069	63.3	7 442
SNCF	France	337 032	55 390	34 441	233 404	769.0	59 618	144.5	51 016

Table 10: The Twelve Railways: Principle Characteristics

RAILWAY	popltn density inhbts/ sq.km	employees per km of railway line	passenger- km per employee	tonne- km per employee	passenger-km per km of railway line	tonne-km per km of railway line
BR	233	10.28	179.69	96.64	1 847.63	993.40
CFL	139	14.02	59.18	143.46	829.62	2 011.11
CH-OSE	76	5.93	133.60	47.20	792.36	279.96
CIE	50	7.72	71.67	38.26	552.98	295.27
CP	112	5.95		61.96		368.58
DB	246	9.92	151.75	35.12	1 505.89	348.53
DSB	119	8.68	211.59	83.54	1 835 69	724.81
FS	190	13.36	188.42	81.30	2 517.40	1 086.27
NS	356	9.75	324.63	113.09	3 166.13	1 102.95
RENFE	77	5.22	235.25	166.55	1 229.93	870.76
SNCB	329	15.26	109.95	134.84	1 677.45	2 056 94
SNCF	164	6.78	255.43	218.57	1 731.01	1 481.26

Table 11: The Twelve Railways: Productivity Ratios

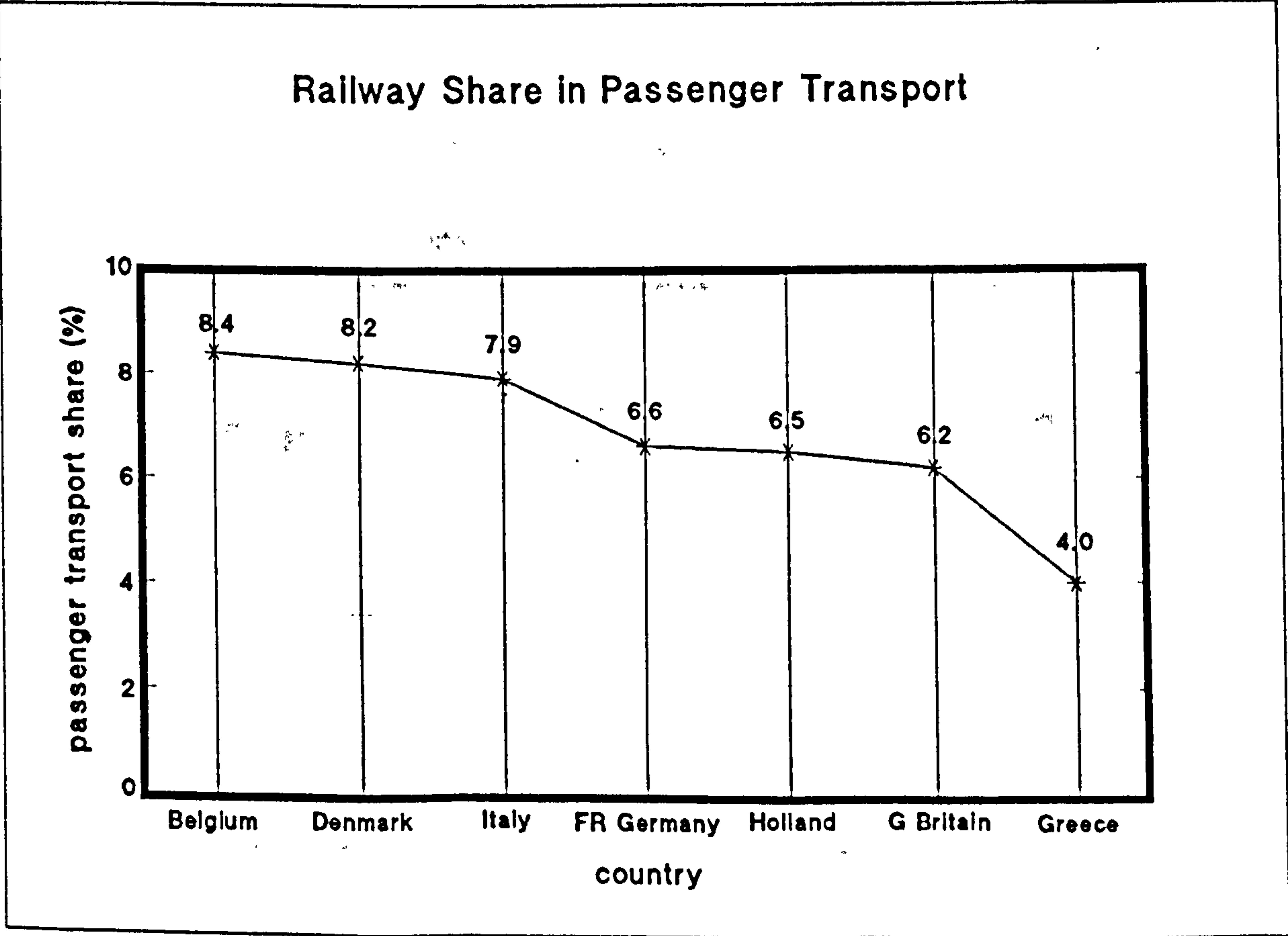


Figure 22: Railway Share in Passenger Land Transport in Selected Countries (1983)

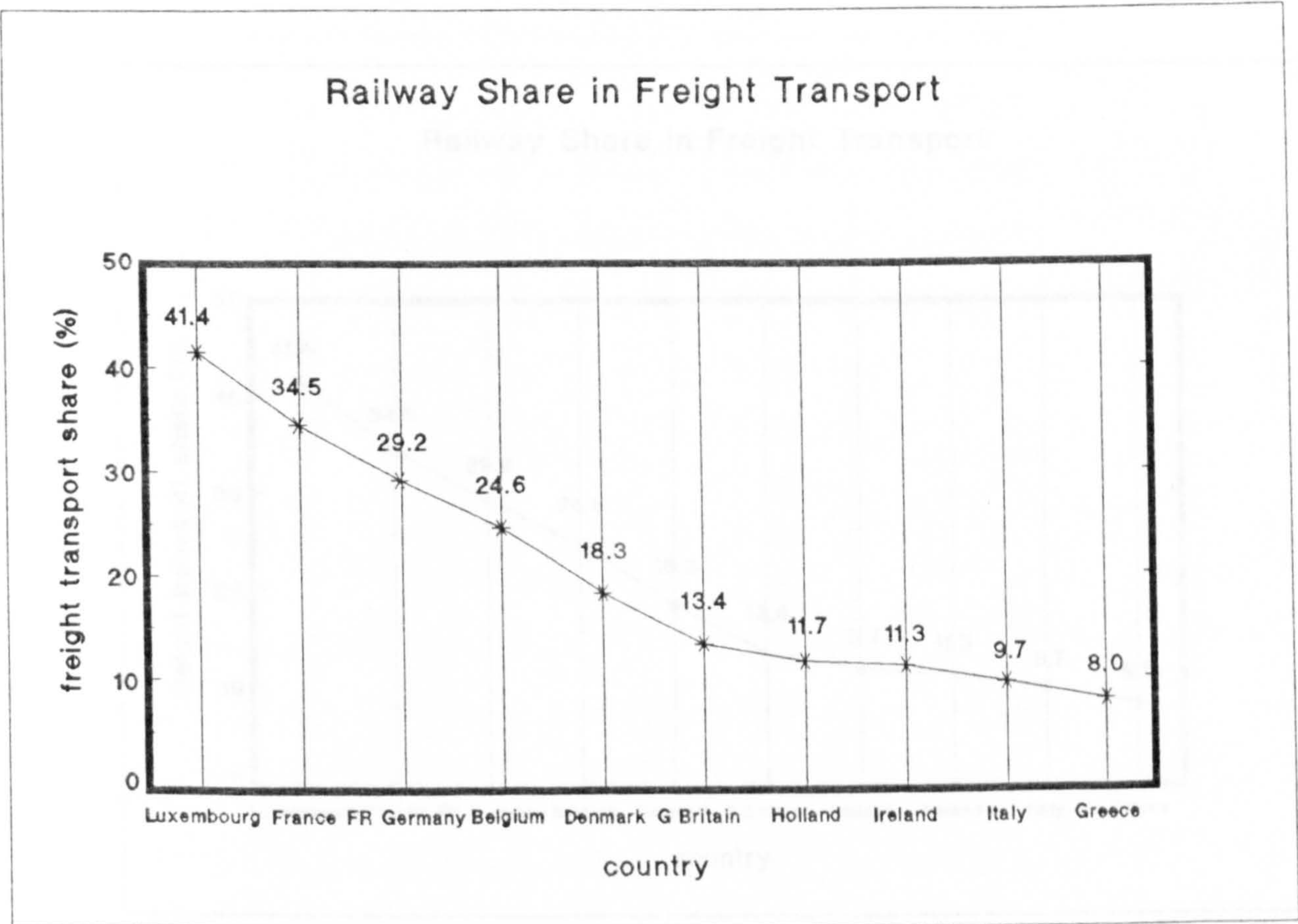


Figure 23: Railway Share in Freight Land Transport in Selected Countries (1983)

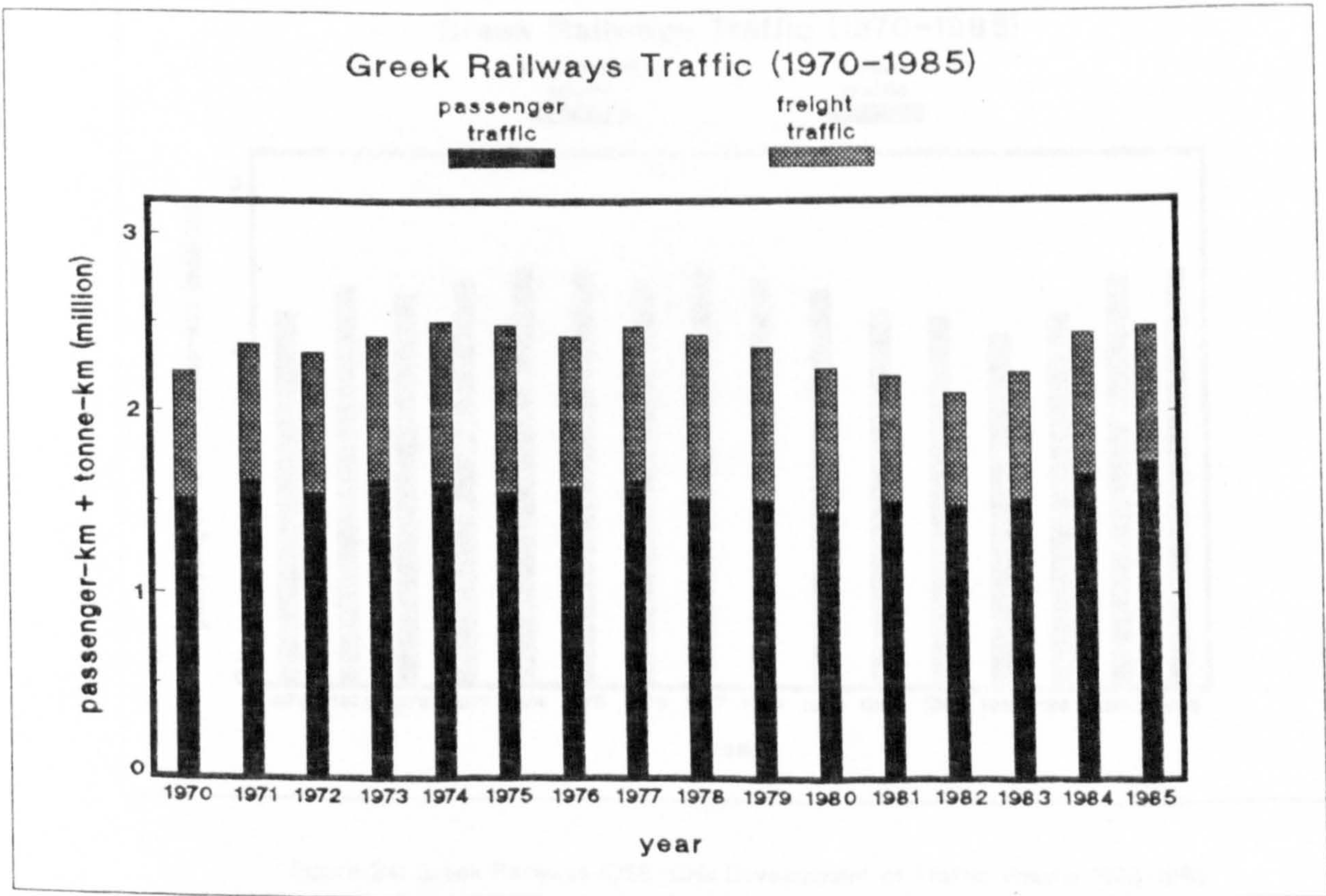


Figure 24: Greek Railways (OSE-CH): Development of Traffic Volume 1970-1985

year	real prices		constant prices (1977)	
	million drs.	% change	million drs.	% change
1979	1 872	+ 24.1	1 109	+ 0.6
1980	2 323	+ 38.8	1 116	+ 20.0
1981	3 224	+ 59.8	1 339	+ 22.9
1982	5 154	+ 20.9	1 646	- 3.1
1983	6 232	+ 26.0	1 595	- 6.8
1984	7 853	+ 43.3	1 486	+ 9.2
1985	11 252		1 623	

Table 12: Greek Railways: Annual Deficit 1979-1985

personnel	y e a r							
	1978	1979	1980	1981	1982	1983	1984	1985
1. permanent								
offices personnel	1 383	1 355	1 325	1 310	1 287	1 234	1 238	1 226
operations	2 951	3 011	2 904	2 851	2 980	2 873	2 775	3 174
rolling stock	3 225	2 849	3 055	2 791	2 859	3 039	3 237	3 262
permanent way	3 394	3 301	3 169	3 085	2 995	2 974	2 779	2 670
other operational	330	589	350	565	345	356	313	314
permanent total	11 313	11 105	10 803	10 602	10 466	10 476	10 342	10 646
2. seasonal	1 670	1 367	1 337	1 516	1 400	1 708	3 074	4 434
total	12 983	12 472	12 140	12 118	11 866	12 184	13 416	15 080

Table 13: Greek Railways: Staff Employed 1978-1985

7.6. THE ORGANIZATION OF THE GREEK RAILWAYS

Today's organizational structure of the company is the best image of ambiguities concerning its objectives, capabilities and relationships both with the state/owner and the environment. A brief historical explanation is provided, since, without this explanation, much of the structure seems irrelevant. The following periods will be considered:

The period prior to the SEK-SPAP merger (1962);

The period of nationwide government ran railway (SEK, 1962-1970);

The period of state-owned autonomous enterprise (OSE, 1970-1983); and

The recent period, after the 'socialization' of the railway enterprise (1983-today).

Organizational structures for each of these periods are displayed in *Appendix B* (Figures B1 to B4).

7.6.1. The Period Prior to the SEK-SPAP Merger (1962)

As stated, till 1962 two major companies were operating: state-owned SEK, ran as a governmental department, and private SPAP (and SVDE over a 75 km line from Kryoneri, opposite to Patras, to Agrinio). As gradually both SPAP and SVDE went public, discussions started for the merger of all railways into one company. With the exclusion of the third Regional (Peloponnese) Department (DPP), *Figure B1* corresponds to the organizational structure of SEK at that time (1958). The structure consists of two regional departments, Athens Region (DPA) and Thessaloniki Region (DPT_h), reporting directly to the General Manager. Within each of the two regions, three principle divisions operated: Operations Division (YEK), Track and Permanent Way Division (YGR), and Rolling Stock and Materials Division (YEL). Tasks of each division were carried out as follows:

Operations Division Manager (YEK) was reported by four Operations Area Inspectors (EPITH), each of whom was responsible for a number of stations and traffic bureaus on a geographical basis.

Track and Permanent Way Division Manager (YGR) was reported by four Track Area Managers (TM.GR), one Area Manager for Bridges and Ironworks (TMK), and one Area Manager for Telegraphs/Telecommunications (TT), the two later having responsibilities over the whole region. Each Track Area Manager (TM.GR) was reported by a number of foremen, responsible for parts of the network. Similarly, Bridges Manager (TMK) was reported by bridges/ironworks shop foremen and foremen of the mobile maintenance units. Finally, Telecommunications Manager (TT) was reported by a number of maintenance foremen.

Rolling Stock and Materials Division Manager (YEL) was reported by the Regional Workshop Manager (ERSIA), controlling his unit with the help of workshop foremen, and the main regional depot manager (MHXSIA), responsible for his depot (through foremen) and for small local depots (through their managers).

The Regional Department had its own administrative, financial control, operational control, etc. offices.

Outside the decentralised structure, five headquarters departments were reporting to the General Manager:

Financial Affairs (DOY),
Permanent Way (DG),
Operations (DEK),
Traction and Materials (DEL), and
New Projects (DMK).

The last one (New Projects Department) reflects within the railway environment an old national tradition, according to which national development is viewed as an aggregation of projects, notably civil engineering projects. Though in early periods of the country's independence this view might be justified by the lack of the necessary infrastructure, it has always ever since been like that. Thus, at a government level, a Ministry of Public Works has always existed, with responsibilities extended to whatever might be assessed as major project: hydroelectric stations, motorways, ports, airports, hospitals, etc (unfortunately railway's infrastructure never happened to come under the wings of this gigantic Ministry, hence the underdevelopment).

Besides this irrelevant New Projects Department (DMK), the rest of the headquarters structure seemed rational. The role of these departments was merely that of monitoring, coordinating and planning at corporate level, without having any organizational power over the regional structure.

At the same time, the organization of SPAP was similar, but simpler, in that it lacked a regional structure, since the company was in fact contained within one geographical region, the Peloponnese.

7.6.2. The Nationwide SEK Period (1962-1970)

The merger added to SEK's organizational structure a third region, the Peloponnese (DPP), beyond which no other major change in structure was recorded. Headquarters departments and offices accounted only for 1.9% of the total personnel number, with 252 employees. Organizational structure of that time is displayed in *Figure B1*.

Sofrerail ⁶, which undertook at that time a study of Greek Railways on behalf of OECD (1966) ⁷, made a number of proposals concerning, amongst other, the organizational structure, and noted:

"The present decentralised organization of SEK is fully compatible with the physical layout of the network; the three regional departments correspond to distinct geographical units, having specific characteristics as regards transport economy in the country..."

As a general rule, Regional Departments assure complete accountability over the day-to-day railway operations. Headquarters departments and units should remain as coordination and planning units, with no direct control over regions. Control is achieved via the general manager..."

We find this solution the best possible and propose to be retained..."

As we have already noted, the manpower of the headquarters departments and units should be increased. However, it is essential in our opinion, to avoid any trend of these units to intervene in regional administration issues, as this trend might result from an increase in their manpower..."

Directions should always be given from the general manager to regional managers. Under the framework of these directions, regional managers should retain full managerial control".

As a result of Sofrerall's advices, a major reorganization of headquarters units took place, the most significant changes being:

The creation of a new department (DOMP) in the place of the old DOS, with responsibilities over short- and long-term planning, statistics, costing, investment, computer applications and personnel education.

The recognition of the significance of commercial operations, reflected in the dichotomization of the Operations Department (DEK) into two parts: Technical Operations (DET) and Commercial Operations (DEM), the former being a synonyme to Transportation.

An increase in the manpower of headquarters units.

In order to avoid misunderstandings and to obtain a more integrated picture, the following characteristics under which the railway reorganization was taking place must be stressed.

- (1) The railway still lacked any quantificative set of operational objectives. Major objective was (and probably still is) the modernization, realised mainly as the updating of an old infrastructure. It was hoped (and, in some ways, still is) that a modern and fast railway will inevitably produce better financial results. Thus, the modernization effort was realised as a series of mainly civil engineering projects.
- (2) The whole country was undergoing a reconstruction. Roads, ports, airports were under construction. House building was probably the major financial activity as the country was undergoing a rapid transition from agricultural to industrial and the cities (notably Athens and Thessaloniki) were growing very fast.
- (3) Within this context, the role of the engineer, notably the civil engineer, was assessed as being central to the issue of development. Being so at a national level, it was even more within the railways, where, traditionally, engineers had been the 'ruling class'. Thus, all innovations proposed by Sofrerall in practice came under the hands of engineers, who in fact had not much to do with costing, statistics, computers and investment. On the other hand, since no pressure existed for a commercial orientation of the company, the commercial operations department (DEM) never gained a significance within the organizational structure and never obtained neither a group of specialists nor a 'loud voice' within the enterprise.

7.6.3. The 'Autonomous Enterprise' OSE period (1970-1983)

All above statements extend into the period starting at 1970, with the creation of an autonomous public enterprise (OSE) in the place of the government railway department (SEK). In fact, Sofrerall's intervention was related to government's wish to cope with the problem of the poor-performing state-owned nationwide railway, and the report it produced was taken as basis for the design of the new enterprise. Sofrerall's consultancy, extending as already stated to a number of company's issues, ended as late as 1977.

As Sofrerail had forecasted, the increased power of headquarters units (increased in fact both in quantitative and qualitative, i.e., status terms) resulted to a gradual alteration of the balance of power between headquarters and regional departments.

A first reason was that since the enterprise lacked any commercial orientation and its performance was related to the completion of a series of modernization projects, it was assumed that these projects could be better supervised centrally. For example, since the introduction of track continuous welding required some specialised knowledge, and since this knowledge existed (to the degree that existed) within the headquarters Permanent Way Department (DG), and since most of the Permanent Way system operation was a series of such modernization projects, the control of the regional Permanent Way Division (YGR) passed, in reality, from the regional manager (DPER) to the Permanent Way manager (DG), though this was never reflected in the existing organization structure. Indeed, the Permanent Way (DG) manager had no reason to ask for formal control over regional Permanent Way Divisions (YGR), as far as this kind of control is always associated with accountability and performance assessment. Headquarters departments gained gradually total control of what should be done, when and how, without having any responsibilities for the actual results.

A second reason relates to the bad financial position of the railway and results, paradoxically at a first glance, to the multiplication of headquarters departments. Till very recently (1985), salaries within OSE were related to organizational position. Obviously, the highest salaries corresponded to the rank of the Head of Department. The bad financial position of the railways (and the state control over salary policies) did not allow for salary increases. Thus, the enterprise had to find a way of compensating its upper level employees, and this was achieved by dichotomizing almost any Department which could produce a minimally acceptable reason for this dichotomization. A careful look at the *Figures B1, B2, and B3 (Appendix B)* will reveal the way in which the four headquarters departments of the 1960s became fourteen in late 1970s. Besides the formation of DOMP and the dichotomization of DEK into Commercial (DEM) and Technical (DET), the following took place:

A Personnel Department (DP) was formed, which, gradually, took a lot of personnel responsibilities out from the regional structure. This department in 1980 produced a counterpart, the Administrative Affairs Department (DD), which tries hard to define beureaucratic duties in order to justify its existence.

Financial Affairs Department (DOY) produced two more: Financial Control Department (DOE) and Receipts Control Department (DEE) under broadly the same process.

Responsibility for materials was taken from the Traction and Materials Department (DEL) and a Materials and Stores Department (DYL) was formed, further broken down in 1980 into Purchases Department (DIP) and Stores Department (DAP).

A New Projects Department appears from time to time under different names, either as DMK, or DK, or, recently, as DNE.

This organizational confusion relates also to pressures of the non-engineering personnel over a structure, which, under the 1960s organization, provided only one (1) place for promotion to upper managerial jobs for not engineers, i.e., the Department of Finance (DOY).

Ending up with fourteen headquarters departments, a way of co-ordinating and controlling them should be invented. Thus, since the former rank of General Manager had been replaced by the Governor and the deputy Governor, provision was made for three general managers, with responsibilities over Personnel and Finance, Rolling Stock and Materials, and Permanent Way and Operations respectively. Three more top level jobs were created, increasing thus the

opportunities for better paid upper personnel, and minimising the possibilities for management control over the enterprise. *Figure B2* illustrates this counter-productive structure. Under such a structure there is little wonder why actually accountability terminated at the regional divisional level (YEK, YEL, and YGR).

7.6.4. The 'Socialised' Railway Enterprise (1983-today)

The election of a new government in 1981 produced hopes that things might change. A first move, i.e., the elimination of the three general managers places was promising further changes. However, the new management didn't prove to be much more thoughtful than the one it replaced, though it engaged in a lot of non-professional attempts to put this structure into move. Thus:

A sort of matrix corporate management was attempted in 1983, by the formation of two groups, a long-term (strategic) planning group and a short-term (tactical) planning group. Both groups had a sort life, mainly because their members lacked a corporate status within the company (particularly the tactical planning group consisted of willing-to-help rather young employees, without decisive positions within the vertical functional structure), but also because top management had not set clear objectives.

A Co-ordination Department (DIS) was formed in 1984 and abandoned three years later, without anyone taking in fact notice of its existence. Indeed, within an enterprise where everyone is "coordinating", since, as explained, neither headquarters nor regional management had, for a long time, bottom-line responsibilities, it would be strange to assess that what was lacking was a coordinating department.

Before discussing further organizational changes, having resulted to the contemporary structure (which are of importance since managers of this structure are the subject of the survey to follow), a few notes should be made on the developing general climate during this period, which is relevant to this study, since it had a lot of implications on both the character and the structure of the enterprise.

General elections of 1981 brought in power the Socialist Party, with a strong public support (48 % of the votes), which support was renewed in 1985, though somewhat reduced (45 %). This was the first time that a non-conservative party was forming a government in this country. Great expectations were grown among the majority of the population (recall that another 10-12 % vote for the Communist Party). These expectations related also to emotional factors, taking into consideration events in recent history of the country such as the Resistance (1941-1944) guided by the Left, the Civil War (1946-1949) and the military dictatorship (1967-1974). These emotional features were exploited to the end by the rather populist character of the Socialist Party, and, indeed, were one of the keys to its electoral victory. Thus, issues like self-management of public enterprises, central role of trade unions to the development, and the like, were very popular, though not at all defined and planned in any details. At the same time, since all-over-the-world civil servants and public enterprises personnel are the very first, among the working population, to declare their support to the ruling party, not surprisingly public sector trade unions "went socialist" (though this argument draws on personal experience, it would be unjust to assume that support to the government was limited to the public sector; as already stated, the ruling party holds a strong majority of votes). A central element in the party's electoral programme was that of the 'socialisation' of basic sectors of the national economy. The term was in fact an invention to replace not very popular definitions such as nationalization, state-ownership, etc. The clear meaning of socialisation was never realised as far as private sector of the economy is concerned. In this sector, things proceed in the way they have always been, during the long pre-socialists period, i.e., under a framework of state paternalistic capitalism, where government's intervention varies in magnitude in different

periods, defined primarily not by ideological/political terms, but by the overall performance of the national economy. However, since something should be done about "socialisation", as it constituted a major pre-electoral promise, it was applied to the public sector of the economy, precisely to three public enterprises: the railways, the telecommunications, and the electricity. The socialisation of the public sector was not strongly supported by either the personnel of the enterprises, or the public opinion formulators, since it was disgraced from the very beginning. Indeed, the Law for the Socialisation of Public Enterprises, passed in Summer 1983, consisted of four articles, from which only the fourth became immediately active, i.e., the one posing restrictions to industrial action in the public sector. The other three articles had to wait for two more years. Nevertheless, when implemented, "socialisation" of the Railways involved the creation of a number of social control bodies, referred to earlier in this chapter, personnel's participation in the Board, and the creation of four assistants to the General Manager, with duties similar to those of the three general managers abolished by the ruling party, when it came in power in 1981.

Figure B3 illustrates the actual organization at the time of the survey (summer 1988). Social Control Central (ASKE) and Regional (PESKE) bodies, or Work Conditions Monitoring Committees (KES), introduced by the socialisation, are not displayed, otherwise the chart should not be readable. During this last period, top management arrived at the opinion that an organizational solution to the problems should involve the formation of a vertical Type I functional structure, to replace regions, which, anyway, had in practice lost any managerial power. *Figure B4* illustrates the proposed structure, which, having been approved by the Board awaits ministerial approval (controversially, in an 'autonomous' public enterprise, even organizational changes are subject to the approval of the minister). Though not yet officially introduced, Type I structure is gradually being implemented. Thus:

Any kind of responsibility for rolling stock repair/maintenance has been taken away from the regions and belongs now to a vertical organization (Department of Rolling Stock-DISTY).

Signalling, Electrical and Telecommunications Regional Units (TTHE) report now to a functional division (YSTHE), not having yet the status of a department, for which provision is made in the new organization (DHST).

The actual organization of OSE, may, therefore, be defined, according to Wyckoff, as hybrid: some functions (rolling stock, signalling) are managed vertically, some other (operations, permanent way) are managed regionally. Indeed, this is not exactly the real case, since regional management, awaiting its from day to day abolition, refrains from interfering in functional matters and just plays a figurehead role at a geographical basis, indeed not very convincingly.

The lack of any proper foresight for the kind of organization that top management wishes to implement is also reflected in the way in which the managing team is working. Thus, there is a technical division of duties between the four assistants to the general manager, each of whom has responsibilities over the following broad areas:

- operations,
- rolling stock,
- permanent way, and
- personnel and finance.

Each of the assistants to the general manager has been promoted from the functional area for which he is today responsible. Thus, in general, he tends to favour the views of

his function, as contrasted to views of other functions, whenever conflict arises. In this cases, conflict resolution is achieved by the intervention of the general manager, whose role is central in this structure, since, according to the legislation he has been appointed directly by the Prime-Minister (considered having consulted the Minister of Transport), and is the only 'political' person in the managerial hierarchy.

No provision for an assistant with commercial responsibilities has been made. This duty has been allocated to the operations assistant, who is an engineer. Thus, at top level, the company returns to the pre-Sofrera period, as regards the formal recognition of the significance of commercial operations.

7.6.5. The Future

When implemented, the new organization, besides having the problem to think of a possible way of discharging the commercial function, will also have to solve a number of technical problems:

- (1) What will the duties of the four assistants to the General Manager be. Obviously the present structure cannot survive, since it inevitably leads to duplication. For example, what will the duties of the operations or the rolling stock Assistant be, since, under the new structure, only one relevant functional manager reports to him. Note that some duties have been left to the Permanent Way Assistant, since the new organization still makes provision for three relevant departments: permanent way, signalling and telecommunications, and new projects.
- (2) Which way will functions be coordinated locally ? Though some provision has been made for a sort of a horizontal organization consisting of the heads of the respective local functional units, coordination seems doubtful in the absence of a commercial function.
- (3) What is the rationale for the existence of a New Projects Department in a Type I structure ? Since the enterprise is organised functionally, which are these projects which cannot be contained within functional departments?

7.6.6. Conclusion

The up-to-know poor performance of the under study company may, partially, be assigned to its inadequate or wrong organization. However, this is not the only limiting factor. Management control problems in public enterprises, discussed in *Chapter 5*, and related to public ownership seem to constitute the core of the problem. Beer's model may be used in order to identify organizational failures or deficiencies. Moreover, the rationale of the cybernetic methodology itself may be adopted as a guide, in order to assess the future of the company as deriving from managerial opinions on key issues.

7.7. FOOTNOTES

1. A brief history of the Greek Railways is provided, amongst other publications, in: Greek Railways (OSE), 1984: *A Synoptical History of the Hellenic Railways* (OSE, Athens).
2. The history, operation, problems and future of the Peloponnese narrow-gauge railway are discussed in: I.Paradissopoulos, 1986: *The Peloponnese Railway: Problems and*

Perspectives (M.Sc.Thesis, Institute for Regional Development, Pantios Graduate School of Political Science, Athens).

3. Options, concerning the immediate post-war period, are contained in the following publications (in Greek):

D.Efstratiades, 1954: "The History of the Railway Reconstruction", *Synkoenonia* (Transport), October, pp.1-42.

D.Efstratiades, 1957: "A General Plan for a Nationwide Rail Network", *Synkoenonia* (Transport), March-December, pp.1-61.

D.Efstratiades, 1959: "Thoughts about the Rail Problem", *Synkoenonia* (Transport), August, pp.3-11.

E.Frohne, 1959: "A Study of the Condition of the Greek Transport System with Specific Reference to the Railways", Report to the Greek Government, Athens, January.

Greek State Railways, 1959: "Railway Management's Opinion on Mr.Frohne's Proposals", SEK, Athens, April.

D.Efstratiades, 1959: "The Five-year Plan for the Reconstruction of the Peloponnese Railway and the Benefits from its Implementation", *Synkoenonia* (Transport), December, pp.3-7.

K.Trikoupis, D.Sinis and N.Momferatos, 1959: "Report on the Condition of the Greek Railways and Proposals for its Improvement", Report to the Greek Government, Athens, October.

T.Marinos, 1960: "Modernisation and Financial Improvement of the Greek Railways", a study preliminary to the preparation of the Five-year Economic Development Plan, Athens.

4. Similar legislation applies to the Electricity and Telecommunications enterprises. When introduced, the legislation was supposed to be shortly extended to all public interest state-owned enterprises, but it has not yet.
5. A detailed description of the modernisation project is contained in: Greek Railways Organization, 1985: **Strategic Planning and Programming for the Improvement of the Railway Transport Services and the Overall Performance of the Company (1983-1997)**, Planning and Programming Department (OSE, Athens), September (in Greek).
6. Sofrerail is a subsidiary of the French Railways (SNCF), acting as an international railway consultant, in a role similar to the BR-owned Transmark.
7. Organization for Economic Cooperation and Development (OECD), 1966: **A General Study of the Railways of the Greek State (SEK)**, Report prepared by Sofrerail, Paris.

CHAPTER 8

CASE STUDY CYBERNETICS

8.1. INTRODUCTION

The previous parts of this thesis have provided information concerning both the theoretical framework (*Chapters 2-5*), and the way in which this framework relates to a railway enterprise (*Chapter 6*). Background information concerning the subject of this research, i.e., the Greek Railway, has also been provided (*Chapter 7*). It seems, therefore, that this is the time to undertake an investigation of the specific enterprise under the selected methodology. This investigation draws mainly on the author's perception of reality, being a result of a long-term actual participation within the company. It also draws on published material concerning the enterprise, i.e., the legislation defining its duties and organization, statistical information, etc.

Thus, the present chapter, providing a detailed account of the application of the viable system's model in the specific organization, reflects an '*ethnographic*' type of research, which might constitute an objective in itself and mark the end of this thesis. However, this is not actually the way in which the findings of this chapter will be employed.

This chapter should be perceived as a preliminary, or pilot, study, highlighting organizational problems, the real dimensions of which will derive by interpreting the views of the 'actors' of the management control issue, i.e., the managers of the enterprise themselves. The general layout and the characteristics of the survey within the case study which follows draw heavily on the findings of this chapter. By making this explicit, the evaluation of both the survey design and findings is facilitated.

According to Espejo (1980), the response of the enterprise to the complexity of the environment is achieved through its implementation function, i.e., the subsystems which are doing what the enterprise is supposed to do. Thus, the organization of these subsystems is of central relevance in studying effectiveness. However, this is not enough; even if their organization is good, if the subsystems are not integrated to the company then the organization of the whole may not be effective. Moreover, even if this integration is achieved but the company as a whole does not have a capacity to assess whether it is 'doing' the right things, it may well be the case that the company may not survive in the long run. ¹

Thus, the cybernetic study of the Greek Railways, undertaken in this chapter, may involve the following three steps:

- (1) studying the organization of the implementation function;
- (2) studying the way in which this function is controlled by corporate management; and
- (3) studying corporate management itself.

8.2. THE ORGANIZATION OF THE IMPLEMENTATION FUNCTION

The implementation function of a railway enterprise consists, as discussed in *Chapter 6*, of four systems ONE, i.e., operations, rolling stock, permanent way and installations, and signalling and telecommunications. Whether these systems appear as systems ONE at the first or the second level of recursion relates, as shown, to the existence or not of regional organization. The resulting Type I and Type II structures have been presented. However, in trying to identify the implementation function in the case-study at the first level of recursion, a difficulty arises, which has to do with the unclear character of regional management.

Since the organization of the company is undergoing a change, the role of regional managers is further minimised, as they are expected shortly to be abolished after the introduction of a functional vertical structure. However, at the time of the survey, regional management (DPER) still existed and was supposed to preside over a regional organization consisting of operations (YEK) and permanent way (YGR) divisions. The study will first provide some reasons for the failure of regional management in terms of managerial cybernetics, and proceed in examining the four elements of the implementation function at the third level of recursion.

8.2.1. The Failure of Regional Management (DPER)

At the first level of recursion, the implementation function of Greek Railways used to consist of four systems ONE. Three of these systems were organized on a geographical basis and contained all operations, permanent way, day-to-day rolling stock maintenance, signalling, and telecommunications activities taking place within this area (Region). Three such regions existed:

Athens Region (DPA),
Thessaloniki Region (DPTh), and
Peloponnese Region (DPP).

A fourth system ONE, the Mechanical Engineering Department (DER, and then DISTY) was responsible for the production of the network's rolling stock workshops (Athens Workshop-EP, Thessaloniki Workshop-ETh, and Volos Workshop-EV). This structure is displayed in the VSM of *Figure 25*.

The principle legislation defining the organization of OSE and the duties of its parts is the 1975 Law *"On amending, supplementing and coding in a unique text legislation concerning the organization of OSE"*. This Law, though further amended, especially each time a new headquarters department was formed (as discussed in *Chapter 7*), may serve as a basis, since, fundamentally, it has not been altered.

According to this legislation, the Head of each of the three regional departments manages the part of the network under his command, being accountable for the implementation of commands, rules and directives of corporate management, and the proper functioning and optimum performance of the divisions under his command. Specifically:

- (1) Acts as head of the region's personnel.
- (2) Co-ordinates the activities of regional divisions or makes proposals to top management for the improvement of this co-ordination.
- (3) Monitors and controls the performance of the divisions and units within the region.

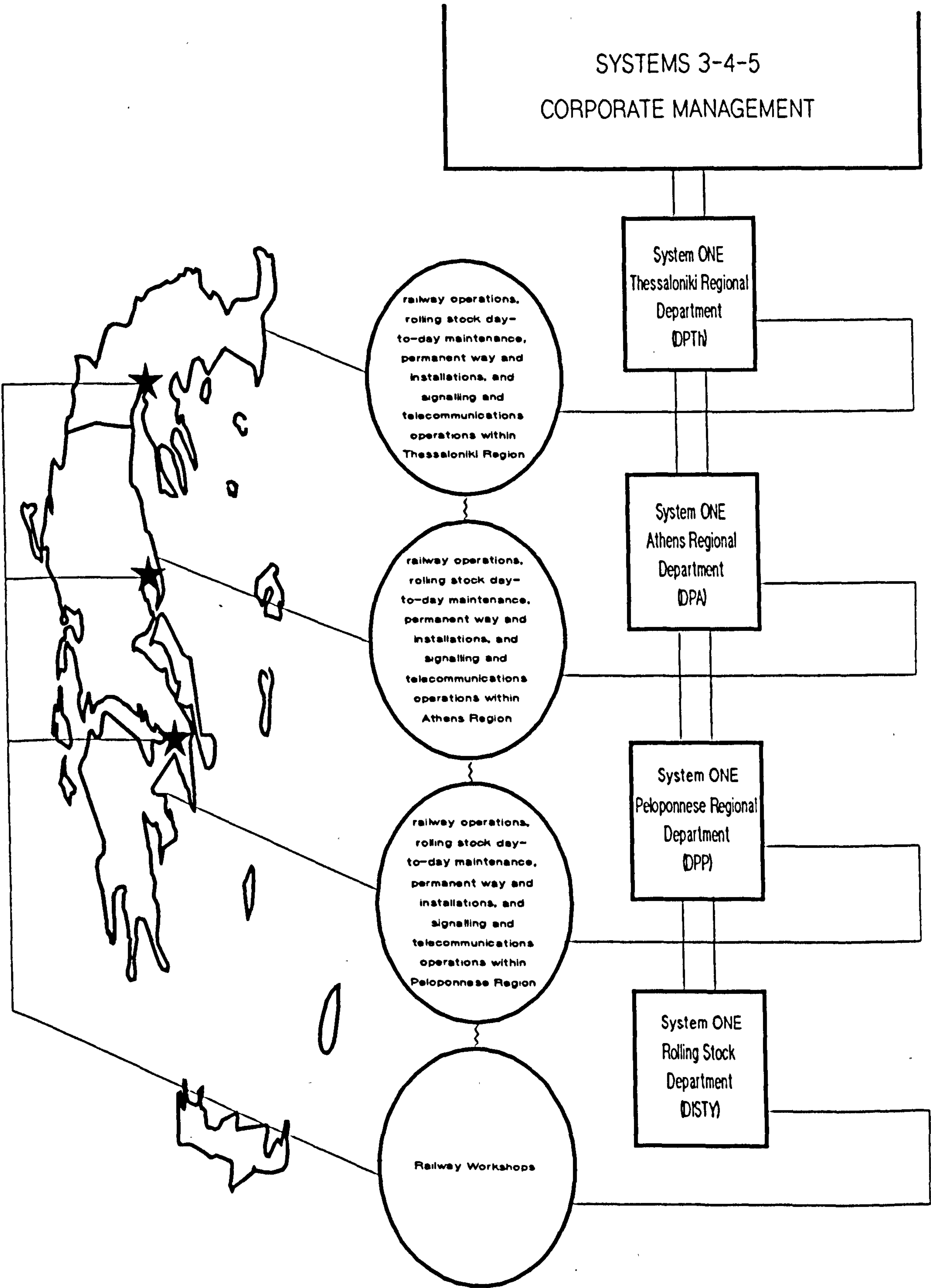


Figure 25: Greek Railways: VSM of Regional Structure

- (4) Monitors transport trends within the region and makes decisions or proposals in order to attract or increase traffic volume.
- (5) Monitors financial results of operations and makes proposals for alterations of pricing policies.
- etc.

Though this legislation seems to realise the region as a system ONE in its own right at the first level of recursion, from the very beginning poses constraints to this managerial freedom. Thus regional management's freedom is limited in that in most cases it is rather allowed to make proposals to the top rather than making its own decisions. Combining this feature with the inherited characteristic of the public manager, who will not very usually engage in proposals, especially when considering that these proposals will come under the scrutiny of an autopoietic bureaucratic corporate structure, we meet a major constraint in performance improvement within the first article concerning the duties of regional manager, that is, the lack of bottom line responsibility.

The same legislation does not make provision for any way in which the regional manager, even under these constraints, might discharge the stated duties. It doesn't provide for any sort of system TWO via which the regional manager should co-ordinate and monitor. In the formal organization, no unit or office directly reporting to the regional manager apart from the management of the functional divisions can be identified. In fact there is one more unit, the Administration Unit (DY), which is engaged in clerical duties, personnel affairs, etc. Thus, the regional manager is supposed to monitor the performance of a regional division, e.g., the permanent way division (YGR), either on the basis of information he personally receives and analyses or, more frequently, on the basis of complaints of the other regional divisions (operations, rolling stock, signalling) or headquarters departments (Permanent Way-DG, New Projects-DNE) related to the performance of this division. A sort of coordination might have been achieved if the planning process was intergrated within the region, and, further, within the company. However, this is not the case. Planning is an annual functional formal exercise with not at all regional integration. It is very usually the case, for example, for a major rolling stock maintenance building/installation construction project to be accepted and included in the annual plan, without the regional permanent way unit, which in fact will undertake all activities related with the completion of this project having the slightest idea, or having included the project in its annual programming, approved also at corporate level.

Similarly, regional system ONE lacks any sort of system FOUR, involved in continuous scanning of the environment in order to realise the future of the company within the region. Anything concerning the future of the company as a whole or as a sum of regions, is studied, analysed and decided at corporate level. Thus, regional management is cut off its environment.

Not possessing any sort of system FOUR operations and lacking any system TWO mechanisms, obviously Regional system ONE cannot perform any system THREE or system FIVE duties, apart from trying to resolve on a crisis basis, operational matters arising, by presiding over informal and not periodical meetings with divisional regional management. This situation is illustrated in *Figure 26*.

Thus, regional management's inherited inability to function properly has in fact led to its abolition, shortly to be formally expressed in the new organization structure. However, a number of real reasons which produced this outcome have already been postulated in the previous chapter.

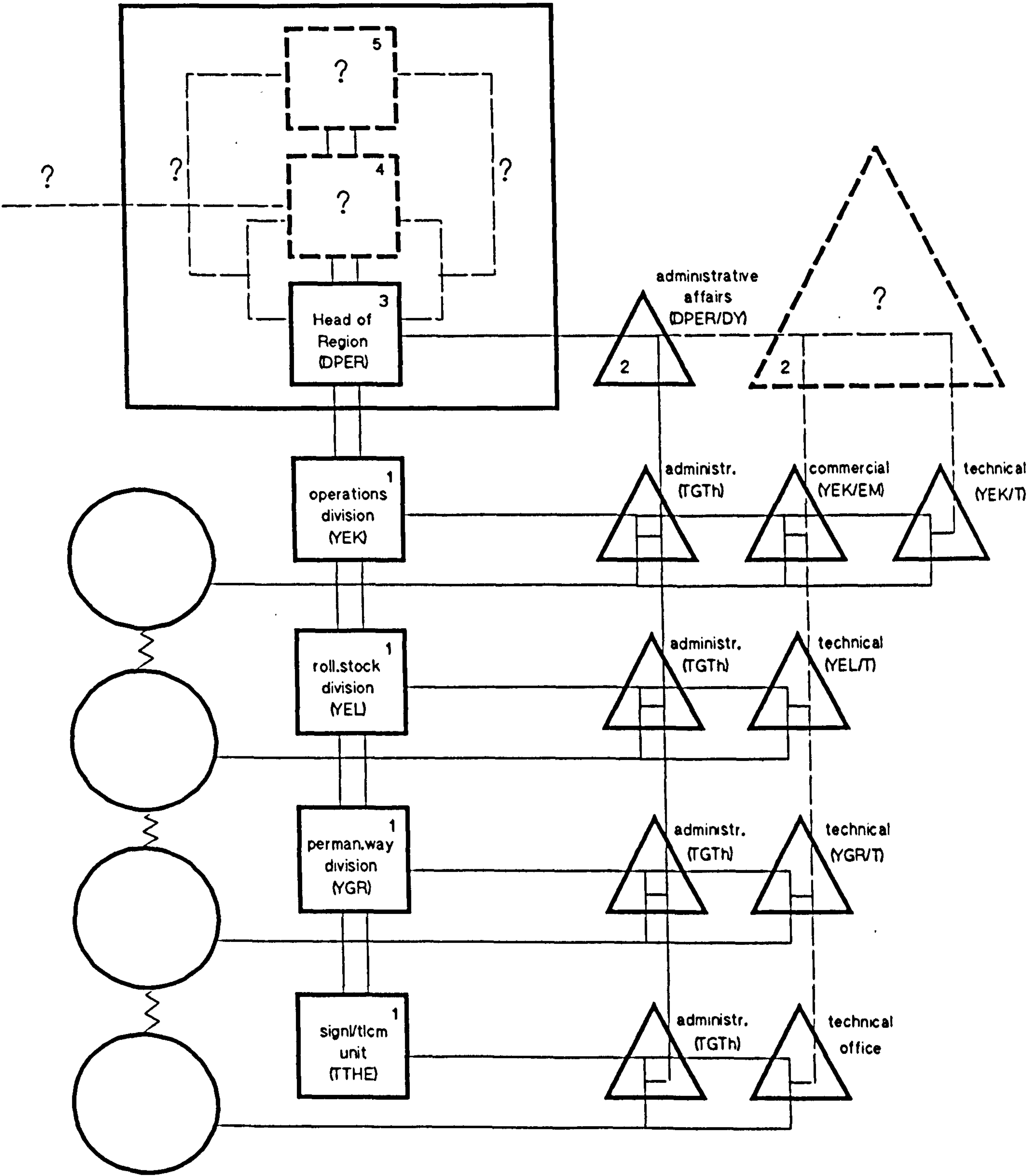


Figure 26: The failure of regional management in Greek Railways as a result of missing systems TWO and FOUR

Before reorganization, regional system ONE contained, at the next level of recursion, four systems ONE: operations, permanent way, rolling stock and signalling and telecommunications, which will, in turn, be examined.

Two of these four systems, i.e, operations (YEK) and permanent way (YGR) are still today contained within the regional structure.

8.2.1.1. Regional Railway Operations Division (YEK)

Figure 27 provides a flowchart-like illustration of the activities within system ONE railway operations. This illustration rests on the analysis provided in Chapter 6.

The flowchart is very simplistic in that it involves only one train and one terminal. Therefore, in the discussion that follows a whole set of running trains and operating terminals within a region should be considered.

The legislation under which the operations regional division (YEK) functions assigns to this division the 'care' ² for the implementation of train services, for the attraction of traffic and the assurance of undisturbed and safe circulation of trains. Two principle offices report to the engineer, head of this division:

Commercial Operations Office (YEK/EM), having the following duties:

- to monitor financial activity in all sectors of national economy;
- to monitor activities and services offered by competing transport undertakings;
- to perform market research and to gain the maximum possible traffic by making appropriate decisions or proposals to top management;
- to cooperate with other transport companies in order to provide combined transport services;
- to monitor optimum utilization of rolling stock;
- to propose the establishment of agencies or travel offices and to monitor and control their performance;
- to take care for the offering, by all means, any kind of services to passengers (buffets, buffet cars, sleeping cars, etc.);
- to monitor the efficiency of stations and freight depots;
- to handle matters related with customers complaints, press publications, etc. public relations;
- to make proposals for construction of new sidings.

Technical Operations Office (YEK/T) with duties:

- to prepare train timetables, on the basis of demand as assessed by the Commercial Operations Office;
- to decide on train composition;
- to decide on terminals staff and trains crews shifts, etc.
- to monitor punctuality and to make decisions to improve it.
- to monitor lighting, central heating and cleanliness of trains and stations.
- to regulate train operations.

Thus, considering the formally prescribed duties of the operations system ONE at the second level of recursion, legislation provides for the realisation of operations division (YEK) as a system ONE in its own right, since it is supposed to possess:

a local system FOUR, in the form of commercial operations office (YEK/EM), and

a system TWO function, divided between commercial and technical operations offices.

However, though the flowchart of *Figure 27* identifies eight systems ONE at the third recursive level, supposed to be managed by system ONE operations, three of them, i.e., train cleaning/servicing, train fuelling and train driving, in practice do not report to the operations division (YEK) but to the depots (MHXSIA), being thus parts of the rolling stock system ONE. This has always been a major problem in the proper functioning of the Greek Railway, which, paradoxically, instead of being solved by bringing depots under the wings of the operations division, has followed the extremely opposite way. Thus, on the way to the implementation of the vertical functional organization, depots do not belong anymore to the regional structure, but to the functional rolling stock repair and maintenance department (DISTY). Thus, problems arising, which in the past were resolved at regional level, by the cooperation of the regional operations (YEK) and the regional rolling stock (YEL) managers, or by the intervention of the regional manager (DPER), now they formally require interdepartmental cooperation.

The way in which this problem is solved in real life, i.e., by the development of informal communication, is expected to be revealed by the survey. The survey will also show whether systems TWO and FOUR of the operations subsystem possess adequate potential to carry out their tasks in the formally correctly prescribed way.

The remaining operations within this system ONE (i.e., terminal operations and train crewing) are managed by the regional operations manager (YEK) via a structure, consisting of:

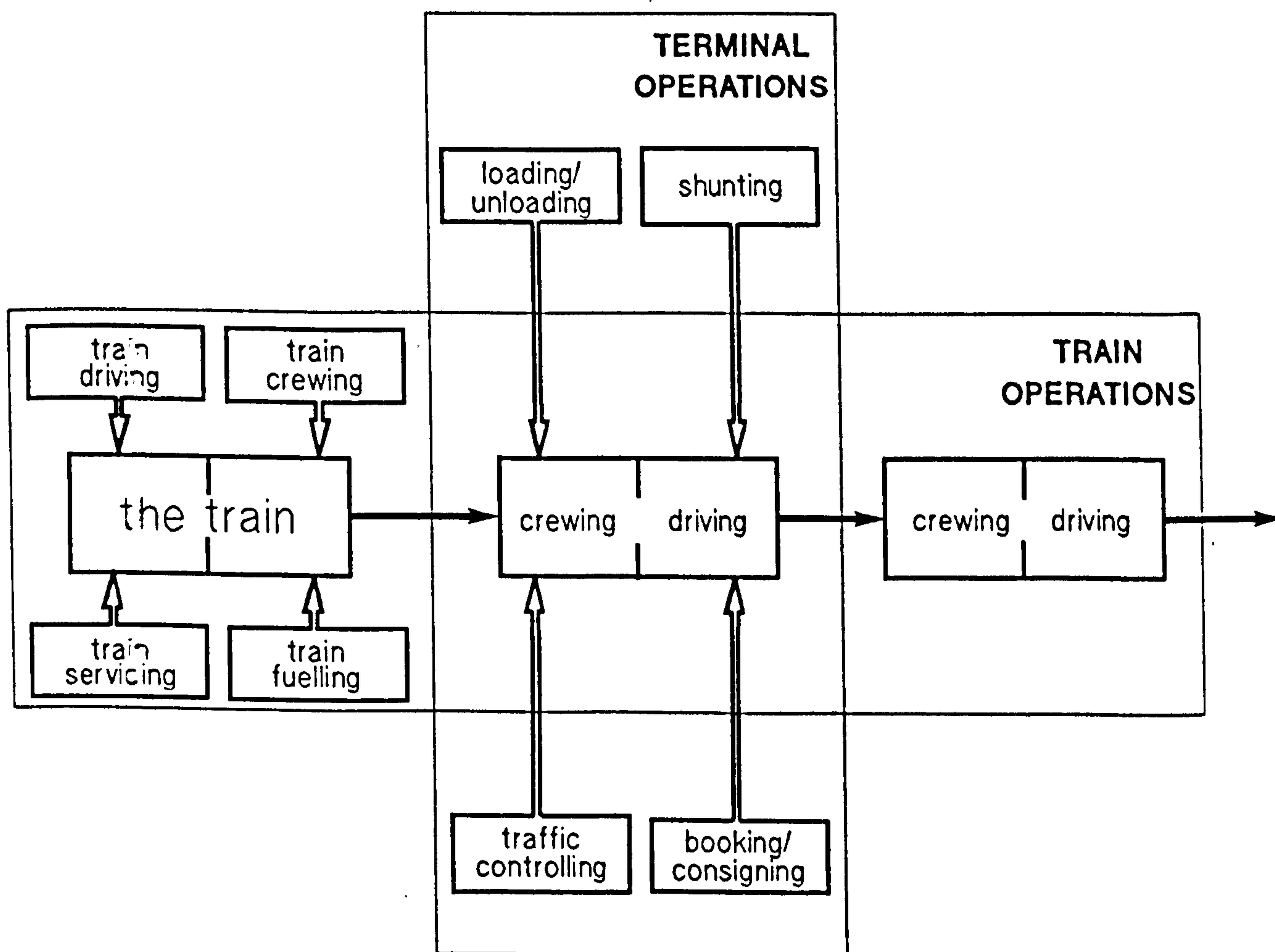


Figure 27: Railway Operations

the area inspectors (EPITH), responsible for terminals operations. Three or four area inspectors exist within each region, with duties extended over a geographical area, containing stations, hauls, freight terminals and yards.

the train crews central office (KGPA), co-ordinating and controlling the train crewing function through local train crews offices (GPA).

8.2.1.2. The Permanent Way Regional Division (YGR)

According to the formal organization, the duties of this division are:

to organize, in general, and to control duties related to the maintenance of the track, the track subgrade, buildings, technical works, bridges and other installations within the region;

to undertake construction projects or to supervise such projects when subcontracted; and

to take any measure related to the safety and the insurance of the assets of the enterprise.

As a system ONE in its own right, the regional permanent way division is headed by the chief civil engineer (YGR). System TWO activities within the division are handled by the technical office (YGR/T), which, according to the legislation:

- monitors the quality of construction projects undertaken within the region;
- monitors the quality of track and permanent installations maintenance works;
- proposes to the chief engineer works to be included in the annual programme;
- monitors the expenditure of projects undertaken;
- proposes to the chief engineer acquisition of materials and mechanical equipment; and
- monitors the implementation by the operating units of issued rules, directives, etc.

The technical office of the regional Permanent Way Division is probably the less problematic unit within the whole organizational structure. Probably it is the only functioning unit within the contemporary Regional Department (DPER). This is related to the following issues:

it reflects traditional attention paid within Greek Railways to civil engineering operations, as explained in previous section.

it is adequately staffed. Usually, within a permanent way technical office, four civil engineers are employed and a relative number of technicians, draughtsmen etc.

As legislation assigns to this unit a further duty *"to prepare studies referring to minor projects"*, and since headquarters civil engineering units are usually either overloaded or inefficient, a lot of technical studies work is finally undertaken by the technical office, since almost any work within the railway may be described as minor project. Thus, a civil-engineering-study tradition is emerging within the regions, which tends to lead to deviation from the principle character of the technical office as the Permanent Way Division's system TWO.

A further characteristic of the regional Permanent Way Division (YGR) is that it lacks an autonomous system FOUR function. As decisions about infrastructure development and materials/equipment acquisition are made at corporate level, the regional division has

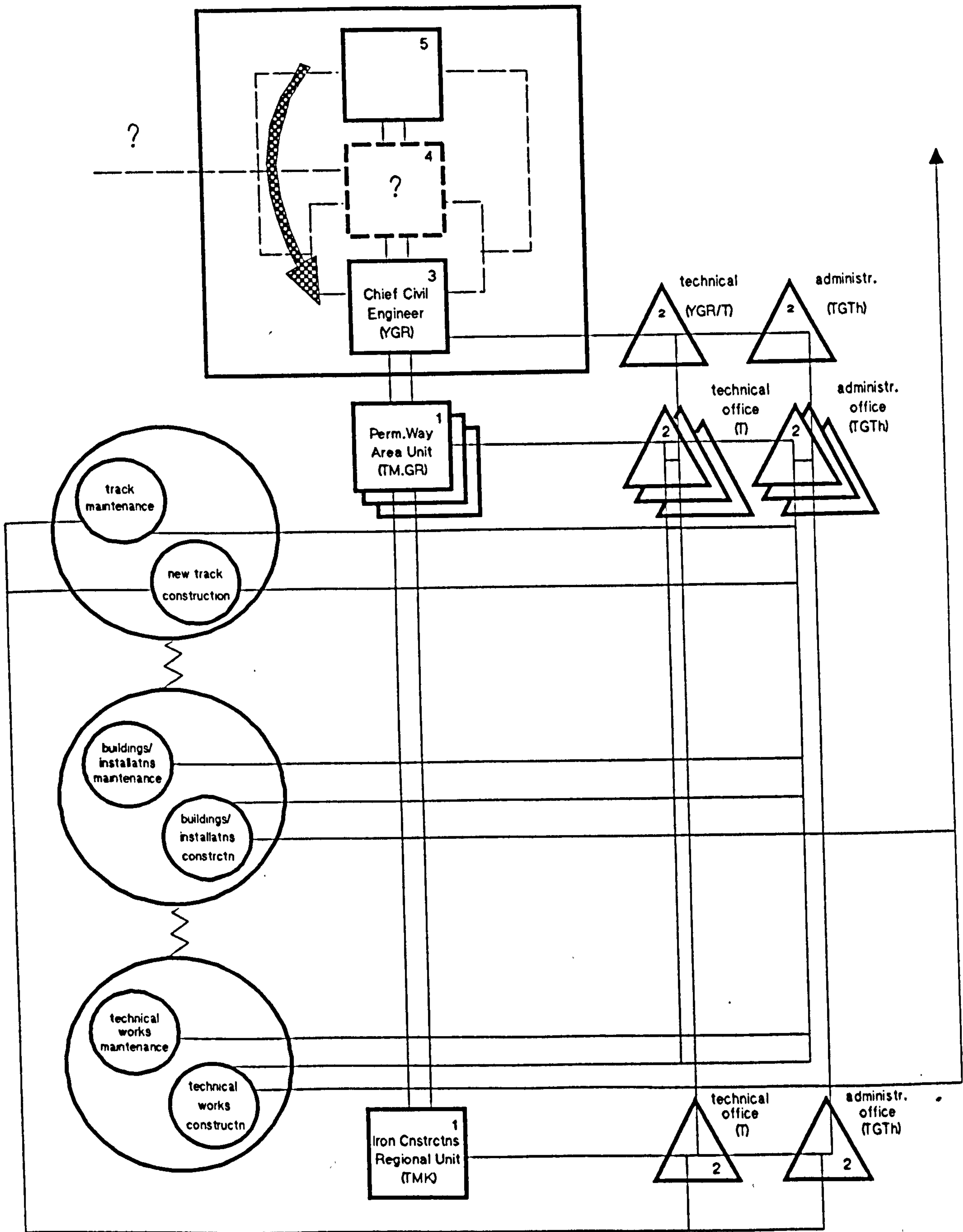


Figure 28: Regional Permanent Way Division (YGR)

lost any incentive in continuously maintaining any relationship with its technological or physical environment. Contacts with modern technology and relevant permanent way issues are supposed to be subjects related to the Permanent WAY (DG) and New Projects (DNE) corporate departments. From time to time, regional civil engineers participate in such technology-injection courses, either by accompanying their headquarters colleagues in educational journeys abroad or by undergoing seminars within the company.

In the absence of system FOUR activities within the division, its management (i.e., the chief engineer) collapses to a system THREE role. Thus, in practice, apart from seniority there are not distinguishable managerial limits between the chief engineer (YGR) and the head of the technical office (YGR/T). *Figure 28* illustrates this situation.

System ONE operations within the division are undertaken by the Permanent Way Area Units (TM.GR). There are three or four such units within each region (headed by a civil engineer), each of which is responsible over an area broadly coinciding with that of the operations inspector. Additionally, an engineering unit with responsibilities over the whole region undertakes maintenance works in bridges, switches and other ironworks (TMK).

In *Chapter 6*, three sub-systems within system ONE permanent way and installations were identified; namely, track, technical works, and buildings and installations. Each sub-system was further broken down to maintenance and new construction duties. Not all of the thus resulting six types of duties are undertaken by the regional permanent way division. A whole department, as earlier stated, the New Projects Department (DNE) is engaged in supervising either subcontracted technical studies or subcontracted major projects. Further reference to this paradox will be made when discussing the corporate structure.

8.2.1.3. The Signalling and Telecommunications Regional Unit (TTHE)

This unit is responsible for system ONE signalling and telecommunications operations within the region. Its status is not that of a regional division but of an area unit. Thus, it lacks a technical office, or, more precisely, its technical office standards are those of the respective permanent way area unit. The increased needs arising from the modernization of the network, involving the introduction of electromechanical signalling or central traffic control, modern telecommunications etc., are expected to alter dramatically the status of this unit, as far as intraorganizational power considerations will permit it.

Recently, the three regional TTHE units have been taken away from the regional structure and report now to YSTHE, a former headquarters unit without the status of a department, which existed in order to provide a sort of functional closure to this type of organization. YSTHE has in the past engaged in a lot of studies concerning modernization of signalling and telecommunications systems. However, in the existing structure, this unit does not seem to have any power over the study, selection and installation of technological systems in this area.

The signalling and telecommunications area of operations within the Greek Railways is, at the moment, very complicated organizationally. The survey is expected to reveal the way in which accountability is diffused between YSTHE, DET, and the Signalling and Telecommunications Division of the New Projects Department (DNE/YMESTH). *Figure 29* attempts to show that many operations belonging to this system are performed outside, usually at the next higher level of recursion.

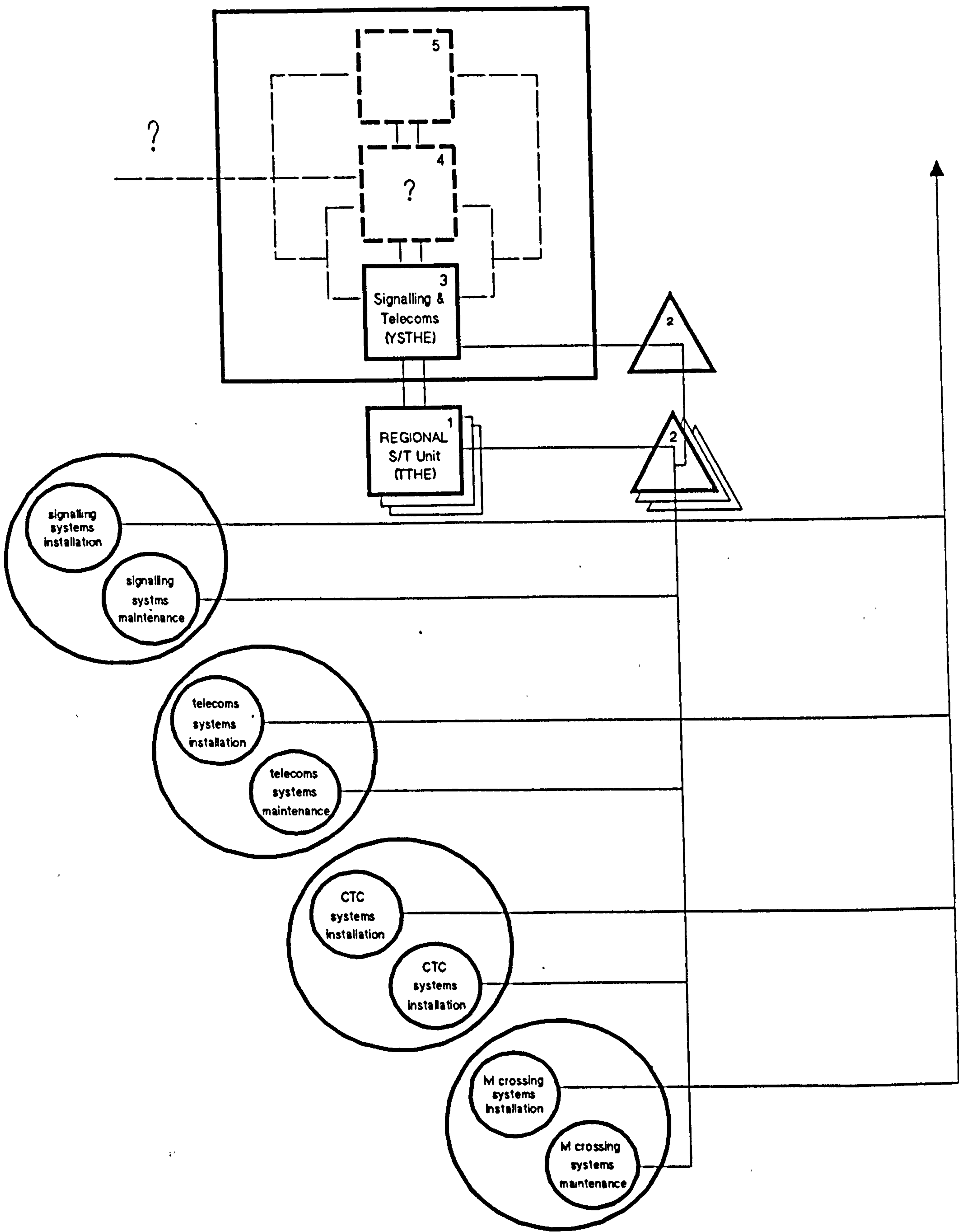


Figure 29: Signalling/Telecommunications Division (YSTHE)

8.2.1.4. The Regional Rolling Stock Division (YEL)

Again this unit does not exist any more within the regional structure. Until recently, i.e., when existed, it was headed by a chief mechanical engineer (YEL), controlling the performance of regional depots and locomotives stations via a technical office (YEL/T), similar organizationally to that of the Permanent Way Division but much less staffed and effective. The main reason why the regional rolling stock technical office was underestimated in practice has to do with the overall organization of this division. Thus, within each region a depot was reckoned as principle. All local depots and locomotives stations were reporting to the principle depot. Under this organization, system TWO and THREE duties were performed by the principle depot. Thus, not only the technical office but the chief mechanical engineer himself (YEL) could not justify his existence. His function, if any, was to facilitate communication flows between his principle depot and the other two regional divisions (operations, permanent way) by means of his head of division status. In other words, this artificial organizational balancing could have been saved by offering to the manager of the principle depot the rank of chief regional mechanical engineer. An alternative solution, i.e., to offer to all regional depots the same status, might be preferable, but in the specific case of the under study company would require major changes, concerning:

the allocation of duties to regional depots. Today the principle regional depot undertakes the vast majority of train servicing, periodic examination and light maintenance work.

the manning of local depots with personnel of respective skills and knowledge.

As mentioned, a major incentive for organizational changes has, in the past, been the wish to increase the number of high-rank positions. Thus, the organization of the Regional Rolling Stock Division, though it seems irrelevant as just described, was absolutely rational in the organization of the 1960s. Recall that at that period the chief mechanical engineer had also power over the materials regional unit. Thus, his role in the homeostatic relationship between needs for materials, spare parts and equipment as arising from day-to-day rolling stock servicing/maintenance operations of depots on the one hand and the capabilities of the supplying unit on the other was crucial.

Further description of depots' duties and operations will be provided in the following section, which depicts the organization of the rolling stock system as it is today.

8.2.2. Rolling Stock Repair and Maintenance (DISTY)

This new department is a major attempt to depart from a regionalised to a functional structure. At the moment it contains all activities undertaken in the past by either the regional rolling stock divisions (YEL) or the workshops' department (DER). An office concerned with train drivers shifts and control has been retained within the regions, under the name rolling stock division technical office (YEL/T).

In *Chapter 6*, two major subsystems were distinguished within the rolling stock system ONE, and were defined as rolling stock repair and rolling stock maintenance respectively. It was also shown that the limits between these two subsystems are not very clear and they rather relate to the amount of the work undertaken on a unit of the fleet and to the time it has to be taken from operations.

Even before the formation of this global functional department, general rules, periodicity of examinations, directives etc. were decided within one department, the

Workshops' Department (DER). The organization of this department is still in use, with the addition of the depots.

Maintenance organizing office (DISTY/YOSTY):

Deciding on rolling stock modification, maintenance and repair issues.

Unifying directions in rolling stock repair and maintenance issues.

Co-ordinating operations of workshops/depots.

Defining rolling stock maintenance duties and periodicity.

Assigning maintenance duties to various workshops/depots and organizing the overall maintenance function.

Producing detailed programmes for the duties of workshops/depots and monitoring the implementation of these programmes.

Preparing and distributing maintenance rules and normes.

Studying and reporting to top management issues related to installations/equipment of workshops/depots.

Preparing the annual rolling stock repair/maintenance budget.

Preparing technical studies

Studying the annual workshops/depots reports on rolling stock behaviour and co-ordinating units on the basis of findings of these studies.

Stock controlling principle materials and spare parts.

Technical Office (DISTY/TY):

Supervising operations and performance of workshops/depots.

Defining standards and costs of rolling stock repair/maintenance jobs.

Monitoring the implementation of rolling stock repair/maintenance rules and directions.

Studying and proposing methods and means of improving the efficiency of repair/maintenance activities.

Monitoring the expenditure of repair/maintenance activities.

Monitoring the flow to workshops/depots of materials/spares and their consumption.

Studying issues related to workshops/depots equipment acquisition.

Participating in rolling stock purchase studies, together with other involved departments (DEL, DET).

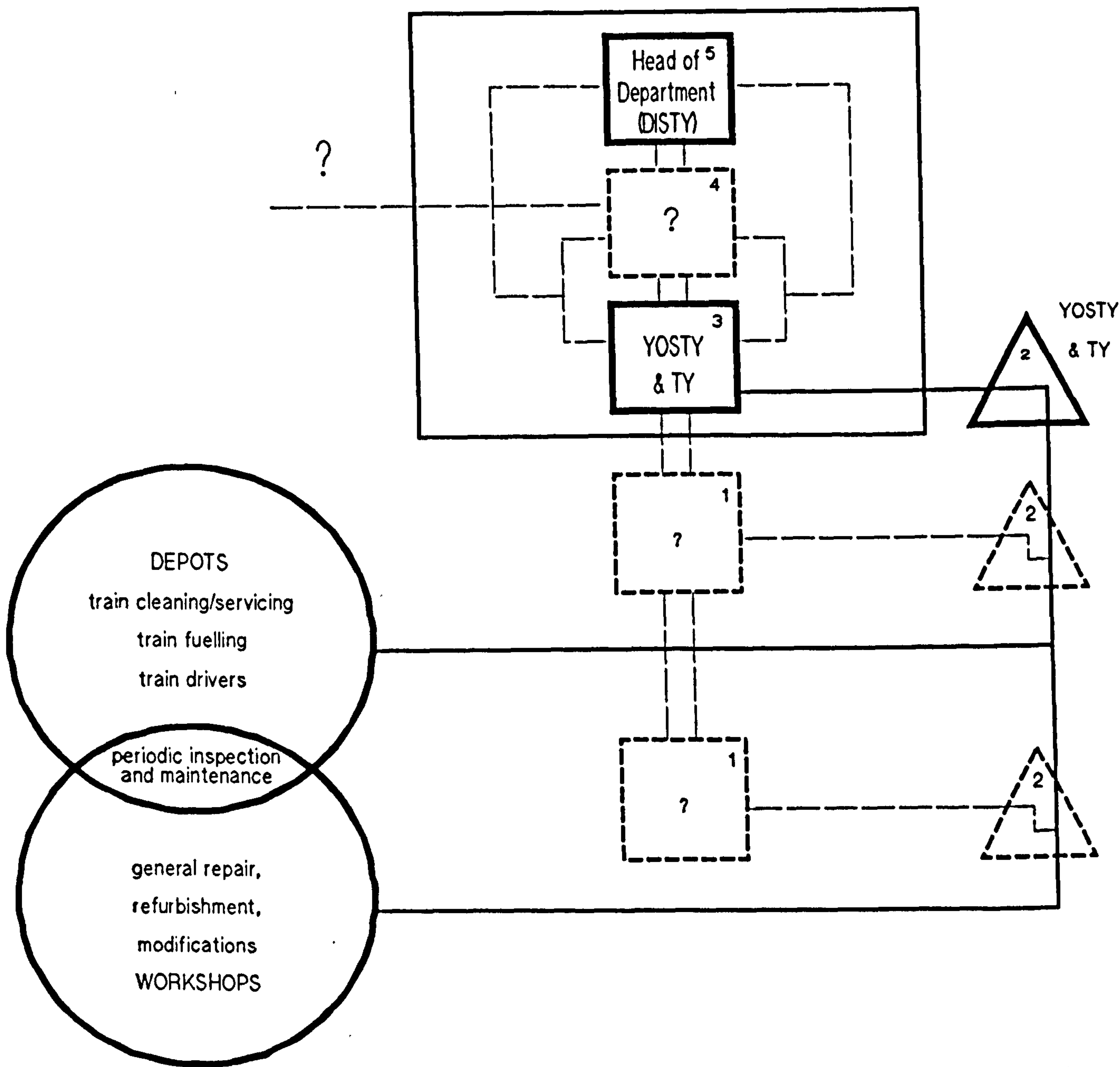


Figure 30: Department of Rolling Stock (DISTY)

No clear distinction of duties between these two offices exist. In fact, both engage in system TWO and system THREE activities. In the absence of prescribed system FOUR duties, the head of the department (DISTY) gets also involved in day-to-day operations. Thus, almost everyone in this department is entitled to manage workshops/depots everyday's work. Hence the constant failure to regulate the performance of the Rolling Stock system.

8.3. CONTROL OF OPERATIONS: CONTROL AND COORDINATION FUNCTIONS

Before proceeding in examining the way in which corporate management controls the implementation function we should recall the overall organization of the enterprise and try to realise it in terms of recursive levels. *Figure 31* shows the actual organization extended over five levels of recursion. At the fifth level we have the units producing the company. They are:

stations, controlling terminal operations,
crews offices (gpa), controlling train crews,
permanent way foremen, controlling track, technical works, and
buildings/installations maintenance,
movement offices, controlling the train driving function,
signalling and telecommunications foremen,
workshops' foremen, and
depots' foremen.

At a wider geographical or local basis, these activities are controlled, at the fourth level of recursion, by:

area inspectors (EPITH) and regional crew offices (KGPA);
permanent way area managers (TM.GR/TMK);
movement offices;
signalling/telecommunications regional managers (TTHE);
workshops' managers (ERSIA); and
depots' managers (MHXSIA).

The third level of recursion consists of regional operations (YEK), permanent way (YGR) and rolling stock (YEL, with the limited function of controlling train drivers) managers. At the same level lies, at the moment, the signalling and telecommunications unit (YSTHE), whereas, as already stated, no rolling stock management may be identified at this level of recursion. This level marks the termination of clear accountability allocation. Further up, accountability is lost somewhere between regional management and headquarters departments.

8.3.1. Structural Obstacles of Operational Control

An assessment of the effectiveness achieved by corporate management in its task to control ongoing operations involves the examination of linkages between systems ONE, TWO and THREE, i.e., between implementation, coordination and control functions in terms of requisite variety. A major constraint has already been identified in the unclear subsystemic status of regional management (DPER) and has been discussed in details. The following organizational deficiencies also affect the way in which control is exercised in the company:

- (1) The non-recognition of 'signalling/telecommunications' activities as a subsystem. As the company introduces modern technology, the emphasis is gradually shifted from the

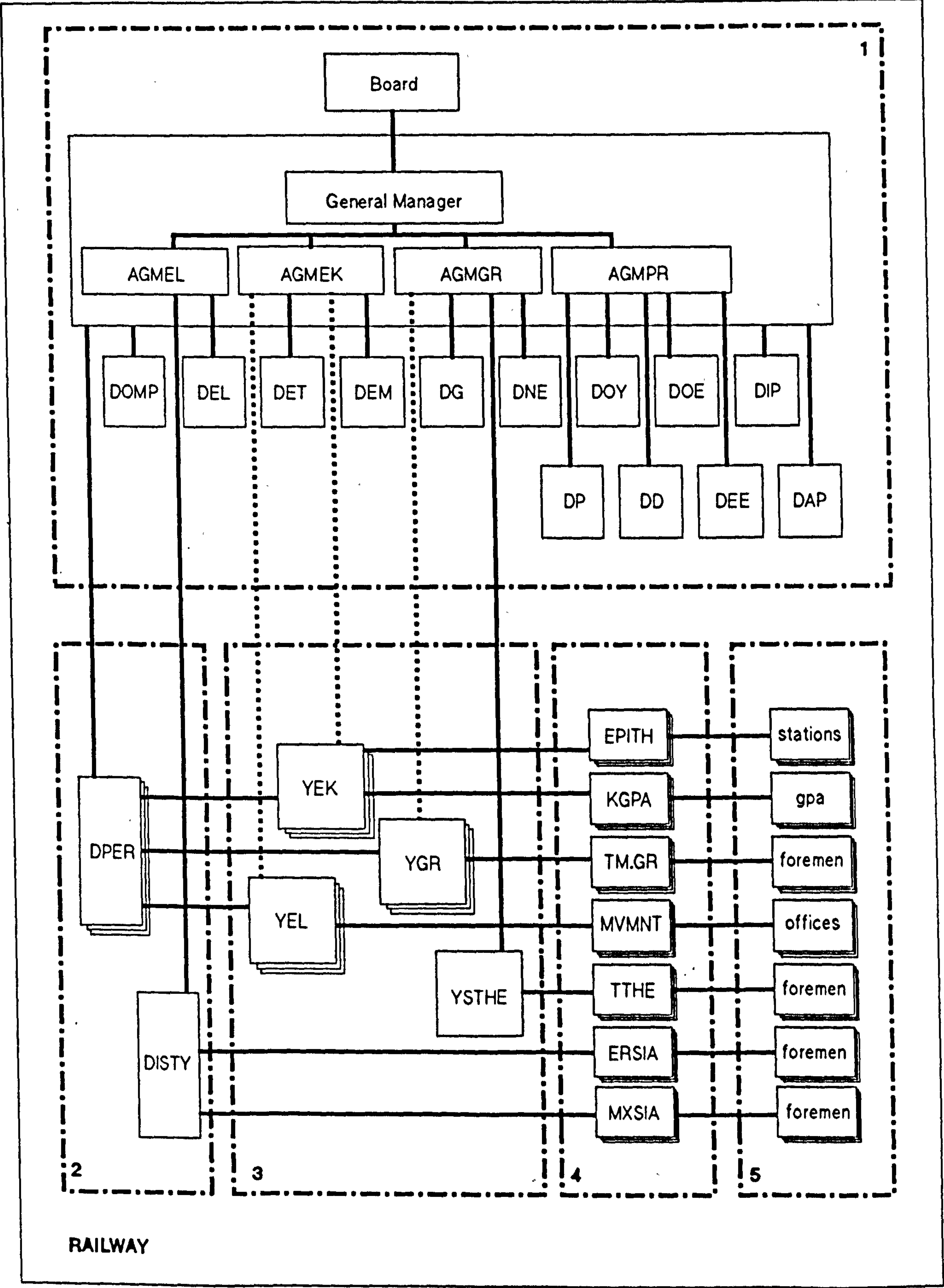


Figure 31: Formal Organization vs. Recursive Levels

permanent way area towards signalling and telecommunications systems, involving as divergent projects as introduction of electromechanical signalling, central traffic control systems, telecommunication networks involving systems for the transmission and reception of messages by means of traditional telephones, radiotelephones, computers, etc., installation and operation of sophisticated automated level crossings warning and guarding systems, and so on. Activities related to decisions concerning technological, operational, financial, organizational etc. dimensions of these problems are, therefore, consuming a large amount of managerial variety at corporate level. However, the existence of a signalling/telecommunications subsystem would facilitate both the absorption of a far larger variety concerning this kind of activities and the allocation of corporate variety more effectively elsewhere. Additionally, in the absence of an accountable managerial structure for this set of activities, no reference levels exist against which the performance of this subsystem could be assessed. This condition is limiting organizational learning.

(2) The division of control for activities of the operations system between three types of units; i.e., regional operations divisions-YEK (controlling terminal operations and the function of train crewing of the train operations), regional traction divisions-YEL (controlling train driving), and depots-MXSIA (reporting to the rolling stock department and undertaking train cleaning and servicing). Under this arrangement, the part of operations system activities managed by YEK and YEL is co-ordinated, at regional level, by the regional manager (DPER), who, as shown, tends to lack any other kind of managerial duties. However, under present organization, overall control of operations (including depots' function) can only be attempted at corporate level. Again, the recognition of the full set of activities of the operations system and the respective organizational rearrangement would facilitate both a more effective managerial control and the allocation of corporate variety to more demanding areas.

(3) The existence of the controversial new projects department (DNE). By its very nature, this department adds largely to the organizational confusion, and not only in respect to the control of ongoing activities. Concerning the latter, discussion has been made in earlier sections and has been summarised in the diagrams of *Figures 28 and 29*, where, as shown, to what relates to permanent way constructions and signalling/telecommunication installations subsystems, functional units lack any kind of actual relation to this type of activities. The decision for the formation of an independent managerial unit, exclusively concerned with the bulk of problems incorporated in a major plan for the modernization of the infrastructure is not always wrong, since the variety of these problems in no case can be matched by the variety of the operating functional divisions. A series of major modernization projects involve technical decisions, technical studies, technico-economic appraisal, tender documents preparation, project allocation, project engineering, and project management (technical and financial monitoring and control). However, any organizational decision concerning this issue has to consider both the impact on the ongoing operations and on future possibilities. Concerning the under study enterprise, as regards the new projects department (DNE), any of the following two solutions might be adopted and produce an improved outcome:

it should either be set up as a subsidiary, specialising in infrastructure projects studies and construction. Thus, a much larger part of the huge amount of environmental variety associated with railway infrastructure technology could be absorbed. At the same time, being an 'outsider', the subsidiary, when performing its duties, could be in a more direct way obliged to conform to regulations, as regards the impact of these works on day-to-day railway operations. Further, as the bulk of the modernization phase will be terminated sooner or later, the subsidiary would hopefully acquire the skills to propose and/or implement railway's

proposals concerning further aspects of, not exclusively technological, innovation. The subsidiary should also be prepared to safeguard its future, considering cases of domestic capital shortage, prohibiting rail investment plans, by developing a purely commercial function in the form of an international railway consultancy/construction company. Similar subsidiaries have been set up not only by advanced enterprises such as the British (Transmark) or the French (Sofrerail) but even in countries possessing a much less impressive railway, as Romania (Contransimex) or Ireland (CIE-Consult).

The alternative would be the abolition of DNE by sharing its duties to two functional departments: the existing Permanent Way Department (DG) and the proposed Signalling/Telecommunications Department, as discussed in the previous page. The negative impact of such a decision on the functioning of the operating divisions is an argument of the magnitude of the modernization projects. The existing and undesired emphasis on the technological function of the company might be further reinforced. However, the enterprise would have hopefully acquired definite functional control references and saved the risk associated with fluctuations of investment funding in future.

Concluding on this third structural obstacle which was taken up in more detail as it is assumed to reflect the main contradiction in a contemporary railway attempting to modernize, two prognostications will be made, as why the enterprise will not proceed in adopting the first proposal (subsidiary formation).

The first concerns power considerations. The dominance of the technological function within the enterprise has been discussed. Therefore, it is rational to expect that this function will resist any attempt implying that engineering should, sooner or later, be pushed outside the railway.

The second reflects the consequent necessity to set up criteria for assessment of the quality of output. The management of the enterprise will be in difficulties when, not possessing a technological function, will have to demonstrate performance achievements in terms other than those it has been used to, i.e., investment absorbed, projects completed, plans prepared, etc.

8.3.2. Corporate Control of Operations

Corporate control of operations is the duty of the General Manager. In the pursuit of this task he is supposed to be assisted by not less than four Assistants and thirteen Headquarters Departments. Trying to identify the duties of each of these departments should be pointless, since, to a large degree, they merely reproduce themselves attempting to justify an existence, which, as shown in *Chapter 7*, was not decided on the grounds of corporate coordination and control requirements. An alternative procedure follows; coordination and control of operations are assumed as involving four managerial areas: production, sales, personnel, and finance. Production and Sales, considering the company as a whole, are realised via the Operations system. Production, Finance and Personnel components of managerial activity have also a functional dimension as regards the three supporting subsystems, i.e., rolling stock, permanent way, and signalling/telecommunications.

8.3.2.1. Railway Production

The production of a railway company may be conceived as the number of train-km offered. For passenger services, this production is scheduled in the form of train timetables, arrived at after an appropriate knowledge of the market demand. Since a railway company has the obligation to publish in advance the passenger services timetable,

twice a year; that is, there is a summer and a winter timetable. For freight/parcels services, usually there is no published timetable obligation. The enterprise tries to accommodate within the network as many trains as possible, provided that this accommodation is commercially justified. In this case, the technological configuration of the network (sidings, types of wagons, loading/unloading facilities, road vehicles, etc.) constitutes the principle *de facto* variety attenuator.

Production control, in the form of monitoring the offering of announced passenger services and making optimum use of freight transport capabilities, is not a formal duty of any of the thirteen headquarters departments. This responsibility, according to the legislation, belongs to the regional manager (DPER). The same manager is responsible, according to the legislation, both for production co-ordination and quality control of services offered.

Planned production may be influenced mainly by the inability of the rolling stock subsystem to offer in the appropriate condition the locomotives and the vehicles programmed, or by interruptions of the permanent way and signalling/telecommunications subsystems, resulting either from a poor organization of their functional production, or from external factors (i.e., adverse climatic conditions). Thus, production control inevitably extends to all four systems ONE of the enterprise. The regional structure, as initially conceived, was facilitating production control. Each of the three regional managers (DPER) had control over all four functional subsystems, as regards day-to-day operations. Rolling stock repair (workshops) was the only centrally organised function. However, under recent rearrangements, as a lot of related operations has been taken off the regional structure, regional manager cannot control the principle element of railway production, that is the trains themselves. Neither can he co-ordinate, since not all the elements to be co-ordinated maintain with him formal and regular information flows. Co-ordination and control of railway production are, therefore, not properly achieved at regional level. Neither are they attempted or achieved at any level lower than the General Manager himself, since a Production Manager, with a role similar to the former Regional Manager but responsibility extended over the totality of the network cannot be identified within the existing structure.

Therefore, production control is a duty of the General Manager, attempted either during meetings with his four assistants (AGM) or by directly intervening as low as to the fourth level of recursion. Indeed, during the time of the survey, as a major problem of the company was rolling stock breakdowns, related either to the lack of technical assistance of headquarters units to workshops/depots, or to shortages of supplies/spares (resulting from the controversial organization and legislation), the General Manager (being at the time also Chairman of the Board) had daily meetings with the Athens area workshop and depots managers (EP, MAI, MPR), to attempt to resolve operational problems. At the same time, a structure consisting of the Assistant General Manager Traction (AGMEL), and the whole Departments of Traction (DEL), Rolling Stock Repair (DISTY), Materials (DIP) and Stores (DAP), supposed to exist exactly in order to resolve such problems, was merely an observer of this peculiar arrangement, which provided the most explicit statement of organizational failure.

Central to railway production is the role of the three functional Assistants to the General Manager. As shown in *Figure 31*, each of the three Operations (AGMEK), Rolling Stock (AGMEL), and Permanent Way (AGMGR) Assistants attempts a vertical co-ordination and control of the respective function (indeed, Permanent Way Assistant had power over two functions, i.e., Permanent Way and Signalling/Telecoms). The need for this functional co-ordination and control at corporate level was partially justified by the confusion caused by the unclear status of regional management (DPER). Thus, for example, since

neither regional manager (DPER) in practice, nor Permanent Way manager (DG) according to the organizational structure, were responsible for the functioning of the regional permanent way divisions (YGR), an ultimate person to blame had to be introduced, and was found in the face of the Assistant GM Permanent Way (AGMGR). He should also be responsible for the coordination between maintenance (DG, YGR) and constructions (DNE) units. However, allocating accountability for the control of 'level 3' activities to a 'level 1' unit results in the actual elimination of the recursive 'level 2' structure. This structure, consisting of functional headquarters departments, has no reasons to complain. For as far as it retains its privileges, that is, status within the company and statutory right to intervene irresponsibly from time to time in the 'doing' of the implementation function, has only 'lost' the obligation to bother about the outcomes of its proposals. Because what the functional AGM probably fails to realise is that he is constantly employing the requisite variety of the units he pretends to 'write-off'. He does so by adopting the bulk of their proposals in the form of budgets, plans, reports, and suggestions. His limited, due to his human nature, variety handling capacity, instead of being employed for the evaluation of these proposals, is spent in attempts to directly impose their not evaluated, and, hence, doubtful, implementation. In terms of variety, the task is overwhelming.

In the absence of a Production Manager, production control, as shown, is supposed to be ultimately achieved by the General Manager himself. Numerous indications that effective control is not achieved may be cited. Achieved rolling stock reliability is one. Delays in projects completion or significant deviations from budgeted costs is another. However, it seems that the least obvious, in the eyes of the management of the enterprise, reason may be offered in terms of variety. No human being has the capacity to handle effectively the variety associated with all three roles of Production Manager, General Manager, and Chairman of the Board of a nationwide railway. This is hardly achievable in a small size family business.

8.3.2.2. Sales

Contrary to production, where main problems are located in technology and supplies, environmental complexity as regards sales is matched via the marketing function, i.e. the capacity to sell. It should be stressed that production is also out of control when its capabilities are not matched by a parallel capacity of the company to put the product, in the market; in other words, to convert train-km offered into passenger-km and tonne-km transported, under the desired combination of price and quality characteristics. In the railway enterprise, sales is interacting with the environment through the Operations system of the implementation function, which, in turn, is decisively influenced by the output of the three other supporting systems.

Sales is a mechanism which amplifies the capacity of the enterprise to interact with its environmental variety and a mechanism to filter this variety. However, every dimension of the sales function has been underestimated within the case-study enterprise. This is a main deficiency of state-owned enterprises which, not having profitability as clear objective, fail to realise alternative measures of quality of output and of overall effectiveness. No elements of a sales organization may be identified at any level other than corporate. In fact, legislation assigns this duty to stationmasters and area inspectors (EPITH). However, it is certain that these people have neither the qualifications nor the time to act as 'salesmen'. Thus, the enterprise lacks 'sensory' organs to 'understand' the environment-operations interaction. Apparently, such interaction, though not programmed, does take place, as the environment, in this case the purchasers of railway services, i.e. the general public, transmits 'signals', in the form of either verbal suggestions, proposals or complaints to the operating staff (train crews,

terminals staff), or via the mass media, or through its representatives (local government, members of parliament), or, in more serious cases, by directly contacting headquarters units. However, in most cases these environmental signals are rather attenuated than amplified, mainly because they are dealt with by the same structure, which, not having the capacity to match the variety of the environment alone (product design) cannot match the variety of both the environment and the channel (complaint).

A measure of the enterprise's capacity to interact with its environment via the sales function may be provided by a comparison of train timetables of subsequent years. An analysis of this kind has not been undertaken within this thesis, thus, a perception drawing on personal experience and suggesting that the timetables over the last ten years remain virtually unchanged, except for when a service is withdrawn, is of limited value.

However, when a rare introduction of a new service proves a success (as the introduction of a 'sleepers only' night train between Athens and Thessaloniki a year ago), the main wonder is not who is the 'marketing brain' who conceived the service, but why a so obviously marketable product took that much time to enter the market. Usually, the answer involves technological capability. That is, in the example, a sleeper service cannot be offered when sleeper coaches are not available. Since capability as a systemic measure of organizational performance directly relates to planning, this example, and not only this, provides a possible explanation of the way in which the present/future interaction is balanced within the case-study enterprise.

This kind of explanation implies someone's balancing activity either over the Systems THREE-FOUR interaction or over the Production-Sales interaction within System THREE. As the THREE-FOUR-FIVE metasystem is discussed in a following section, there is a scope to focus now on the monitoring of the production-sales interaction. Following the logic of the viable system's model, if Production Manager is the General Manager himself as previously demonstrated, then he has also to be the Sales Manager. Because in no case can anyone act as a referee in a debate involving himself and another person. Either there is no debate or the other person does not exist. Further, if there is no debate, i.e., if production-sales homeostatic relation does not exist, what is the role of the other person as Sales Manager?

The identification of the actual Sales Manager of the enterprise may be obtained on more traditional grounds. Thus:

For subsequent years, annual budgeted revenue from rail traffic has been the previous year's result corrected for inflation.

The recently prepared 'operations five-year plan' (i.e., plan concerning issues other than infrastructure modernization), which sets the goals of 22 % increase in passenger and 61 % in freight traffic volume (within five years) has been prepared by the 'technical' Department of Planning (DOMP).

The bulk of prime-interest freight traffic 'specific customers' contracts refer to either public sector transportation needs (nationalised industries, army, etc.) or to bilateral agreements at government level (e.g., exporting agricultural products to Eastern European countries).

The company does not engage in any planned advertising of services offered. The bulk of railway's 'designed' appearance in the mass media refers to future benefits of modernization in progress. It aims to a lesser degree at improving the company's image, and mainly at gaining political support on behalf of the each time ruling party, by demonstrating national development achievements.

Market research activities during the last ten years consist of one questionnaire survey conducted amongst train passengers in 1983.

Concluding on Sales, the formation of a Commercial Operations Department (DEM) at headquarters level in the early seventies did not result in a proper organization and discharging of this function.

8.3.2.3. Finance

Properly conceived, Finance is adding the dimension of viability to whatever is done by the implementation function, not because financial viability is an end in itself, but mainly because most of practical levels of reference to assess performance are expressed in financial terms, as discussed in *Chapter 5*. Therefore, the support that this area can offer to the control function is easily understandable.

Finance (and Personnel, as will be shown later) at system THREE level is controlled by the Assistant GM Finance/Personnel (AGMPR), who, in carrying out his tasks, seems to have more freedom than the other AGMs and to maintain more regular contacts with the environment of the railway. An explanation could be offered in terms of functional specialization. That is, the GM, being himself a mechanical engineer, refrains from a lot of intervention in other areas of knowledge, in the same way in which, being he not an engineer, functional AGMs might have enjoyed greater freedom. Another explanation, related to the previous, has already been offered in terms of GM's variety, which is virtually exhausted over a set of other activities. However, it seems that the principle reason may be expressed in terms of the railway's metasystem's variety handling capacity. According to the public railway literature, extensively discussed in *Chapter 5*, what mostly matters the government as regards public enterprise is financial performance. Thus, the unit controlling this function from within the enterprise must have the ability and the willingness to collaborate, especially because controversial government policies (dictated by wider considerations) frequently seriously affect developing railway plans. The same is valid in the case of the Personnel function, where the principle element of state's interest is the management's capacity to control trade unions, in order to avoid the political cost of industrial action. This ability and willingness to collaborate is interpreted, all over the world, as synonymous to close political relationship. When demanding implementation of policies, the bureaucratic government of any existing, however democratic, society, has no time to discuss options. The person must be there to guarantee implementation.

The same is not valid in the case of 'functional' managers, since, for them, finance and personnel are, to a large degree, inputs with externally decided characteristics. Thus, the requirement of political relationship is not in this case compulsory, being an argument of the overall political freedom in the country. In practice, however, even the 'functional' manager realises that much debate and unease over policies dictated from the top is resolved by his substitution.

Within the case study, there are serious symptoms of ineffective financial management, which do not only relate to internal functioning. That is, as the Investment budget is exclusively funded by the Government, and as, in the Operations budget, revenue from customers is only a fraction of the overall expenditure (e.g., approx. 7:21 in 1985), much is decided by State's ability to pay against the budgeted deficit at the agreed periods. Moreover, as Operations Budget has not been thoroughly prepared (as already mentioned, when discussing planning activities and sales forecasting), it is probably over-optimistic. The enterprise does not have the ability to reduce expenditure, being predominantly labour intensive (the proportion of wages/salaries expenditure to overall expenditure was, in 1985, 18:21), where the labour is fully protected and guaranteed the

job by the legislation. Lacking as well the ability to increase revenue (both because, as discussed, the commercial function is missing, and due to government's control over pricing policy), attempts to overcome cash flow problems by transferring funds from the Investments to the Operations budget under invented explanations, or by negotiating short-term loans with commercial banks under the State's guarantee.

A measure of the enterprise's failure to control the Finance function, which is also an indication of top management's realization of this failure, is the recent application (Summer 1988) to the Ministry of Transport for the recruitment of upper level personnel, outside the hierarchical structure and with much improved salary terms. This application involved 16 managers, covering almost the totality of non-technical head-of-department and other upper level positions (Financial Affairs, Operations Commercial, Purchases, Information Systems). Functional small trade unions, e.g., engineers and other university graduates, opposed strongly this application, which has not yet produced an outcome, as they realised a threat to their status within the company. Their preoccupation that the 'specialists' would not be recruited on the basis of their ability to solve problems but on that of their political relationship with the ruling party may not be totally wrong, especially when considering that not many capable and common-sense managers should risk a name and a career in an attempt to tackle problems of a nature, which has more to do with the State/Public Enterprise relationship than with 'traditional' management.

8.3.2.4. Personnel

The most obvious way of controlling this function has to do with the control over trade unions. Workforce in the public sector enterprises is concentrated and demanding, for two main reasons:

the first reason relates to the predominance of history. Railways, being in any country among the oldest industries, incorporate strong trade unions, the members of which are aware of a history of labour movement, in particular of the 'heroic' period.

the second is that nowadays, in most countries, railwaymen and other public sector employees function under the certainty of the permanent job, which has transferred the unemployment stress to upper hierarchical positions.

The Enterprise/Personnel interaction within the case study is monitored, as already noted, by the Assistant GM Personnel/Finance (AGMPR). However, the greatest part of homeostasis as regards this interaction is achieved at a higher level of recursion, the political level, in terms of the government/people interaction. It seems that political parties, being amongst the most bureaucratic organizations in contemporary society, have limited variety handling capacity. Therefore, they constantly attempt to attenuate environmental variety by controlling the labour movement through the control of trade unions. Thus, in a public sector enterprise, the variety of the Enterprise/Personnel interaction is an argument of the ability and willingness of the trade union to collaborate, which, again, may be expressed in terms of political relationship.

In the case study example, this political relationship exists. Thus, the job of the AGM Personnel is simplified, in that the 'sensory' organs he requires are provided by the opposite side of the interaction. However, in a democratic society, and the case study enterprise is embedded in a democratic society, the trade union leaders are elected. Besides the fact that their election is decided by variety attenuating mechanisms, i.e., political relationship, which do not assess the leaders' variety handling capacity as regards the wishes of the working people in the enterprise's level of recursion, a control of the enterprise/personnel interaction is readily translated to the control of the trade union leaders/personnel interaction.

Both the Personnel manager and train union leaders being political relatives, i.e., having attenuated their perception of the society and the future through the mechanisms of the same political party, have an interest in facilitating the t.u.leaders/personnel homeostasis, at the minimum expense defined by the overall political conditions.

This variety handling arrangement, as regards the case study, has proved effective, as the measure of this effectiveness, i.e., industrial action within the enterprise, indicates. However, this effectiveness depends on the ability of the each time ruling party to extend its control over the whole spectrum of social reality within a country. This is not always easy, mainly because when a ruling party leaves government, it might be accompanied by the top management of the enterprise but not always by the trade union leaders as well. However, this has not been the case during the last eight years in the case study, thus, over this period, this variety handling mechanism has built up and strengthened.

Controlling an interaction, as in this case, through the mechanisms of the opposite side of the interaction, however desirable for the metasystem, i.e., the government, has disastrous effects on the enterprise, and, hence indirectly on the metasystem itself.

First, it has resulted to an inability of the company to build up an administrative organization engaged in the handling of this variety from within.

Second, in the case study example, trade union leaders become a reference for the assessment of the effectiveness of the managerial structure as regards the enterprise/personnel interaction, and take full advantage of this status, by intervening at all levels of this structure. In the absence of the organization of the type just mentioned, much of the time of the 'functional' management at all levels (i.e., from area management to regional manager) is consumed in meetings with trade unionists, discussing various demands, however rational.

Third, no other measures of the enterprise/personnel relationship, apart from industrial action, develop. Absenteism, assumed by Beer an indirect measure of the Personnel morale, is not monitored, neither can be controlled, since, a large degree of tolerance is a prerequisite for this type of homeostasis as regards both the enterprise/trade unionists and trade unionists/personnel interactions.

8.3.3. Corporate Coordination

In the Viable Systems' Model, coordination is a systemic mechanism supporting self-regulation, and limiting the need for managerial intervention in the details of the implementation function. In the case study, there is a risk of confusing the need for coordination between the managerial units engaged in Production, Sales, Finance, and Personnel control, and the coordination of managers of the four subsystemic operations (Operations, Roll.Stock, Perm.Way, Signalling/Telecom).

The first type of coordination is a mechanism to increase, to amplify the variety of the control function. System THREE of the enterprise has to be in possession of much information regarding these four areas (i.e., Production, Sales, Personnel, and Finance), since this type of information constitutes the material which it has to process, in order to define an operational policy and to monitor both its implementation and the inevitable need for readjustments.

The second type of coordination, i.e., the coordination of the four subsystems, is a mechanism to attenuate, to filter the variety reaching the control function (system

THREE), because the variety of the implementation function is far larger than the variety of the control function.

However, it has been shown that the existing organizational structure of the company, under the influence of the public enterprise 'culture' and historical conditions, has resulted in both:

a wrong interpretation of all Production, Sales, Finance and Personnel areas of managerial interest at corporate level, where the only area under control (by means of a peculiar mechanism, continuously generating problems, and endangering future) is the Personnel function, and in

a complete lack of recognition of the need for subsystemic autonomy, expressed in the form of continuous system THREE interventions in the details of the implementation function, reinforced by a wrong perception of organizational reality and, hence, of an irrelevant organizational design (dispersion of managerial duties of the Operations subsystem, not recognition of the Signalling/Telecom subsystem, confusion related to the New Projects Department (DNE)).

Consequently, both interdepartmental and subsystemic coordination lack a physical embodiment, or, more precisely, elements of such coordination are confused with elements of control, and are all exercised either directly by the GM (Production, Sales), or the AGM Personnel/Finance (Finance, Personnel) or by the functional Assistants (Operations, Rolling Stock, Permanent Way and Signalling) under frequent interventions of the General Manager.

Effective coordination and control, especially when considering nationwide enterprises as in the case study, can only be achieved by effective information management. Modern companies have paid attention in the building of relevant management information systems, and this issue has been quite detailed discussed in *Chapter 2*, where it was also shown that the main dimension of systems of this kind is organizational. *Chapter 4* has discussed the fundamentals of a management information system based on the Viable System's Model. *Chapter 6* has illustrated the features of a system of this kind in a railway enterprise environment (Dutch Railways), which seems to draw very much on VSM principles, though it nowhere refers explicitly to Beer.

The equivalent of such a management information system, producing 'algedonic', exception-reporting information on sub-systemic performance and detailed information for planning purposes does not exist in Greek Railways. What exists is a computer department (DOMP/MK) producing uncritically piles of printouts of data on receipts and traffic volume, which in themselves do not constitute information. Recall (*Chapter 2*), that information is data that have been processed into a form of real perceived value in current or prospective decisions. Contrary, 'information' produced by DOMP/MK merely conforms to imposed regulations, as the obligation to provide statistical data to the Government, the National Statistical service, the International Union of Railways (UIC) and possibly other bodies, at regular intervals.

The physical location of a centre collecting data and transforming them to information for corporate coordination and control purposes depends on the adopted organizational design. However, whatever the design, there must be a point within the corporate management, where all this information is put together and evaluated. However, no other managerial unit in the service of this purpose may be identified within the existing organizational structure, apart from the General Manager himself.

8.4. THE 3-4-5 METASYSTEM

As discussed in *Chapter 4*, Beer's model assumes a distinction between control, intelligence, and policy functions at corporate level within the organization. Whereas the control function (System THREE) is concerned with the 'inside-and-now' of the enterprise, attempting to 'steer' operations towards desired outputs arrived at during the planning process, the intelligence function (system FOUR) is concerned with the 'outside-and-then', i.e., with the task to realise the future of the enterprise within the changing environment, and to materialise this future. The interaction between 'inside-and-now' and 'outside-and-then', i.e., the systems THREE-FOUR interaction, is monitored by System FIVE, the policy function. System FIVE is responsible for the direction of the whole enterprise. It is assumed to be the thinking part of the organization, formulating policy on the basis of all the information passed to it by System FOUR and communicating this policy downwards to System THREE for implementation by Systems ONE. System FIVE must also represent the essential qualities of the whole organization to any wider system of which it is part, acting in this case simply as the localised management of a particular system ONE of the wider system. Systems THREE, FOUR and FIVE need to form a THREE-FOUR-FIVE metasystem, to encourage 'synergy' and interactivity. Without a constant interaction and exchange of information between them, System THREE is vulnerable to 'narrow tunnel' syndrome' and System FOUR is exposed to the perils of 'flights of imagination'.

8.4.1. System FIVE

It is very difficult to personalise a system FIVE at corporate level within the case-study enterprise. Contrary to the usual case in a private firm, where the overall character and 'ethos' of the company is assigned either to the owner (in early stages, or in small firms), or to the managing board, Greek Railways seem to lack a system FIVE of this kind.

Unambiguously, the central figure within the company, at the time of the survey, was the General Manager, who also happened to be Chairman of the Board. He seemed to hold all the relationships with the state-owner, either directly or through the Assistant General Manager Personnel/Finance, and to act as a mediator between the government and the company. This is not strange since:

the other members of the Board, probably with the exception of the employees' delegates, have neither any railway enterprise experience, nor any sort of wider acceptable status, by being, for example, some kinds of authorities in related fields or by representing interests of broad segments of the society.

the General Manager/Chairman was the only 'political' person within this structure, since he had been appointed by the prime minister, that is, he maintained relationships with the ruling party, facilitating thus contacts at governmental level.

However, it is questionable whether the Chairman/GM could himself function as a 'variety sponge' according to Beer, since he too, when appointed, had neither any specific knowledge of the railway industry, nor any experience of running public or private sector enterprises. Provided that he started his top career within OSE at a time just after a major government change (1981), he had the additional duty of attempting to implement a new concept of the public railway enterprise, which concept was not clear even at the highest levels of the government.

Besides, any bureaucratic organization maintains its own ways of doing things, which are not seriously influenced by attempts of external appointees, as far as these attempts are not planned and organised in some detail, and, at the same time, require the support of the bureaucratic structure in order to be implemented. Therefore, in some way, system FIVE in the case study enterprise may be identified within this bureaucratic structure, which has continuously defeated any more or less serious attempt implying change. It is the process through which young, ambitious and capable university graduate employees (mainly engineers) end up as corporate bureaucrats (heads of departments, etc.), denying any change of the kind they themselves were advocating, when younger.

Even though, as regards the public enterprise, most of these conclusions are products of interactions at higher levels of recursion, i.e., the political, the societal, the national economic, etc., their examination at a public railway level is justified, since, in turn, the ineffective functioning of the public enterprise provides arguments to the wider system for further interventions. The elimination of the bureaucratic spirit (in conceptual, not physical terms) implies, at least, the establishment of a formal System FIVE possessing this anti-bureaucratic quality. Such a system FIVE, would generate serious tensions both within the company's managerial structure and, mainly, while acting as a system ONE of a wider system, the public sector, system FIVE of which is the government.

To avoid this sort of tensions, the government employs a Railway Board, both with limited variety handling capacity, i.e., incapable of realising disastrous effects of certain government policies and capable and willing to participate in the implementation of these policies. The latter is achieved via the attenuating mechanisms of political relationship, already discussed. However, in a democratic society, at the next higher level of recursion, the government is just the system ONE of a viable system, the country itself, system FIVE of which is no other than the People. Paradoxically, therefore, people elect a government, which deliberately employs a railway board incapable of realising their will, which resulted in the government's election.

The explanation that this outcome of the people/politics interaction is seriously deformed by the functioning of a complex of variety handling mechanisms (amplifiers and attenuators) provides some clues, self-defeated, in turn, in the light of the historical experience, where the constant failure to materialise people's wishes has very much disgraced in their eyes both politics and politicians. Whether a solution might be sought in the further reinforcement of the central authority, or in the achievement of a more participatory democracy is a matter of political science achieved through political practice, and, hence, associated with the historical and cultural experience, that is, seriously affected in its development both by people's values, perceptions, and customs, and by the society's wish to ensure the viability of its prevalent institutions.

The overall equilibrium achieved, therefore, as regards the enterprise, the country and their relationship, is the outcome of these multiple interactions. The level at which this equilibrium is achieved is defined, and defines in turn, an index of the performance of the country as a system, a version of Beer's 'capability', measured against a complex and not universally agreed-upon scale, usually termed 'level of development'.

8.4.2. System FOUR

In a previous paragraph, when discussing the Sales Function, it was shown that since the General Manager of the Enterprise was also playing the role of the Production Manager, either he himself was the Sales Manager too, or there wasn't a Production/Sales interaction.

By analogy, an assessment of System FOUR activities within the company may directly derive when considering that the dominant figure of the formal System FIVE structure, i.e., the Chairman of a Board, the rest members of which have very much reduced capability and willingness to define the company's policy, happens also to be the System THREE figurehead (General Manager).

A direct consequence of this arrangement is that System FOUR activities are tailored to the company's needs, as perceived by System THREE, that is the Operations Directorate. Hence, they are 'inside-oriented'; instead of attempting to realise the future they try to justify the present.

A second consequence is the resulting organizational confusion in respect to operational, strategic and normative plans, the inability to distinguish between means and ends and to assess investment made in operational terms.

However, the third and most dramatic consequence is, that any assumption made by this System FOUR concerning the future reaches the top of the company (Board) or the higher level of recursion (Government) after being filtered by the 'inside-and-now' figurehead, the General Manager. In a thus devised organizational structure, there is no need to monitor the System THREE-FOUR interaction, since homeostasis is 'achieved' within System THREE. As the 'intelligence' function reports to 'implementation' it is both discouraged to scan the future, and obliged to justify the present.

Within the case-study enterprise, the bulk of System FOUR activities is formally assigned to the Department of Planning and Organization (DOMP). The quality of output of this Department, assessed in terms of requirements from a corporate System FOUR, has been decided by:

Its subservient role to the actual System THREE. DOMP is directly reporting to the General Manager. Hence, even if the Chairman of the Board was a different person and/or the other members of the Board possessed the properties requested as previously defined, any action of the department should seriously consider this power relationship.

Its strongly 'technical' character. The management of DOMP consists exclusively of engineers, specifically of civil engineers. Consequently, they tend to overestimate the 'permanent way and installations' problem of the company's development, and, to put aside other issues, which they do not feel adequately qualified to tackle. However, such issues concern information technology, major projects appraisal, organizational design, future transport trends forecasting, manpower capabilities enhancement, etc., plus the operations, rolling stock and signalling/telecommunications elements of the functional character of the enterprise. Formally, anything related to planning activities with respect to these issues is assigned to DOMP.

Its dual 'inside-outside' character. Besides these research areas, the same department contains the respective operating units, such as the Statistics and Costing Division (DOMP/YSK), the Informatique and Organization Division (DOMP/YO), the Computer Centre (DOMP/MK), the Investment Budget Preparation and Monitoring Division (DOMP/YP), and, until recently, the Infrastructure Studies Division and the Personnel Education Division. The output standards of these activities, as continuously perceived by the enterprise as a whole, directly reflect the limited variety handling capacity which has governed the inputs.

Within the case-study enterprise, DOMP is assumed responsible for any aspect of planning, either it refers to distant-future scenarios of the railway network, or to the preparation of strategic plans, or even to the annual investment programme, which, as already stated, is prepared and monitored by this department. All this type of planning is of poor quality, both because of shortage in equipment and specialised staff, but, predominantly, because it is prepared without the participation of the implementation units. Thus, either the plans are prepared under wider political and other non-railway considerations, or reflect the best intention of the 'planners' and their care for the enterprise, the outcome is the same: they are not implementable. They do not reflect actual priorities, they lack justification, and, therefore, no quantified aspects of performance improvement are really expected upon their implementation.

The decision for the formation of a proper System FOUR serving the needs of the railway enterprise is a quite difficult one in a public enterprise environment. It reflects the contradiction between government's desire to offer a sort of autonomy to the enterprise, in order to overcome the bureaucratic rigidity, and its inability to refrain from intervening and using the enterprise as a tool for the pursuit of goals, not necessarily compatible with the enterprise's best interests.

8.5. CONCLUSION

The cybernetic study of the railway enterprise undertaken in this Chapter has highlighted organizational problems responsible for the poor performance of the company. The problems are both structural and 'cultural'. Alternative options for the solution of the structural problems are available and may be proposed by organizational design specialists. However, the building-up of an appropriate organizational culture is more difficult, since it directly relates to the character of the company as a public enterprise, the requirements of the state-owner from this company and the level of development, defining the characteristics of the company, the government, the country, and their interrelations.

However, though based on a long-term participation within the company and on the study of related material, the 'aphorism' remains, inevitably, subjective. Thus, this chapter, instead of marking the termination of an application of the management cybernetics methodology in a railway enterprise, provides the initiative to obtain a more objective view, by interpreting opinions of the acting managers of the company. The way in which this task was designed and undertaken, as well as the view of the company it produced are the subject of the remaining part of this thesis.

8.6. SYNOPSIS

The following fundamental faults in organizational design were diagnosed:

8.6.1. Implementation (System ONE)

8.6.1.1. Implementation Units

The activities of the Operations sub-system have not been properly conceived. Hence managerial responsibility for these activities is divided between Operations (YEK), Traction (YEL) and Rolling Stock (MXSIA) units.

The Signalling/Telecommunications sub-system has not been realised as such. Hence it lacks a status within the company similar to those of the other three sub-systems.

The part of the Permanent Way and Installations sub-system activities which relates to new constructions is performed outside the structure of this sub-system by the New Projects Department (DNE).

The same is true for the new systems selection and installation activities of the Signalling and Telecommunications sub-system.

8.6.1.2. Management of Implementation

The gradual reorganization of the company from Type II to Type I has minimised the role of the Regional Management (DPER). At the moment, it is still reported by Operations (YEK) and Permanent Way (YGR) regional divisions. However, not having discretion over all components of railway production within his area, Regional Manager is rather playing only a limited figurehead role.

8.6.2. Coordination and Control of Operations (Systems TWO and THREE)

8.6.2.1. Operations Directorate (System THREE)

Coordination and Control of each function was vertically attempted by each of the three functional Assistants to the General Manager. However, the GM himself was also frequently intervening.

Corporate Production coordination and control was exercised, in the absence of a corporate managerial unit to substitute the devaluated Regional Manager, by the General Manager himself. However, corporate production has not been properly realised and, hence, ineffectively controlled.

The enterprise lacks a Sales organization, mainly because it has emerged as a government department, still retaining many of these characteristics. The company seeks principle potential customers (freight) mainly in the wider public sector, under the government's protection.

Financial management within the company is ineffective. Revenue from operations is only a fraction of overall expenditure, more than three quarters of which correspond to salaries expenses.

Personnel management is attempted by agreements with trade union leaders on the basis of political relationship. The enterprise lacks a proper personnel administration function. The trade-unionists have become the referees of managerial performance.

8.6.2.2. Corporate Coordination (System TWO)

The enterprise lacks a corporate information collection and processing centre. Information collection and processing, wherever happens (corporate, functional, regional levels), refers to a formal procedure, neither properly evaluated nor realised as a prerequisite of corrective action and adaptation.

8.6.3. The Metasystem (Systems THREE-FOUR-FIVE)

8.6.3.1. System FIVE

The Board is in practice overridden by the General Manager, both because of his dual role (being also the Chairman of the Board) and due to the actual characteristics of its members. However, neither the Chairman/GM impersonates a System FIVE, which may rather be identified within the bureaucratic upper hierarchical echelons.

8.6.3.2. System FOUR

The System FOUR status of the Department of Planning and Organization (DOMP) is seriously constrained by:

its subservient role to the GM, as prescribed in the organization.

its strongly technological characteristics.

its dual role as both a 'future scanner' and an 'operations planner'.

Many of the diagnostic points made above relate strongly to the public enterprise character of the under study railway and to the specific way in which successive governments have realised this character. A survey within the case study was assumed necessary, in order to evaluate these assumptions and to provide a more objective picture.

8.7. FOOTNOTES

1. R.Espejo, 1980: "Information Management: the Cybernetics of a Small Company", in Lucas et al. (eds.): *The Information Systems Environment* (North-Holland Publishing Co., Amsterdam).
2. In the legislation defining organization and duties within OSE, words like accountability, bottom-line responsibility, etc., are very rarely met, if traced at all. On the contrary, vague definitions such as care, provision, etc., are very frequently met to permit for both frequent corporate interventions and the disappearance of accountability, which is diluted within a spectrum of undefined responsibilities.

CHAPTER 9

SURVEY WITHIN THE CASE STUDY

9.1. INTRODUCTION

The 'ethnographic-type' cybernetic study of the company under investigation, undertaken in *Chapter 8*, has identified several reasons of poor performance, i.e., symptoms of inadequate management control, in the incorrect design of the organizational structure. However, both in *Chapters 7* and *8* it has been shown that much of this incorrect design is a result of a certain organizational culture, reflecting both the character of the specific railway as a declining industry and a public enterprise.

The management cybernetics area of knowledge may be employed in order to further elucidate structural problems, by facilitating the construction of the actual organizational model of the enterprise, i.e., the one that corresponds to the real way in which, in life, management control is attempted. The weaknesses or inadequacy of this organizational arrangement may be consequently demonstrated, and, hopefully, result in an organizational redesign.

The same area of knowledge, management cybernetics, may lend its underlying principles in order to examine cultural problems within the organization, i.e., problems that are not readily resolved by the introduction of a more rational organizational structure. Problems of this type are more likely to constitute the core of the problem, besides the fact that they are further amplified by an irrational organization.

A management cybernetics analysis of the enterprise implies, therefore, a bi-calculus approach, in order to deal with both realised dimensions of the organizational problem.

The material for both stages of the organizational analysis will be provided by answers of members of the actual managerial structure to questions posed during a survey within the case study. This chapter provides details concerning the design, the objectives, the methodology, and the sample characteristics of this survey.

9.2. SURVEY OBJECTIVES

The objectives of this piece of research, as defined in *Chapter 1*, i.e.,

to attempt to identify structural and cultural reasons of ineffectiveness in a state-owned railway enterprise, in the light of the management cybernetics area of knowledge, and

to assess the capacity of this area of knowledge, especially in its abstract and coded form (VSM), to provide adequate explanations of organizational performance and organizational failure,

have demonstrated, in the light of the preliminary analysis, the need to seek the following targets, by conducting a survey within the case study:

(1) To identify the actual VSM of the enterprise, i.e., the organization of the subsystems producing the company (systems ONE), and the way in which these subsystems are integrated to the company. Since a major part of the cybernetic study has been undertaken in *Chapter 8*, and has resulted in certain conclusions concerning the ineffectiveness of the organizational structure, as deriving from the formal assignment of responsibilities and duties, managers' responses will provide the actual picture, with respect to the following issues:

- which units constitute, in practice, Beer's Systems ONE to FIVE in the case of Greek Railways;
- which way the actual functioning attempts to overcome deficiencies inherited from poor organizational design, as described in the previous chapter, and whether it succeeds or further violates management cybernetics principles;
- which are the actual information flows within the enterprise and between the enterprise and the environment;
- to what degree do these flows provide for variety handling and effective performance.

(2) To examine the cohesiveness of the enterprise, and the content of this cohesiveness (or lack of cohesiveness), since, as has been argued, even if the organization is perfect, if the company as a whole does not have a capacity to assess whether it is 'doing' the right things, viability is in danger. This type of assessment, in this thesis, is considered to extend over the following issues, as will be further explained:

- the reason(s) of the company's existence;
- specific goals to be sought;
- the internal character of the enterprise (planning, budgeting, participation);
- the performance of the enterprise;
- the reasons constraining performance improvement;
- the methods to be employed in order to improve performance.

Cohesiveness may be interpreted as the degree of managerial agreement on these issues and will be tested statistically. Whether cohesiveness is a favourable or unfavourable sign relates to the content of this agreement.

9.3. SURVEY DESIGN

The method employed in order to achieve the targets mentioned was that of obtaining information through interviews with managers of the Greek Railways, requested to fill a questionnaire, specifically designed for this purpose, in the light of the preliminary analysis and under the theoretical approach, as described in earlier chapters.

A copy of the questionnaire on which the survey has been based is provided in *Appendix C*. This part of the thesis offers details on information requirements which the questionnaire has been designed to serve.

9.3.1. Constructing the Actual VSM of the Railway Enterprise

Data for the first research theme were obtained from answers to the questions of **Section Three** and **Section Four** of the survey questionnaire.

In *Chapter 8*, a management cybernetics study of the Greek Railways has been provided, drawing on personal interpretation of the reality, and on published material, especially the legislation defining the organizational structure and the duties of various parts. Certain structural deficiencies have been identified, whereas the fulfillment of other, properly designed, managerial activities has been assumed to rest on information flows of questionable adequacy.

This part attempts to set up the actual VSM of the enterprise, i.e., the management control function within the company as understood by the managers themselves. For this purpose, according to the framework discussed in *Chapter 6*, a detailed list of managerial activities was constructed, to reflect what railway managers were supposed to do in order to control the enterprise.

Listed activities may be grouped either by railway function or by managerial function, or managerial content, according to the following three tables:

(1) Subgrouping of Activities by RAILWAY FUNCTION

	Corporate Level	Railway Operations	Rolling Stock	Permanent Way	Signalling & Telecoms	total
No. of activities	23	37	27	33	48	168

(2) Subgrouping of Activities by MANAGERIAL FUNCTION

	Relations with State	Research & Development	Planning/ Organizing	Annual Programming	Performance Monitoring	total
No. of activities	5	21	46	30	66	168

(3) Subgrouping of Activities by MANAGERIAL CONTENT

	Relations with State	Research & Development	Production	Sales/ Pricing	Materials	Finance	Personnel	total
No. of activities	5	21	86	4	22	16	14	168

The analysis in this part of the research is mainly descriptive ¹ and involves the following steps:

- (1) Identification of responsible manager (or managers) for each of the listed activities.
- (2) Recording of actual information flows, associated with the listed managerial activities, in terms of type, frequency and assessed quality.
- (3) Graphical illustration of the actual VSM in terms of systems ONE to FIVE, in the three first levels of recursion.
- (4) Conclusions on the efficiency of the actual organization, as interpreted in terms of the management cybernetics methodology.

To a large degree, elements of phases (3) and (4) of the above methodology have been provided in the preliminary study (*Chapter 8*). In addition, details of the structure of the Viable System's Model and diagnostic prescriptions have been offered both in general (*Chapter 4*) and in details (*Appendix A*), as well as in the general case of a railway (*Chapter 6*).

Therefore, only two methodological points require further clarification and are discussed in this section. These points refer to phases (1) and (2) above , i.e., to accountability allocation and information flows handling.

9.3.1.1. Accountability Allocation

Each of the managers interviewed was asked to indicate whom he thought to be responsible for any activity, in front which a black square was marked. That is, in order to avoid misunderstandings and mistakes which might have occurred if a manager was asked about accountabilities for activities outside his managerial area, accountability allocation for every activity was requested only from the manager in the broad area of this activity. E.g., questions related to permanent way activities were asked to permanent way managers, etc. Two notes should be made here:

- (1) Activities for which, as revealed by the preliminary study, accountability was not clearly allocated, or required explicitly the cooperation of functional areas were discussed with all managers assumed to be, in one way or the other, responsible.

(2) As a rule, managers at corporate level such as assistant general managers, planning and budgeting managers etc., were requested to answer an extended set of questions.

critterion	p (accountability allocation)	interviewed	accepted responsibility	n (%) ("noone + "not known")
a	p > 75	Y	Y	-
			N	
		N	-	
b	p > 67	Y	Y	n < 10
		N	-	
c	p > 50	Y	Y	n < 20
		N	-	
d	p > 50	Y	Y	n > 20
		N	-	
e	every other case			

Table 13: Acountability Allocation Criteria

The task of accountability allocation implies the adoption of an appropriate methodology. Since, as explained, questions were posed only to relevant managers in a way which minimises possible errors due to irrelevance ², a percentage criterion seems to be an appropriate heuristic. Thus, three levels were distinguished:

Level 1: More than three quarters (75 %) of the managers interviewed agree on who is responsible for a certain activity.

Level 2: More than two thirds (67 %) of the managers interviewed agree.

Level 3: More than half (51 %) of the managers interviewed agree.

Combining these three levels of agreement with three more conditions, i.e.,

- (1) whether the manager indicated as responsible has been interviewed,
- (2) when interviewed, if he accepts responsibility, and
- (3) whether there is a significant percentage of "don't know" and "no one responsible" answers to the question about accountability for a certain

activity, a set of five criteria (a to e) was established, where "a" corresponds to an almost unanimous agreement on accountability allocation and "e" to a lack of a manager accountable for a certain activity. *Table 13* summarises the definition of these criteria.

Obviously the above set of criteria were not used rigidly, but in order to facilitate the VSM construction.

9.3.1.2. Information Flows

Since the essence in Beer's model is the emphasis in information handling, a further stage of data collection and analysis was required, in order to identify the actual information flows between managerial units or between units and environment. Thus, for each activity for which a manager was declaring responsibility, he was requested to provide the following information (Section Four of the Questionnaire):

Sources, type, frequency, and assessed quality of information received, related to this managerial activity.

Destination, type, frequency, and assessed quality of information sent.

An extended data-base on actual information flows was thus constructed and is displayed in *Appendix D (Survey Data)*. However, though this data-base may assist in assessing the adequacy of almost any of the recorded information flows, not all of the information contained has been utilised for the purposes of this thesis. Besides illustrating a complete network of recorded flows, and providing some conclusions for the type and quality of principle managerial activities, the material awaits further detailed analysis at a level, which could not have been undertaken within this work, without generating the danger of getting involved in micro-consultancy issues.

9.3.2. Degree and Content of Managerial Cohesiveness

As stated, a management cybernetics study of an enterprise, should not be limited to the analysis of the organizational structure; neither can a work of the type undertaken in this thesis end up with suggestions about organizational rebuilding, without considering the way in which fundamental issues are realised by the acting managers of the enterprise. The cybernetic model of the organization in its abstract form is based on a series of hypotheses, which cannot be tested by merely allocating accountability for activities and assessing information flows. Besides organizational structure, management control requires planning, aiming at goals arrived at in order to fulfil objectives. Management control, especially under a cybernetic paradigm, also requires performance measurement and feedback leading to corrective action. In summary, VSM assumes a cohesive enterprise, precisely 'positively cohesive', i.e., one in which people are not only generally in agreement, but in which this agreement guarantees viability in the long run.

The second part of the case-study research deals, therefore, with the cohesiveness of the enterprise. To the degree that information analysed arrives from managers' responses this part deals more specifically with managerial cohesiveness.

Cohesiveness is examined in relation with the following issues:

- (1) The objectives of the enterprise;
- (2) Operational tasks to be achieved;
- (3) Contribution of units in achieving these tasks;

- (4) The planning process;
- (5) Overall view of the company;
- (6) Performance assessment;
- (7) Objectivity of performance assessment;
- (8) Reasons constraining performance improvement; and
- (9) Measures assisting performance improvement.

These issues are examined by analysing managers' answers to questions of Section Two of the Survey Questionnaire. Before showing which way managerial cohesiveness will be tested and assessed, the relation of these issues to opinions discussed in earlier chapters, concerning the specific characteristics of a state-owned railway enterprise, will be presented, together with an explanation of the rationale of the specific questions asked.

9.3.2.1. Objectives of the State-Owned Railway Enterprise

Managers were asked to indicate on a five-interval scale from 1 (*strongly agree*) to 5 (*strongly disagree*) their rate of agreement to the following seven stated objectives, referred to hereafter as variables object1 to object7. Managers were asked to state what OSE does by existing as a public enterprise, not what is required or supposed to do.

object1: "OSE exists mainly in order to offer railway services better than those to be offered by a private railway enterprise".

This question, obviously, relates to the very character of the railway as a public enterprise and attempts to reveal whether, in the managers' opinion, real life justifies state-ownership of the railway for the pursuit of some sort of public interest constrained by private ownership.

object2: "OSE exists mainly in order to serve transportation needs of the lower income classes".

object3: "OSE exists mainly in order to serve excess transport demand during peak periods, since this kind of demand cannot be undertaken by the rest of the transport system".

object4: "OSE exists mainly in order to help the state in achieving wider policy goals (development goals, e.g., regional development, social goals, e.g., employment maintenance, inflation control), via the spectrum of public enterprises under its control.

object7: "OSE exists mainly in order to assist in tackling some sort of wider national problem in future".

These variables comprise four forms of public interest to be pursued by the existence of the state-owned railway enterprise.

object5: "OSE exists mainly in order to maintain a complex of relations, associated with financial and political interests of individuals".

This variable may be used as a measure of the realization of the impact of political considerations (or other sorts of external interest) on the functioning of a railway.

object6: "OSE exists mainly in order to assure the survival of the railway as a means of transport, which, being technologically outdated, could not survive in free competition conditions".

Obviously, this reason could not stand by itself as an objective of railway state-ownership and functioning. This variable was employed to check whether the interviewees followed the logic of the questionnaire and provided rational answers.

The questions posed relate both to the contradictory character of the public enterprise, as discussed in *Chapter 5*, and to the actual characteristics of the under-study enterprise, as presented in *Chapters 7 and 8*. For example, a statement of the type "OSE exists mainly in order to provide an effective means of commuting", or "OSE exists mainly in order to relieve motorways from freight transport" could not be contained in a question, since, as shown, OSE does not offer such services, at least at the moment.

9.3.2.2. Operational Tasks to be Achieved

Managers were asked to indicate on a six-interval scale, from 0 (*unimportant*) to 5 (*vital*), their impression on the importance of the following seven operational tasks (variables task1 to task7).

Three of these tasks are customer-oriented (compare to non-financial criteria of performance). They are:

task3: "to improve service reliability";

task5: "to reduce journey times"; and

task6: "to improve quality of services" (aspects other than reliability and journey times).

Two tasks relate to financial performance:

task1: "to reduce total expenditure"; and

task2: "to reduce staff expenditure".

Finally, two tasks relate to overall railway performance assessed by a nationwide viewpoint:

task4: "to increase traffic volume"; and

task7: "to increase market share".

The questions of this section have to be understood as a measure of the ability of public-enterprise managers to realise the "commercial" dimension of railway activities. Recall (*para.5.2.2.2*) that literature doubts this ability.

9.3.2.3. Contribution of Units in Achieving Operational Tasks

Again, on a six-interval scale (0=*negligible*, 5=*vital*), managers were asked to assess their unit's contribution in achieving the tasks stated in the previous paragraph. Variables contr1 to contr7 of this section are employed as:

a measure of managers' realisation of their unit's significance, from a corporate viewpoint, and

a measure of actual capability of various units.

9.3.2.4. The Planning Process

Three variables measure managers' impression of the actual planning process in the under-study enterprise:

Variable plan ("which way do you think planning is organized in OSE?"), is measured on a five-interval scale, with the following values:

"1": There is planning and is strictly implemented.

"2": There is planning adapting to changing conditions.

"3": There is planning but so imperfect that becomes not implementable.

"4": There is no planning. Everyone tries to serve the interest of the company as he realises it, and

"5": There is no planning: Everyone tries to avoid being charged with duties, which are not definitely his responsibility.

Variable budget ("which way do you participate in your unit's budget preparation ?"), taking values from the following five-interval scale:

"1": I sum up the proposals of the units reporting to me.

"2": I examine the proposals of the units reporting to me and ask for justification of expenses.

"3": I examine the proposals of the units reporting to me in relation with directives from my superiors.

"4": I exhaust the capabilities for discussion with units & superiors prior to unit's budget preparation, and

"5": My unit's budget is the outcome of discussion and agreement between all involved headquarters, production and supportive units.

Variable freqbudg ("How often is your opinion asked, before your unit's budget is amended ?"), with values:

"1": Almost never,

"2": Rarely,

"3": Sometimes,

"4": Often, and

"5": Almost always.

These variables were expected to reveal the participative or authoritarian character of the planning process and the degree to which planning constitutes a fully integrated organizational activity contrasted to a merely formal periodic process. Recall (*Chapter 6*) that according to Beer *"planning is the 'glue' of organizational cohesiveness"*.

9.3.2.5. Overall View of the Company

Variables in this question ("What kind of view do you think that the following managerial levels hold for the company ?") measure managers' impression of the way in which certain managerial levels (view1: top management; view2: headquarters departments; view3: production departments; and view4: production units) view the company. A five-interval scale is employed, where

- "1" : View the enterprise as a whole: They are mainly interested in the performance of the totality.
- "2" : View the enterprise as a set of activities in close interrelationship: The performance of parts is significant to the extent that defines overall performance.
- "3" : View the enterprise as a set of activities relatively interrelated: The performance of parts is equally significant as overall performance.
- "4" : View the enterprise as a sum of relatively independent activities: They are more interested in the performance of parts than in overall performance.
- "5" : View the enterprise as a sum of independent activities: They are only interested in the performance of each part. This will define overall performance.

Value "1" corresponds to an integrated or "holistic" view and value "5" to a "reductionist" view of the company.

9.3.2.6. Performance Assessment

Nine measures of railway performance were employed:

- opin1: OSE's traffic volume (in absolute figures);
- opin2: OSE's market share;
- opin3: Service reliability;
- opin4: Track quality, concerning train punctuality;
- opin5: Track quality, concerning quality of journey;
- opin6: Rolling stock quality, concerning train punctuality;
- opin7: Rolling stock quality, concerning quality of journey;
- opin8: Terminals' capabilities, concerning traffic handling; and
- opin9: Terminals' capabilities, concerning quality of services offered.

On a five-interval scale with values from "1" (*"has significantly improved"*) to "5" (*"has significantly deteriorated"*), managers were asked to state which way they think that each variable has developed during the last three years.

Managers' responses would provide a measure of:

- (1) The internal communication of information on achieved performance; and
- (2) The tendency to overevaluate "our" performance and to underevaluate the performance of "others";

9.3.2.7. Objectivity of Performance Assessment

It is likely that opinions expressed by managers on railway performance may either:

- (1) be based on information without personal knowledge of the situation; and/or
- (2) be based on a geographically partial knowledge of the situation, i.e., judging for the whole of the network based on experience gained from a part of it.

Variables in this section ("How often have you travelled by train during the last three years ?") refer to

journ1: the Athens-Thessaloniki "main line",

journ2: the North Greece network, and

journ3: the narrow gauge (Peloponnese) network,

and take values on a six-interval scale reflecting frequency of visits, where value "1" corresponds to weekly frequency and "6" to less than once yearly.

The same variables may reflect the importance which headquarters assign to several parts of the network, as assessed by the number of visits they pay.

9.3.2.8. Reasons Constraining Performance Improvement

This part of the questionnaire has to be examined in close relation with the part of *Chapter 5* referring to inherent disadvantages under state ownership. Nine principle reasons constraining performance improvement have been stated:

reason1: OSE's old technological equipment;

reason2: OSE's inflexibility as a result of State's interventions;

reason3: Lack of planning;

reason4: Lack of control;

reason5: Limited capacity of the managers themselves;

reason6: Indifference of operating staff;

reason7: Absence of incentives for the personnel of all levels;

reason8: Loss of proper orientation on behalf of the trade unions; and

reason9: Pro-workers legislation within and outside the railways.

Variables were measured on the same five-interval scale as variables object1 to object7, i.e., "1" corresponds to "strongly agree" and "5" to "strongly disagree".

9.3.2.9. Measures Assisting in Performance Improvement

The goal of performance improvement was expressed in the form of six sub-goals:

sub-goal 1: Improved quality of services offered;

sub-goal 2: Optimum utilization of resources available (i.e., rolling stock, track and installations);

sub-goal 3: Improved co-operation between sub-systems (i.e., operations, rolling stock, permanent way, and signalling and telecommunications).

sub-goal 4: Improved performance of the Rolling Stock sub-system.

sub-goal 5: Improved performance of the Permanent Way and Installations sub-system.

sub-goal 6: Improved performance of the Signalling and Telecommunications sub-system.

Seven methods of achieving these goals were stated, i.e.,

method1: reorganization;

method2: change of respective managers;

method3: improved planning;

method4: effective control;

method5: intensive staff training;

method6: improved work conditions; and

method7: salary increases.

Managers were asked to produce six rank orders of these methods, each corresponding to one of the sub-goals mentioned.

9.3.2.10 Testing Cohesiveness

The major hypothesis in this part of the research is that if the company's character and strategy are clear, and if they have been communicated throughout the organization, managers will agree which are the main objectives sought by the enterprise, how important various tasks and activities are to the company, which are the ways to overcome major difficulties. The managers' answers to listed objectives, activities and methods should, therefore, be analyzed, to provide evidence of a common understanding. The research questions posed can be answered in a positive/negative fashion: Do the managers agree or do they disagree ?

Statistical tests may be employed to test several 'statistical hypotheses', providing thus a basis upon which to answer the research questions. For each question, the 'null hypothesis', symbolised as H_0 , states that the managers do agree. If a statistically significant relationship between managers' ratings is found, the null hypothesis will be

rejected and the conclusion will be that the managers do not agree. The extent of thus identified managerial disagreement will provide a measure of managerial cohesiveness within the under study enterprise.

A first derivation of the degree of cohesiveness involves the examination of descriptive statistics concerning the whole sample, such as frequencies distributions and standard deviations.

Cohesiveness may be further examined respectively to subdivisions of the managerial structure, since for at least some of the variables, significant disagreement is expected. This disagreement may be attributed either to different ages of managers, or to different managerial level, function, or jobtype. The following subgroupings will be considered.

(1) subgrouping by AGE of managers

A G E group				
1	2	3	4	5
-30 years	30-40 years	40-50 years	50-60 years	+60 years

(2) subgrouping by managerial LEVEL

L E V E L group			
1	2	3	4
Top Management	Heads of Depts	Heads of Divisions	Area Managers

(3) subgrouping by FUNCTION of managers

F U N C T I O N group				
1	2	3	4	5
Operations	Rolling Stock	Permanent Way	Signalling Telecom	Other

(4) subgrouping by JOBTYP E of managers

J O B T Y P E group	
1	2
Headquarters	Production

Since the sample population (from the nature of this research) will be quite limited to allow for assumptions about the normality of distributions, nonparametric tests will be employed in order to determine whether the managers in the under study organization agree with each other.

The nonparametric test appropriate for this study ³ is either the two-sample or the k-sample median tests, depending on the number of subpopulations involved.

The rationale for the median test is as follows: ⁴

Let n_1 random quantitative observations be obtained from Population 1, n_2 similar observations be obtained from Population 2, ..., and n_k observations from Population k. If $M_1, M_2, \dots, M_k$ denote the medians for the first, second, ..., kth sample respectively, then the differences between the sample medians can be used to make an inference about differences in the population values. Thus, one can test the hypothesis:

$$H_0 : M_1 = M_2 = \dots = M_k = M_0$$

against the alternative

$$H_1 : M_1 \neq M_2 \neq \dots \neq M_k$$

Under H_0 , it is hypothesized that there is no statistical difference between the medians of the populations from which the samples are drawn. As a result, the k samples can be combined into one sample. For the combined observations, it is possible to find the common median, M_0 , determine the number of observations in each sample that are above and below the common median, and then test the hypothesis

$$H_0 : M_1 = M_2 = \dots = M_k .$$

H_0 can be tested by use of the Karl Pearson's statistic :

$$X^2 = \sum_{i=1}^2 \sum_{k=1}^k \frac{|X_{ik} - E(X_{ik})|^2}{E(X_{ik})}$$

which can be computed simply as

$$X^2 = \sum_{i=1}^2 \sum_{k=1}^k \frac{X_{ik}^2}{E(X_{ik})} - n$$

or, in terms of the cell and marginal frequencies, by:

$$X^2 = \sum_{i=1}^2 \sum_{k=1}^k \left[\frac{X_{ik}^2}{X_{i.} X_{.k}} - 1 \right] n$$

If the cell frequencies in the expected frequency table are all greater than five 5, then X^2 can be approximated by a chi-square variable with $v = (K - 1)$ degrees of freedom.

9.3.2.11. Content of Cohesiveness

The described test of managerial cohesiveness provides a measure of managers' agreement on the issues examined. However, the degree of managerial agreement does not provide by itself a measure of organizational effectiveness. The content of this agreement or disagreement must, further, be examined. Thus, after performing the statistical tests, an interpretation of the values obtained will proceed, to reveal whether the existence or lack of cohesiveness provides an indication that the under-study organization, as far as its managers are concerned, is capable of pursuing viability and development.

9.4. SURVEY POPULATION

A detailed organizational description of the Greek Railways (OSE) is provided in *Appendix B (Figure B5)*. As can be seen, listed from left to right are the following five managerial levels:

Level 1: Top Management,
consisting of the Board (nine members, including the Chairman and the vice-Chairman), the General Manager, and his Assistants (four Assistants).

Level 2: Heads of Departments
(18 Heads of the respective Departments of the company).

Level 3: Heads of Divisions;
each Department consists of several divisions, each managed by the Head of Division manager. As an exception, two divisions [the Signalling, Telecommunications and Electrical Installations Division (YSTHE) and the Road Transport Division (YA)] are not contained within a Department but report directly to the General Manager and his assistants.

Level 4: Heads of Area Units;
each Division consists of smaller units, termed here under the general title Area Units. Actually, referring to Divisions within Production Departments [i.e., Regional Departments (DPA, DPP, DPT_h), Mechanical Engineering Department (DISTY) and Signalling/Telecommunications Division (YSTHE)], the term 'area unit' has an exact geographical meaning, denoting, in the case of Divisions within Regional Departments, the Operations Area Managers and the Permanent Way Area Managers, in the case of Mechanical Engineering Department Workshops Managers and Depots Managers, and in the case of Signalling/Telecommunications Division S/TCM Regional Area Managers. However, in the case of Headquarters Departments the term 'head of area unit' denotes merely the manager of a small office within the division, reported usually by a few members of the personnel.

Level 5: Heads of Local Units;
the term refers only to Area Units within Divisions within Production Departments and denotes:

- Stationmasters,
- Depots and Workshops foremen,

- Permanent way maintenance foremen,
- S/T maintenance foremen.

The survey was designed to interview managers of levels 1 to 4. *Table B2 (Appendix B)* displays the numbers of managers in these levels, the total population being 112. Considering both the resources available and the scope of the research, the following sampling was arrived at:

1. Headquarters Administrative and Clerical Departments (DOY, DOE, DEE, DP, DD, DNY, DIP, DAP) should be excluded from the survey, because:
 - They exert quite limited influence on the overall performance of the company, as revealed by the preliminary cybernetic study (*Chapter 8*).
 - They represent a very small percentage of the total personnel employed ($0.90+0.13+0.88+0.41+1.79+0.34+0.65=5.10$ %, see *Table B1, Appendix B*).
2. North Greece Region (Thessaloniki Regional Department - DPT_h) should be excluded due to limitations in resources. Equally excluded should be the Thessaloniki based workshop, depot and S/T unit.
3. From the remaining managerial structure, the achieved response should enable the obtaining of a clear picture in all four managerial levels examined. For the purposes of the actual VSM construction, this involved that any gaps resulting from a manager's unwillingness to participate should be filled by interviewing managers above and under him. Similarly, in order to examine organizational style, the target population should be of the magnitude of 50% of the sample, as already defined. The same minimum percentage should be achieved within each of the four managerial levels.

9.5. SURVEY IMPLEMENTATION

The questionnaire was presented to the Chairman of the Board (who, at that time, happened also to be the General Manager) and his permission was requested to conduct the survey. A recommendation letter was not requested, as it was thought that the respondents might consider top management being behind the survey, expressing, thus, opinions favourable to top management. Obviously, this danger could only be reduced, not totally avoided. However, an advantage in the survey procedure was that the interviewer happened to be a railwayman for more than ten years, and that he personally knew most of the interviewees, who in turn, trusted his promise of confidentiality.

After permission was obtained, interviews were arranged, at a rate of 2-3 per day. Average interview duration was 1 1/2 - 2 hours, though a few lasted much longer.

No time for preparation was given to the interviewees, i.e., they did not have prior knowledge of the contents of the questionnaire.

Table 14 provides details about the rate of response to the survey. As can be seen, there was a very high rate of response amongst the managers contacted (50 out of 53, or 94.4 %). The overall achieved number of responses was also high, compared to the size of the sample, as defined in previous paragraphs (50 out of 73, or 68.5 %).

Managers not interviewed fall within one of the following categories:

1. Vacant places: 2 (nos. 6 and 55 in *Table 14*).
2. On sick leave: 1 (no. 73).
3. Outside the Railway, not frequently calling: 3 (nos. 3, 4 and 5).
4. Based outside the Athens/Piraeus area: 9 (nos. 42, 43, 44, 49, 50, 51, 56, 57, 63).
5. It did not become possible to contact, within the time available, managers nos. 28 and 29.
6. Finally, managers nos. 1, 2, and 10 was planned to be contacted and interviewed during the last week of the time available, which coincided with changes in OSE's top management (a new GM was appointed), discouraging, thus, contacts for interviews.

List of Target Sample Members	contacted		interviewed		remarks
Board					
1. Chairman	N		N		
2. Vice-Chairman	N		N		
3. Member	N		N		
4. Member	N		N		
5. Member	N		N		
6. Member	N		N		
7. Member		Y		Y	
8. Member		Y		Y	
9. Member		Y		Y	
10. General Manager	N		N		
11. Assistant GM, Operations		Y		N	accepted; not available
12. Assistant GM, Perm.Way		Y		Y	
13. Assistant GM, Traction		Y		Y	
14. Assistant GM, Personnel		Y		Y	
15. Dept. of Planning (DOMP)		Y	N		declined
16. DOMP/YM		Y		Y	
17. DOMP/YP		Y		Y	
18. DOMP/YSK		Y		Y	
19. DOMP/YO/TO		Y		Y	
20. DOMP/MK		Y		Y	
21. Dept. of Traction (DEL)		Y	N		declined
22. DEL/TY		Y		Y	
23. DEL/TK		Y		Y	
24. DEL/YM294		Y		Y	
25. Operations Technicl (DET)		Y		Y	
26. DET/TY		Y		Y	
27. Operations Commercl (DEM)		Y		Y	
28. DEM/YEpM	N		N		
29. DEM/YEmM	N		N		
30. Permanent Way (DG)		Y		Y	
31. DG/YG		Y		Y	
32. DG/YKTE		Y		Y	
33. DG/GEME		Y		Y	

(continued)

34. New Projects (DNE) 35. DNE/YK 36. DNE/YME 37. DNE/YMEEKE 38. DNE/YMESTH		Y Y Y Y Y		Y Y Y Y Y	
39. Athens Region (DPA) 40. DPA/YEK 41. DPA/YEK/A'EPITH 42. DPA/YEK/B'EPITH 43. DPA/YEK/C'EPITH 44. DPA/YEK/D'EPITH 45. DPA/YEK/KGPA 46. DPA/YGR 47. DPA/YGR/T 48. DPA/YGR/A'TM.GR. 49. DPA/YGR/B'TM.GR. 50. DPA/YGR/C'TM.GR. 51. DPA/YGR/D'TM.GR. 52. DPA/YGR/TMK	 N N N N N N	 Y Y Y Y Y Y Y Y	 N N N N N N	 Y Y Y Y Y Y	 based at Lamia based at Larissa based at Volos based at Lamia based at Larissa based at Volos
53. Peloponnese Region (DPP) 54. DPP/YEK 55. DPP/YEK/A'EPITH 56. DPP/YEK/B'EPITH 57. DPP/YEK/C'EPITH 58. DPP/YEK/KGPA 59. DPP/YGR 60. DPP/YGR/T 61. DPP/YGR/A'TM.GR. 62. DPP/YGR/B'TM.GR. 63. DPP/YGR/C'TM.GR. 64. DPP/YGR/TMK	 N N N N	 Y Y Y Y Y Y Y Y	 N N N N	 Y Y Y Y Y Y Y	 vacant based at Patras based at Tripolis based at Patras based at Tripolis
65. Roll.Stock Repair (DISTY) 66. DISTY/TY 67. DISTY/YOSTY 68. DISTY/EP 69. DISTY/MAI 70. DISTY/MPR		Y Y Y Y Y Y		Y Y Y Y Y	
71. Signalling/Tlcm (YSTHE) 72. YSTHE/TTHE/A 73. YSTHE/TTHE/P	 N	 Y Y	 N	 Y Y	
T O T A L	20	53	23	50	73

Notes: 1. All managers listed are based within the Athens Metropolitan Area, unless otherwise stated.
2. For an explanation of abbreviated titles see Chapter 7.

Table 14: Sample Members of the Survey

A graphical/visual illustration of survey sample and achieved response are provided respectively in *Figures B5 and B6 (Appendix B)*.

Table 15 provides the sub-division of the managers interviewed into the previously defined subgroups.

A G E	1	2	3	4	5	total
	-30 years	30-40 years	40-50 years	50-60 years	+60 years	
No. of respondents	0	6	17	23	4	50
Percentage	0%	12%	34%	46%	8%	100%
L E V E L	1	2	3	4		total
	Top Management	Heads of Depts.	Heads of Divisions	Area Managers		
No. of respondents	6	7	20	17		50
Percentage	12%	14%	40%	34%		100%
F U N C T I O N	1	2	3	4	5	total
	Operations	Rolling Stock	Permanent Way	Signalling Telecom	Other	
No. of respondents	8	10	18	3	11	50
Percentage	16%	20%	36%	6%	22%	100%
J O B T Y P E	1	2				total
	Headqtrts	Production				
No. of respondents	21	29				50
Percentage	42%	58%				100%

Table 15: Subgrouping of Respondents by Age, Level, Function and Jobtype

Finally, all information collected during the survey is displayed in subsequent tables of *Appendix D*.

9.6 SYNOPSIS

A survey involving managers within the case-study was undertaken. The survey was designed to provide data in order to:

Identify the actual VSM of the enterprise, and

Examine managerial cohesiveness in the enterprise.

The identification of the actual VSM involved the examination of:

- (1) Accountability allocation;
- (2) Information flows network.

On the basis of the description provided in *Chapter 8*, a cybernetic analysis of the actual functioning of the Greek Railways was undertaken in order to reveal:

- (1) Which way do managers, in practice, overcome disadvantages inherited from the poor design of the formal organization.
- (2) Whether, in the course of overcoming these disadvantages, they further violate cybernetic principles of organization.
- (3) Whether the principle characteristics of actual flows (type, frequency, quality) provide adequate information for management control.

The examination of managerial cohesiveness involves testing managerial agreement on issues concerning:

- (1) The objectives of the enterprise,
- (2) Operational tasks to be achieved,
- (3) Contribution of units in achieving these tasks,
- (4) The planning process,
- (5) The integrated view of the company,
- (6) Performance assessment,
- (7) Reasons constraining performance improvement, and
- (8) Measures assisting performance improvement,

and assessing the content of this agreement (or disagreement).

A first test of managerial cohesiveness involved the analysis of descriptive statistics, such as frequencies distributions and standard deviations, concerning the survey sample.

Managers interviewed were further subdivided into groups by age, level, function and jobtype. Managerial agreement was tested by contrasting opinions of subgroups within groups, providing, thus, more details concerning the degree of managerial cohesiveness.

Finally, the meaning of this cohesiveness (or lack of cohesiveness) was examined, by interpreting the findings of the survey.

The survey was designed to be extended over the totality of managers in four managerial levels, with the exclusion, mainly due to limitations in resources, of:

- (1) A number of headquarters clerical and supportive departments.

(2) One of the three regional departments, the most remote.

Managers interviewed comprise 68.5 % of the designed sample (50 out of 73) and the 94.4 % of the managers contacted (50 out of 53). The magnitude of the response achieved satisfies almost completely the requirements of this thesis.

The analysis of information collected is undertaken in following chapters.

9.7. FOOTNOTES

1. G.A.Britton and H.McCallion (1985) have proposed that to assist potential users in correctly applying the model, case studies demonstrating valid uses of the model should be published. Furthermore, they suggest, the studies should be primarily descriptive. *"Our experience with the model indicates that significant organizational deficiencies can be 'discovered' using the model at the descriptive level. More importantly though, if the mathematics is to come out right, the analogy must first be appropriate".*
2. *Table E1 (Appendix E)* provides a functional analysis of managers interviewed for each of the 168 listed activities.
3. S. Siegel, 1956: *Non-Parametric Statistics for the Behavioural Sciences* (McGraw-Hill, New York).
4. L.A.Marascuilo and M.McSweeney, 1977: *Non-Parametric and Distribution-Free Methods for the Social Sciences* (Brooks/Cole Publishing Co., Monterey, California).
5. *"Actually, there is some evidence that this assumption can be weakened without violating the integrity of the Karl Pearson form of the test. However, extreme violations cannot be tolerated"* (L.A.Marascuilo and M.McSweeney, 1977: page 133).

CHAPTER 10

VSM OF THE ENTERPRISE

10.1. INTRODUCTION

In *Chapter 8*, the VSM structure of the enterprise was discussed, as resulting mainly from the legislation, which assigns specific duties to various parts of the company, and various deficiencies were identified. Further, the ability of various sub-systems and units to absorb the emerging environmental, operational and managerial varieties was questioned, but could not be evaluated without performing a survey, to show which way was, in practice, this variety engineering attempted.

This chapter illustrates the findings of the survey in terms of Beer's model of the viable system. The picture it provides is more objective, than the one offered in *Chapter 8*, as it draws on the opinions expressed by the managers themselves, but probably less rich, as it is based on responses to a structured questionnaire. Somehow, the relative merits and disadvantages of two types of social research, i.e., 'ethnography' and 'survey' are both reflected in this thesis. Therefore, a parallel evaluation of the respective chapters is recommended.

The cybernetic model of the enterprise is constructed in two stages:

First, an identification of systems ONE to FIVE at various levels of recursion is attempted by examining accountability for listed in the questionnaire managerial activities.

Then, by assessing recorded information flows the above model is enriched.

10.2. PRELIMINARIES TO ACCOUNTABILITY ALLOCATION

10.2.1. Variety Engineering

Accountability allocation was attempted on the basis of the cybernetic modelling of the railway enterprise, which was provided in *Chapter 6*, taking into account the specific organizational characteristics of the under-study enterprise, as discussed in *Chapter 8*. Thus, a list of 168 managerial activities at various levels and areas within the railway enterprise has been constructed and contained in the survey questionnaire. The methodology adopted for the allocation of accountability for each managerial activity has been described in *Chapter 9*. *Table 16* illustrates the relation of the activities listed in the questionnaire to the recursive levels of the enterprise. The table summarises the methodology for the derivation of the actual VSM of the enterprise, by providing a means of visually interpreting actual managerial discretion, to be shown by managers' responses to questions about accountability for activities. ¹ Two notes, concerning this table, should be made here, related to limitations in space:

[illegible]

Table 16: Relation of Managerial Activities of Survey Questionnaire to Recursive Levels of the Enterprise

- (1) Each activity at any level of recursion is, obviously, related also to any higher level, though, in the table, this has only been shown for activities for which this was explicit. For example, in the extreme case, all of the 168 activities are related to recursive level 1 (railway enterprise).
- (2) Activities nos.1-5 of the survey questionnaire (Relations with the State) are the only not to be shown in the table, since they obviously relate only to recursive level 1 and they require an additional column, not available for practical reasons.

The way in which variety is handled in real life, that is, the way in which managerial accountability is allocated within the enterprise, will provide the real version of this table, enabling thus the identification of the VSM.

10.2.2. Some General Findings of Accountability Allocation

Detailed information on the 'accountability allocation' methodology is contained in *Appendix E*, where:

Table E1 provides a functional analysis of managers interviewed for each of the 168 listed activities;

Tables E2 to E6 illustrate the results of the adopted methodology as regards the five functional areas of managerial activities, i.e., Corporate (*Table E2*), Operations (*Table E3*), Rolling Stock (*Table E4*), Permanent Way (*Table E5*), and Signalling/Telecommunications (*Table E6*); and

Table E7 summarises the findings of accountability allocation by criterion and functional content of activity.

Figures E1 to E13 provide graphical interpretation of accountability allocation,

either in terms of Type of activity, Content of activity and Specific Content (as regards Production, Materials, and Finance content) in respect to the allocation criteria (a to e),

or in terms of the accountable managerial units in respect to Type, Content and Specific Content of groups of activities.

Prior to departing to the construction of the VSM of the enterprise at certain levels of recursion, it is, therefore, possible to arrive at general conclusions by interpreting some of the information carried by the processed data. Information concerning the total sample is contained in *Figures E1, E2, and E3*, which provide the rate of precision of accountability allocation (according to the described criteria *a* to *e*) and the managers accountable for the activities contained in the survey questionnaire.

A first interesting finding (*Figure E1*) is the substantial overall percentage (12 %) of activities, for which no manager was found accountable (*criterion e*). Concerning the separation of activities in five types (Relations with State, Research & Development, Planning/Organizing, Annual Programming, Performance Monitoring) and five contents (Production, Sales, Materials, Finance, Personnel), the most problematic areas in the case-study enterprise were by type of activity Annual Programming (19 % non-accountable) and Performance Monitoring (13 %) and by content of activity Personnel (29 %), Finance (25 %) and Production (13 %). Within activities of the Production content, 22 % of activities related to Production Rules were found not having manager accountable. The

respective percentages for Production Plans and Budgets were 17 % and 12 %. Within activities of the Finance content, 29 % of managerial activities related to Financial Expenditure were not performed by an accountable manager.

A second revealing finding is the minimal role of Regional Management (DPER) in the overall functioning of the enterprise. Thus, as illustrated in *Figures E2* and *E3*, Regional Managers perform only the 0.5 % of the activities listed in the questionnaire, which relate, by type, only to Performance Monitoring (1 % within this type), by content to Production (again 1 %) and by specific content within production to Quality Control (4 % of such activities). This finding validates the assumptions made in *Chapter 8*, i.e., that besides the formal regional structure the enterprise tends, in fact, to be organised vertically functionally. It consequently justifies the modification of the initially assumed recursive structure. This modification, employed in the remainder of the thesis, reflects a Type I railway enterprise, as discussed in *Chapter 6*, the Systems ONE of which, in the first level of recursion, are the four functional sub-systems, i.e., operations, rolling stock, permanent way, and signalling/telecommunications. This assumption, though explained in details in the remainder of this chapter, has to be mentioned at this stage, where the analysis starts to examine each of the sub-systems actually 'producing' the case-study enterprise.

10.3. ACCOUNTABILITY ALLOCATION

10.3.1. Recursion No.2: System ONE Operations

Table 17 provides the actual managerial discretion for the activities of the System ONE Operations. As illustrated, almost the totality of these activities are performed at the top of the company, outside the regional structure. Indeed the regional manager (DPER) was assumed by the interviewees accountable only for activities nos. 38 and 57, i.e., with defining the standards of services on trains and with monitoring the offering of these services. This was a rational assumption, as the Operations Manager within the Region (YEK) has no power over a number of activities, performed outside his area of responsibility (train cleaning/servicing, train fuelling, train running), as shown in *Chapter 8*. On the other hand, the only activity accountability for which was assigned to the Operations Manager (YEK) was no.58 (monitoring the standards of services offered at terminals), which obviously relates to his power over the terminals staff. Accountability for activities concerning the trains crews and terminals staff (nos. 59 and 60 respectively) was not clearly allocated, in that it lied somewhere between the Regional (DPER) and the Operations (YEK) managers.

Any other managerial activity of the Operations System ONE was either performed outside the regional structure or not performed at all. Thus:

Research and Development activities (nos. 24-27) were performed by the headquarters departments of Planning (DOMP), Operations Commercial (DEM), and Operations Technical (DET). However, it should be noted that managers interviewed were not very definite in allocating accountability for these activities, as *Figure E6* (top graph) in *Appendix E* illustrates.

Planning/Organizing activities (nos. 28-33) were again performed by headquarters operations departments (DEM and DET), but again not very clearly (almost in any case by *criterion c*). An interesting finding in this section is that no one is responsible for identifying requirements in technical configuration of the track, i.e., required axle loads, journey speeds, etc. (activity no.30). Combining this finding with the

LEVEL OF RECURSION					RESEARCH & DEVELOPMENT					PRODUCTION					SALES	pricing	MATERIALS			FINANCE			PERSONNEL
5	4	3	2	1	nl/bends	economy	monitoring	preparing scenarios	rules	plans	budgets	control	quality control				require-ments	buying	stock control	revenue	expen-diture	cash flow	
train clearing & servicing																							
train																							
fueling																							
train																							
turning																							
train inspection/crewing																							
	train operations (KCPA)																						
traffic																							
controlling																							
booking																							
consigning																							
loading/unloading																							
shunting																							
	terminal operations (EPHA)																						
		OPERATIONS (FBO)							38					58									59 60
			REGION (DFER)						38					57									59 60
				RAILWAY COMPANY DSB	24	25	26	27	32 33	28	35	46 47	53			34					50		
									36 37	29			54								51		
									41 42	31			55								52		
									43 44														
	non-accountable								39	30			56										
									40														
									45														

8: activities performed by other system ONE (Rolling Stock/Depot/ICM/CSA)
84: activities performed by other system ONE (DFER/MEU)

Table 17: System ONE Operations: Actual Managerial Discretion
(Activities nos. 24-60)

next one concerning activity no.31 (identification of requirements in line's capacity configuration, i.e., single/double, type of signalling, CTC), which was marginally allocated to DET (criterion c), an early assumption made in this thesis (*Chapter 7*) is validated. That is, that modernization of the infrastructure has not been related to any operational objectives, but has been realised as a series of civil engineering projects, hoped to inevitably produce improved financial results.

Annual Programming Activities of the questionnaire consist of four parts.

Overall Programming Activities, concerning Timetable Preparation (no.35) and Pricing Policy (no.34) were assumed to be performed by DET and DEM respectively. Timetable preparation, i.e., production planning, outside the operational (regional) structure reveals the bureaucratic and intolerant character of the under-study enterprise, and offers an explanation of the inadequacy of the Sales function, as discussed in *Chapter 8*. On the other hand, it is questionable whether the Operations Commercial Department (DEM) has any real power to define and implement a pricing policy, since this is subject to interventions and regulations from outside the enterprise (compliance to State's policies), also discussed in the same chapter. Thus, such decisions, though probably bearing the signature of the Head of the DEM department are almost in any case made at the very top of the enterprise, if not outside.

The rest three parts of Annual Programming activities relate to the definition of the requirements posed by the Operations System ONE to the three other main supporting systems.

Regarding the Traction and Rolling Stock System ONE, availability (no.36) and operationality (no.37) requirements, i.e., rules, are posed by DET. Cleanliness, comfort, etc. rules (no.38) by the Regional Manager (DPER), as already stated.

Rules for the Track component of the Permanent Way System ONE, concerning availability (no.39) and operationality (no.40) are not posed by any managerial unit of the Operations system. That is, the Permanent Way System ONE is not assumed to have any obligation to comply, while functioning, to the Operations System requirements. This is a probable explanation of the serious deviations from train schedules caused by the infrastructure updating projects. It also reveals the priority assigned to infrastructure modernization, in relation to day-to-day operations. Rules for Terminals and Installations operationality (no.41) are responsibility of DET.

DET is also responsible for rules concerning the operationality of the Signalling Systems (no.42) and Telecommunication/Radiotelephones (no.43) elements of the Signalling/Telecommunications System ONE. Rules for the Level Crossings Guarding and Warning Systems (no.44) are the job of the Permanent Way Department (DG), since, traditionally, in the absence of a recognised Signalling/Telecoms functional structure, Level Crossings, though part of the Signalling System, have been managed at any level by the Permanent Way managers. Finally, no one has been identified as responsible for posing rules for the operationality of the Central Traffic Control recently installed systems (no.45). This lack of accountability will be reexamined when discussing the Signalling/Telecommunications System ONE.

Performance monitoring activities are subdivided to the following groups:

Commercial performance, i.e. traffic volume (nos. 46 and 47) and receipts (nos. 48 and 49) development, is monitored by the Operations Commercial Department (DEM), the former marginally (criterion c).

Operations expenditure (nos. 50, 51 and 52) is very doubtfully monitored by the Financial Affairs Department (DOY), since accountability for these activities has been allocated in terms of the least precise criterion (criterion d).

Schedule reliability (no.53) is definitely monitored by DET. DET is also assumed to monitor the behaviour of the supporting systems on behalf of the Operations System ONE, but this is not very convincing as:

Traction/Rolling Stock system is judged to be monitored by DET by the criterion c (no.54)

Permanent Way (no.55) by the criterion d, implying a very doubtful monitoring, made more doubtful by the fact that, as stated earlier, there are no rules against which the performance of this system should be judged (activities nos.39 and 40).

Signalling/Telecommunications system (no.56) is not monitored.

Finally concerning the standards of services offered (nos. 57 and 58) and the operations staff (nos. 59 and 60), accountability lies somewhere between the Regional (DPER) and the Regional Operations Divisional (YEK) managers, as stated in the beginning of this section.

Figure E6 (Appendix E) provides an illustration of the precision of accountability allocation within the Operations sub-system and reflects the overall lack of this precision. *Figure E7* illustrates both the substantial percentage of non-accountable (or non-performed) managerial activities within this System ONE of the enterprise, as well as the dominance of the headquarters departments of Operations Technical (DET) and Commercial (DEM) in the management of this sub-system.

On the basis of the information discussed in this section, the VSM of the Operations System ONE, displayed in *Figure 32*, was constructed. The three system ONE elements, i.e., YEK, YEL, and MXSIA are reproduced within each region. Thus, because of space limitations, they are shown as overlapping. The most significant diagnostic points concerning this VSM, which have been made in *Chapter 8*, have been validated during the survey. Thus:

- (1) A part of train operations is performed and managed outside the managerial structure of this sub-system.
- (2) The subsystem is actually managed functionally. The role of regional management (DPER) is minimal.
- (3) However, since the vertical structure has not yet been officially introduced, there is a lack of a clearly responsible system THREE for this kind of operations. System THREE duties are divided between the two headquarters operations departments (DEM and DET), the regional management (DPER) and the Financial Affairs Department (DOY).
- (4) An integrated information centre as regards this subsystem does not exist. System TWO duties are again distributed between the independent units which undertake system THREE activities.

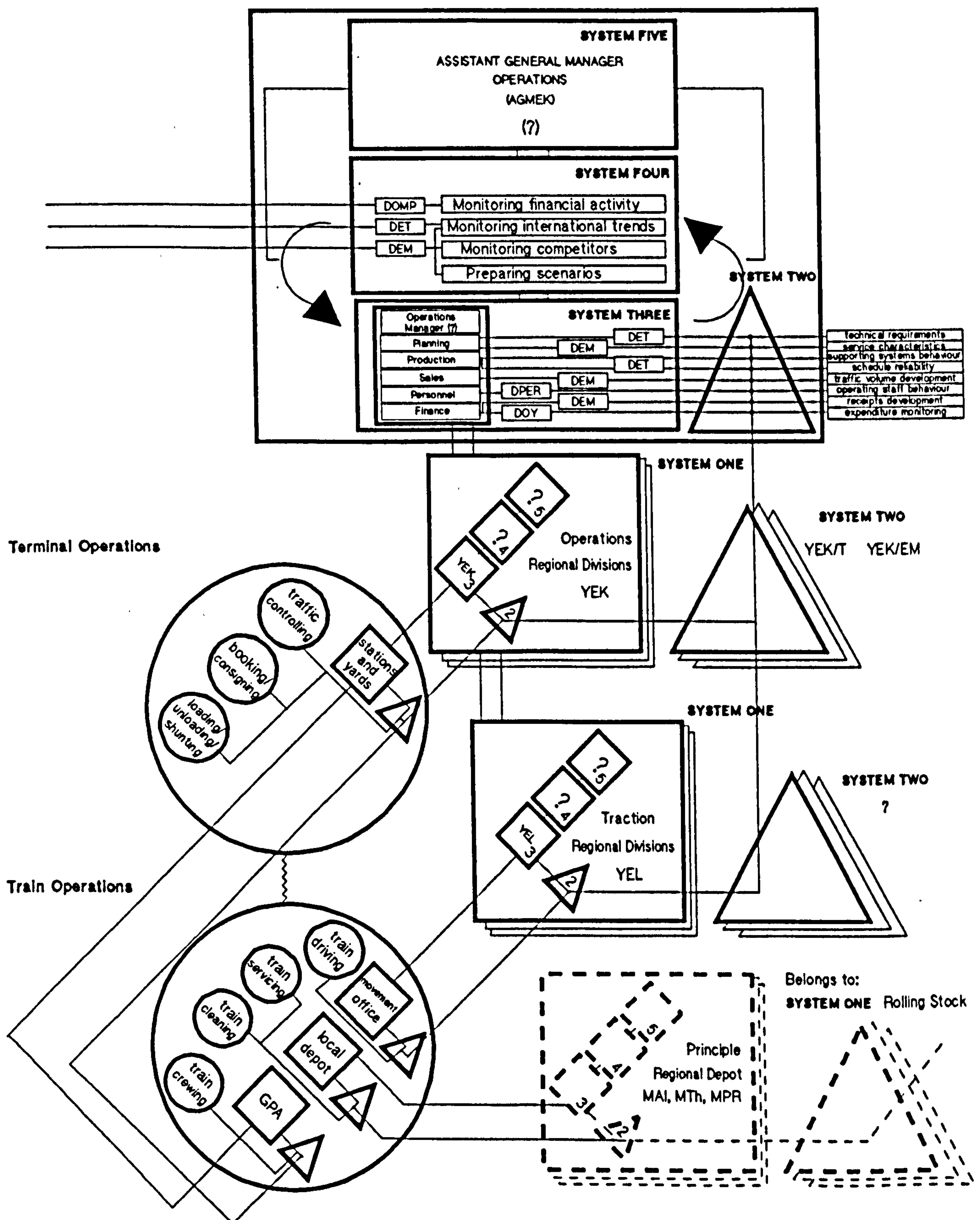


Figure 32: Recursion No.2: System ONE Operations

(5) System FOUR activities are also divided between DEM and DET. However, part of such activities is undertaken by DOMP.

(6) Probably, system FIVE in the VSM of this function is the Assistant General Manager Operations (AGMEK). However, he too gets involved in day-to-day operational matters, whereas the confusion concerning system THREE and system FOUR duties does not help in interpreting what kind of system THREE-FOUR interaction he is monitoring.

Further points related to the information links between these units will be made in a later section.

10.3.2. Recursion No.2: System ONE Rolling Stock

Actual managerial discretion for the activities of the System ONE Rolling Stock is provided by *Table 18*. Phenomenically, responsibilities in this area are more clearly allocated, since, in practice, they are almost exclusively contained within one department, the department of Rolling Stock (DISTY).

Most of the managerial activities concerning this subsystem have been definitely allocated by the criterion a. However, as *Table E4* indicates, there seems to be some unease when allocating accountability for alternative scenarios preparation (activity no.65, criterion b), or expenditure, personnel, and subcontracted services quality monitoring (activities nos.82-87, criteria b or c). The dominance of DISTY as the principle and almost exclusive managerial unit in this area is also illustrated in *Figure E9*. However, this fact has not prevented rolling stock sub-system from being the most problematic part of the enterprise.

The reasons producing this unfavourable outcome are partly illustrated in *Figure 33*, which depicts the VSM of this sub-system. Since almost any activity has been clearly allocated to DISTY, an alternative procedure follows in an attempt to highlight organizational problems in this area.

10.3.2.1. Rolling Stock Acquisition

Any decision made for the acquisition of certain types of rolling stock defines the outcome of the rolling stock sub-system and, hence, the overall performance of the enterprise, via the influence it exerts on the train operations sub-system. A principle method for the attenuation of the variety of the technological environment is the standardisation of the types of rolling stock within the company's fleet. For example, the less the types of locomotives in possession, the less the need for understanding various components and 'translating' them into rules and directions, to be implemented by the operating staff engaged in the job of upkeeping these units. Similarly, the easier it is to 'educate' staff and to distribute relatively few pieces of technological knowledge over big numbers of, thus, skilled workers.

In most railway networks, a *de facto* attenuator of environmental technological variety is the capability of the domestic manufacturing production. Thus, when a domestic manufacturing industry exists, the railway favours its products, mainly because, this way, further problems are minimised (i.e., technological support, spares availability, on-site solution of problems in operation).

When this is not the case, either the railway builds up its own manufacturing sub-system (e.g., BREL), or arrives to long-term agreements with foreign manufacturers to guarantee a continuous cooperation in future.

LEVEL OF RECURSION					RESEARCH & DEVELOPMENT					PRODUCTION					SALES	pricing	MATERIALS			FINANCE			PERSONNEL
5	4	3	2	1	int'l trends	monitoring	economy	competitors	preparing scenarios	rules	plans	budgets	control	quality control			require-ments	buying	stock control	revenue	expen-diture	cash flow	
locomotives repair coaches repair wagons repair																							
	rolling stock repair (ERSU)																						
locomotives maintenance coaches maintenance wagons maintenance train cleaning servicing train fueling																							
	rolling stock maintenance (MCSU)																						
train running																							
		?																					
			ROLLING STOCK DSTU		63 64					66 67 68 69	72 73	78 79	82 76 77				70 71	74 75	80 81		83 84		86 87
				RAILWAY COMPANY DCE	61 62				65												85		

1: activities belonging to the Operations System ONE
and performed by the Rolling stock system

2: activity belonging to the Operations System ONE
and performed by special regional unit (REU)

Table 18: System ONE Rolling Stock Actual Managerial Discretion

(Activities nos. 61-87)

However, in the case-study, as discussed in *Chapter 7*, rolling stock acquisition policy virtually does not exist. Rolling stock is in most cases purchased under direct or indirect interventions of the State. These interventions relate mainly to the balance of payments. Thus, both because domestic manufacturing industry does not exist (and hence the required rolling stock has to be imported), and because the international trade with some countries has to be balanced, the railway is constantly used by the State as a facilitator. Note, that the same is not true for the national airline. The choice in this area is limited to the products of 3-4 international manufacturers and no one imagines to use this public enterprise as a means of solving the country's international trade problems, by purchasing aircrafts of not universally guaranteed quality.

Thus, a first conclusion is either that the system FOUR of the Rolling Stock sub-system does not carry on its duties properly, or that the thoughtful proposals it produces are overridden at the next level of recursion. Probably both conclusions are valid, because if a long-term rolling stock policy existed, many of the State's interventions would have been avoided. Recall, that the government's variety handling capacity, as regards the railway enterprise, is even smaller. Thus, no minister in a democratic society should, in principle, insist in a certain decision, when the enterprise has the ability to demonstrate the disastrous effects of its implementation. However, the enterprise communicates with the state/owner at the next level of recursion, where the respective system FOUR, i.e., the Department of Planning (DOMP), as shown in *Chapter 8*, has nothing to do with rolling stock, being mainly civil-engineering-oriented. Hence, it has neither the ability, nor the knowledge, the willingness, or the incentives to oppose government's decisions.

10.3.2.2. Rolling Stock Upkeeping: Rules and Directives

Since the environmental technological variety has not been attenuated at the stage of acquisition, there is an increased need to study the various types of rolling stock and to produce rules and directions for the upkeeping of the units. Formally, within DISTY, this task is allocated to the Maintenance Organizing Unit (DISTY/YOSTY). A part of the poor performance of the rolling stock of the enterprise may be attributed to the inadequate output of this unit.

However, as the same unit is also responsible for judging the overall needs in repair/maintenance installations and equipment and making proposals for certain projects, it seems that it has been defeated by the complexity of the task. The general condition of workshops/depots buildings, installations and equipment within the case study enterprise reflects this not balanced attention paid by the top of the company to the alternative functional areas. Hence, while the modernization of the permanent way and signalling is well under way, the rolling stock is looked after in very old and inadequate installations.

10.3.2.3. Rolling Stock Upkeeping: Periodic Maintenance (Workshops/Depots)

Within a railway, overall operational performance is defined by the performance of the various sub-systems. Thus, the technological characteristics of the Signalling system define the capacity and the journey speeds over a line. The same is true as regards the Line configuration (single/double) and Track's geometrical (curves, slopes) and technical (axle loads, etc.) characteristics. The Operations installations/equipment (terminals, yards, stations, sidings, etc.) limit the type and quantities of traffic that can be transported. Overall, the extent of the Network itself within the country, i.e., railway lines and terminals/yards, governs the traffic handling capability of the system.

However, the characteristics of the sub-systems mentioned define 'once and for ever' the capacity of the enterprise. Certain 'bottlenecks' cannot be erased unless more or less

substantial projects are undertaken. Further, the condition of any of these sub-systems is *a priori* considered and reflected in the service timetable. For example, speed limits are lowered when the condition of the track over a segment of line is not proper. Hence the customer does not 'feel' so strongly the impact of this deterioration, in that a journey between any two points may take much more time than what a customer would like, or than what would be possible if the infrastructure was of a better quality, but the customer is from the beginning aware of this situation, when deciding to board on a train. Therefore, he/she does not expect the journey to take less time than advertised. What really bothers him is when he suffers long stoppages or poor quality of journey due to rolling stock condition. There is no way of incorporating the poor quality of the rolling stock in the timetables (as it is, as shown, for the other subsystems). Hence the perception, within the enterprise and among the customers, that the principle 'bottleneck' is the rolling stock condition.

The principle quality characteristics of the rolling stock have already been defined, as demonstrated, at the acquisition phase. The multiplicity of types has resulted in difficulties for maintenance rules and directives preparation and digestion. The poor condition of repair/maintenance installations and equipment has also been discussed. A further problem relates to the organization of the rolling stock repair/maintenance.

Figure 33 reflects an attempt to illustrate the complexity of the operations of the rolling stock sub-system. In principle, as discussed in *Chapter 6*, railway equipment is inspected/examined in predetermined intervals. In the same chapter, an example of this periodic preventive maintenance has been offered, where, according to the type of inspection or repair, different period of time is required. Locomotives safety control and fuelling and vehicles inspection and cleaning constitute what was defined as the trains cleaning and servicing part of the trains operations sub-system, in system ONE Operations. These duties are undertaken within railway depots and are not meant to last for longer than few hours. This phase of the implementation function has been distinguished in the diagram of *Figure 33*, and constitutes the operational circles definitely belonging to depots, and, further, in a properly designed organization, to system ONE Operations.

More detailed examinations and repairs are required at subsequent phases and constitute what has initially been defined as periodic maintenance. The way in which these tasks are divided between workshops and depots is not clear. Usually both shops engage in this kind of repairs, where the more demanding are attributed to workshops. This phase is illustrated by the operational circles within the intersection of the repair and maintenance circles.

However, real life is even more complicated than this complex diagram illustrates. The ability to follow the prescribed phases of rolling stock inspection and repair presupposes other abilities which, as shown, do not exist. Thus, beyond the formal 'task schedule' hanging from the wall, the real job of the depots is that of trouble-shooting. Under a shortage of technical knowledge, skilled staff, and spares, the depot manager is continuously under pressure attempting to offer the equipment required for the composition of scheduled trains. Sometimes he succeeds. Sometimes the equipment breaks down either before arriving to the origin station or during the journey.

The top management of the enterprise, not having the capacity to handle the variety of this situation via a re-examination of the whole circle of rolling stock system ONE activities, attempts an 'artificial' improvement of the reliability index by a method which does not solve the problem and is, at the same time, very costly. That is, it purchases more locomotives and diesel multiple units and throws them into the same circle. Locomotives' availability index is thus improved for a while. When it starts deteriorating seriously, and this does not take more than two or three years to happen, a new order is

already under way. Beer (1981), commending on Lord Beeching's proposals in early 1960s for the reduction of the size of the British railway network has shown that, thus, *"a machine for eating the railways"* was defined ². Greek Railway's rolling stock policy is, by analogy, *"a machine for eating locomotives"*.

10.3.2.4. Rolling Stock Upkeeping: Repairs (Workshops)

The third set of operational circles definitely belonging to workshops relates to rolling stock repair and involves:

(1) Rolling stock reconditioning and general repairs, i.e.:

- bogies overhauls,
- traction motors and generators general repairs,
- body general repairs,
- wheel turning and wheel changing, and
- painting.

(2) Rolling stock refurbishment and conversions, e.g.,

- coaches interior refurbishment,
- fitting new technical systems (heating, air-brakes),
- conversions of coaches to sleepers, etc.

(3) Casualty repairs.

While the first two sets of workshops' output may well be programmed and undertaken within the unit, its production becomes complicated to the degree that the number of casualty repairs rises. This number is proportional to the poor organization of periodic maintenance, which, as shown, originates from the phase of acquisition and is further influenced by the inadequate technical knowledge both at headquarters and staff level, the inappropriate standards of repair/maintenance installations and equipment and difficulties in purchasing spares and materials needed. However, since the production of a workshop is inevitably serialised, there is a limit as to the number of casualty repairs that the unit can undertake. This 'bottleneck' is interpreted at headquarters levels as a constraint to overcome 'inside-and-now' by further rolling stock purchase, with the disastrous effects already mentioned.

Summarising this discussion in terms of the VSM of this sub-system, displayed in *Figure 33*, the following points should be made:

- (1) The Enterprise has not succeeded in devising a rolling stock policy, both because its corporate system FOUR is exclusively Permanent Way-oriented and because rolling stock acquisition complies to externally defined requirements.
- (2) The multiplicity of types of rolling stock and the inadequate repair/maintenance installations and equipment make difficult both the preparation of standard repair/maintenance rules and the implementation of these rules.
- (3) The task of the principle regional depot (MXSIA) to offer in the appropriate condition the equipment required for scheduled train operations, which is constrained by inadequate technical knowledge, poor installations/equipment, inadequately trained staff and shortages in spares and materials, is further complicated by its dual role, i.e., as a sub-system of both the Operations system (engaged in train inspection, cleaning and servicing) and the Rolling Stock system (engaged in Rolling Stock periodic maintenance and repair).

- (4) Though the principle workshop and the three principle regional depots (shown overlapping in the diagram) constitute the systems ONE of this sub-system, they lack properly conceived system TWO and system FOUR functions. Much of the DISTY structure based at the company's headquarters should move outside this building and become part of the workshops/depots structure. Thus, much more activity will be operations oriented and at the same moment the task of structuring proper systems TWO and FOUR for the whole sub-system will be facilitated.
- (5) Under present arrangements, the roles of both the Heads of DISTY and DEL Departments and the Assistant General Manager Traction (AGMEL) as systems THREE or FIVE of this sub-system is strongly questioned.

10.3.3. Recursion No.2: System ONE Permanent Way and Installations

Table 19 illustrates the actual way in which managerial accountability is allocated, as regards the Permanent Way and Installations system ONE. A first interesting finding is that the Regional Management (DPER), to which the Permanent Way Division (YGR) is assumed to report, has nothing to do with the management of this sub-system. A second finding, illustrated in *Figure E10*, is that the precision of accountability allocation is reduced in the areas of Performance Monitoring, Finance and Personnel. A third finding, illustrated in *Figure E11* is that accountability is almost equally shared between the functioning units (YGR) and the two headquarters departments in this area; i.e., the Permanent Way Department (DG) and the New Projects Department (DNE).

Table E5 summarises the findings of accountability allocation. For most of the activities of this area accountability for one activity is allocated to more than one organizational units. When the units have a vertical relationship, i.e, Department of Permanent Way (DG) and Regional P.W. Division (YGR), this is a good sign, as it demonstrates an integrated perception of the sub-system. However, in a horizontal relationship (i.e, DG and DNE) shared accountability implies either waste of resources or, indeed, lack of accountability.

10.3.3.1. Research and Development

Technological development in track issues (no.88) is monitored both by DG (criterion a) and DNE (criterion c). However, though not reflected in the questionnaire, DG is more interested in track structure and components, as it technically supervises and directs both track maintenance and laying of new track, whereas DNE is more concerned with track infrastructure, as this unit is associated with the study and supervision of subgrade construction projects.

For the same reason, technological development in tunnels, bridges and other technical works is monitored by DNE (no.89).

Terminals issues monitoring, i.e., buildings, accessibility, sidings, layout (no.90) is allocated to DNE and Operations Technical (DET), both by the criterion a.

Finally, both DG and DNE seem to engage in civil-engineering-projects-management developments monitoring (no.91), but the less definite allocation (criteria b and c respectively) implies rather that they should engage than that they are really tackling this issue.

Though decisions concerning the overall layout of the network are made at the next higher level of recursion, the Permanent Way subsystem has developed more or less a perspective of the future it wants to pursue. This perspective is also reflected in the

LEVEL OF RECURSION					RESEARCH & DEVELOPMENT				PRODUCTION					SALES	pricing	MATERIALS			FINANCE			PERSONNEL	
5	4	3	2	1	intrends	monitoring		preparing scenarios	rules	plans	budgets	control	quality control			require-ments	buying	stock control	revenue	expen- diture	cash flow		
						economy	competitors																
track maintenance new track construction																							
	track (TMGR)																						
techn works maintenance techn works construction																							
	technical works (TMGR & TMK)												111										
buildings/infra tele lions maintenance buildings/infra tele lions construction																							
	building infra tele lions (TMGR)												112										
level crossings & systems operation																							* 168
		PERMANENT WAY (MGR)									106 107	114 112 113	110 111 112 113			100 101 102 103 104 105	108 109	116					119
			REGION DPER																				
				RAILWAY COMPANY DSD	88 89 90 91				92 93 96 97 94 95 98 99	107	114 115 110 113			100 101 103 104	108 109	116		118					120
	non-accountable																						117

activities belonging to the Signaling & Telecoms System ONE and performed by the Permanent Way system (TMGR)

Table 19: System ONE Permanent Way: Actual Managerial Discretion (Activities nos.88-120)

company's corporate plans, although, as stated, the modernization of the permanent way has not been associated with any sort of expected financial, social, etc. results.

10.3.3.2. Planning/Organizing

Anything associated with rules and methods of permanent way maintenance (activities nos. 92-95) is clearly allocated to DG (*criterion a*).

Studies preparation concerning technical projects (nos. 96-100) is shared between DG and DNE in a way reflecting the division of tasks within the sub-system, as illustrated in Chapter 8 (Figure 28).

Requirements in materials, tools and equipment (nos. 100-105) are decided by the Regional Units (YGR) and, further, by DG.

10.3.3.3. Annual Programming

The preparation of the annual programme of track and installations maintenance/renewal (no. 106) is clearly allocated to DG (*criterion a*).

The new projects annual programme (no. 107) is marginally allocated to DNE and YGR (*criterion c*), reflecting, thus, an argument provided in an earlier part of the thesis (Chapter 8), i.e., that plans, especially modernization plans, are decided at the higher level of recursion.

The preparation of the annual programme for machinery, equipment and materials for p.w. renewal/maintenance (nos. 108, 109) is allocated to the regional divisions (YGR) and the Permanent Way Department (DG), both by the criterion a. However, this initial preparation is subject to corporate and, further, government truncation. The degree to which the units participate in budget's reformulation, i.e., after State's suggestions have been considered, is discussed in Chapter 11.

As all projects are subcontracted, the role of the New Projects Department (DNE) is supervisory. Therefore, no programmes for materials, equipment or machinery acquisition are associated with this part of the implementation function.

10.3.3.4. Performance Monitoring

Though accountability for up-to-now examined activities within this sub-system has been, more or less, clearly allocated, in the last part referring to performance monitoring problems associated with the wrong organizational design are reflected. Thus,

The monitoring of the condition of the track and the quality of renewal/maintenance works (no. 110) is definitely allocated to Regional Divisions (YGR), but it is less clear that the Permanent Way Department (DG) engages in a kind of quality control (*criterion b*). In fact this is the only case where DG appears to have some participation, since

the monitoring of the condition of technical works and constructions (no. 111) terminates within the region (YGR-*criterion a*, TM.GR-*criterion b*), and

the same is true for the condition of buildings, terminals and other installations (no. 112, YGR-*criterion b*, TM.GR-*criterion c*).

The monitoring of the quality of subcontracted projects (no. 113) is allocated to DNE and to YGR, since the regional divisions are too supervising smaller projects, or projects not directly associated with the main-line modernization plan. The least precise allocation in this case (*criterion c*) implies rather a not proper formulation of the question (i.e., the lack of distinction between these two types of projects), than ambiguities in accountability allocation.

The monitoring of the development of the annual renewal/maintenance programme (no. 114) is a job of both DG and regional divisions (YGR). The less precise allocation (*criteria b* and *c* respectively) is rather associated with the incompleteness of this programme, reflecting an inadequate planning phase, as discussed in *Chapter 8*.

The same is true in the case of materials/tools availability monitoring (no. 116).

Contrary, the new constructions annual programme (no. 115) is definitely monitored by DNE (*criterion a*), both because it is more structured, and because top management is interested in its development, since, as discussed in *Chapter 8*, the modernization plan development has become the principle criterion for the overall assessment of the company's performance.

The wrongly conceived 'public enterprise' character of the railway is directly reflected in answers concerning financial control within the permanent way sub-system. Thus,

No unit is responsible for expenditure monitoring of permanent way renewal/maintenance works (no. 117), and

The control of the expenditure of subcontracted projects (no. 118), though easier, since it refers to contracts with third parties, expressed in the form of detailed budgets, is allocated to DNE by a less precise criterion (*criterion c*). This reflects both a poor planning phase and an inadequate production control, which leads to significant deviations from both budgeted expenditure and expected completion time, as discussed in *Chapter 8*.

Finally, the less precise allocation (*criterion c*) of accountability for the permanent way personnel (nos. 119 and 120) reflects the characteristics of the enterprise/personnel relationship, discussed, in *Chapter 8*, in details.

The VSM structure in *Figure 34* summarises the principle organizational characteristics of the Permanent Way sub-system.

- (1) Implementation duties within this system ONE are divided between the three regional divisions (YGR) on the one hand, shown overlapping in the diagram, and the Constructions Division (DNE/YK) of the New Projects Department on the other.
- (2) This division is maintained all the way up the organizational pyramid. On the one hand, DNE develops as a 'projects-specialist' department, possessing its own coordination, control, and intelligence functions. On the other hand, DG develops as a 'track specialist', not having the ability to control properly the implementation function, i.e., the regional divisions (YGR), since this function still reports formally to regional management (DPER). This is shown in the diagram with the dotted rectangles in the areas of P.W. maintenance financial and personnel control. However, as DG is also possessing a system FOUR function,

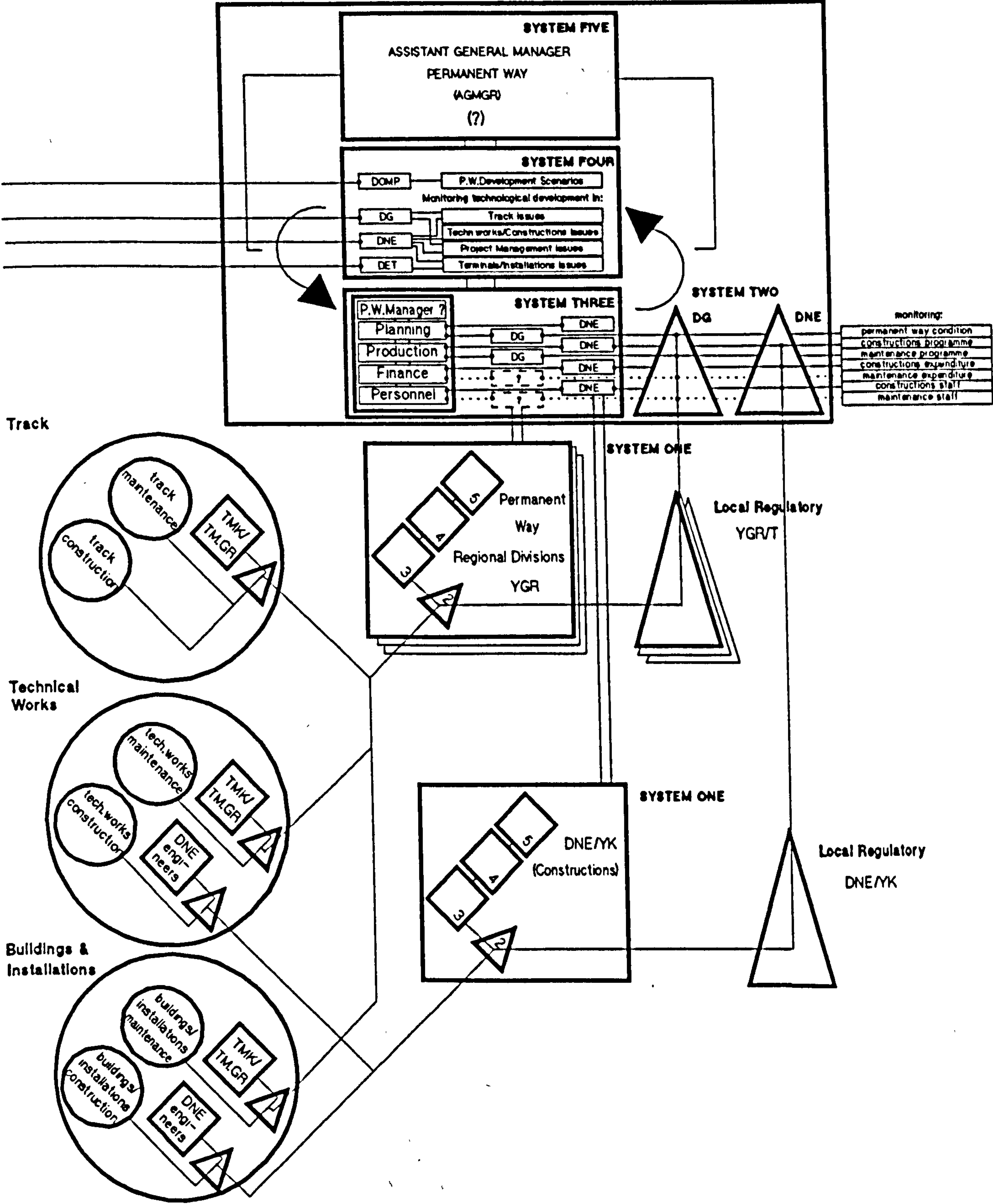


Figure 34: Recursion No.2: System ONE Permanent Way

duties in this area cannot properly distinguish and this is also shown in the system FOUR area of the diagram.

- (3) An overall system THREE unit for this sub-system cannot be identified within the hierarchical structure. Probably this role is played by the Assistant General Manager Permanent Way (AGMGR).
- (4) The same person plays also a system FIVE role, especially by representing the Permanent Way sub-system to the wider system of which he is member (corporate management). However, the arguments provided in *Chapter 8*, concerning the naturally limited human capacity, hold and in this case, especially when considering that
 - most of the infrastructure modernization in the company takes place within the Permanent Way functional area,
 - consequently, increased system FOUR needs exist,
 - the organizational confusion (as a result of the existence of DNE) does not facilitate the solution of problems at a head-of-department level, and
 - the same manager (AGMGR) probably had system FIVE responsibility for the Signalling/Telecommunications sub-system, as will be discussed later.

10.3.4. Recursion No.2: System ONE Signalling and Telecommunications

Actual managerial discretion for the activities of the system ONE Signalling and Telecommunications is illustrated in *Table 20*. This table indicates also the big number of non-accountable activities in this area. *Figure E12* illustrates the lack of precision of accountability allocation, especially by Type of Activity. The same lack of precision is detailed presented in *Table E6*, according to which, most managerial activities were allocated by the *criterion c*. *Figure E13* shows that accountability for activities within this sub-system is divided between the functioning part, i.e., the signalling and telecommunications division (YSTHE) and a part of the New Projects Department (DNE/YMESTH), recently set up to undertake modernization projects in this area, on the respective Permanent Way example.

In *Chapter 8*, it has been shown that the system ONE Signalling/Telecommunications has not been realised as such in the under study enterprise. However, its inevitably increasing significance in relation to the developing modernization project starts being gradually understood. Thus, in the new organization to be implemented (*Appendix B, Figure B4*), provision has been made for a Signalling and Telecommunications functional Department (DHST). However, the narrow 'technical' perspective which has governed this proposal is reflected to the full set of activities of this unit, which has been perceived as Electrification, Signalling and Telecommunications Department. Obviously, electrification, apart from external similarities (wires and electricity), has not much to do with signalling and telecommunications. Besides, the separation of electrification as a project from its natural context, that is, traction, might result to future problems when electrified lines become operational.

Though Permanent Way, and, to a lesser degree, Rolling Stock may be understood as almost independent subsystems supporting operations, the signalling and telecommunications subsystem lies at the heart of operations. Thus, the distinction employed in this thesis, as explained in *Chapter 6*, has to do with the certain modernization phase that the enterprise is undergoing and refers to the technical (installation and maintenance)

LEVEL OF RECURSION					RESEARCH & DEVELOPMENT				PRODUCTION					SALES	pricing	MATERIALS			FINANCE			PERSONNEL
5	4	3	2	1	in-trade	monitoring economy	competitors	preparing scenarios	rules	plans	budgets	control	quality control			requirements	buying	stock control	revenue	expenditure	cash flow	
signaling systems installation																						
signaling systems maintenance																						
	signaling systems																					
telecoms systems installation																						
telecoms systems maintenance																						
	telecommunications systems																					
CTC systems installation																						
CTC systems maintenance																						
	central traffic control systems																					
in-charge systems running																						
in-charge systems running																						
in-charge systems operation																						
	level crossings warning systems																					
		SIGNALING & TELECOMS (VSTHE)			121 122				128 130		142 143		150 151			138 139		160		155 156		163
					123 124				131 133 129 132		144 145		152 153			140 141		161 162				164 165
			?																			
				RAILWAY COMPANY (DSE)	121 122				126		127 130 129 132 147 149		154									
					123 124																	
				non-accountable	125				136	135	146 148									157 158 159		166 167

Activities belonging to the Signaling/Telecommunications System ONE and performed by the Permanent Way system (PW/SR) (Activities nos. 121-168)

Table 20: Sustem ONE Signaling/Telecommunications: Actual Managerial Discretion

dimension of technological systems within this subsystem. Apparently, signalling and telecommunications systems operation is exercised within the Operations system by staff which either directly belongs to the Operations function (terminals staff, controllers, etc.), or should belong to this function in a properly designed organization (train drivers, level crossings keepers).

10.3.4.1. Research and Development

As this subsystem lacks a proper recognition, and, consequently, a relevant status and organization within the enterprise, several units engage in environment scanning activities, as *Table E6* illustrates. However, such activities are undertaken '*as it happens*', and this is reflected in the less precise allocation criteria (*criterion c*, in any case).

Accountability (if any) is shared between the Operations Technical Department (DET), the Signalling/Telecommunications autonomous Division (YSTHE) and the Signalling/Telecommunications Division of the New Projects Department (DNE/YMESTH). The Permanent Way Department (DG) also engages in studying Level Crossings issues, since, traditionally, this sub-system has been managed from within the Permanent Way function.

10.3.4.2. Planning/Organizing

For each of the four subsystems comprising the Signalling/Telecommunications system three principle questions were asked:

- Who decides which technological product will be purchased and installed;
- Who decides the technical details of the system's installation; and
- Who defines the rules and regulations for the maintenance of the installed system.

Managers' responses did not allow for a definite allocation of accountability for the types of decisions mentioned. Thus, always under the less precise *criterion c*, it was shown that, in general, DNE/YMESTH and DET were mainly engaged in the selection and installation of a technological product and YSTHE in its maintenance. However, as DNE/YMESTH is a very junior unit and as DET's personnel lacks the experience and the qualifications to make such decisions, it is implied that either a lot of informal communication with YSTHE is taking place or that, in the end, exact criteria for choosing certain technological systems do not exist. Within the survey, both these implicit assumptions were expressed by managers interviewed. Thus:

one manager insisted that, in real life, most decisions were made at YSTHE level. By not allowing this reality to be expressed organizationally (i.e., by forming the DNE/YMESTH unit), top management was complicating management process within the signalling and telecommunications area.

one corporate manager, having by status a more integrated view of this area, filled the part of the questionnaire next to activities nos. 126-127, 129-130, and 132-133 by writing "*no one is responsible*", and explained that decisions for the selection of a technological system relate more to the manufacturer's capacity to sell it to the railway than to the company's ability to assess among alternative products.

In maintenance issues, accountability is clearly allocated. Thus, the responsibility to identify required maintenance resources, i.e., materials, tools, and equipment (activities nos. 138-141) belongs definitely to YSTHE (*criterion a*).

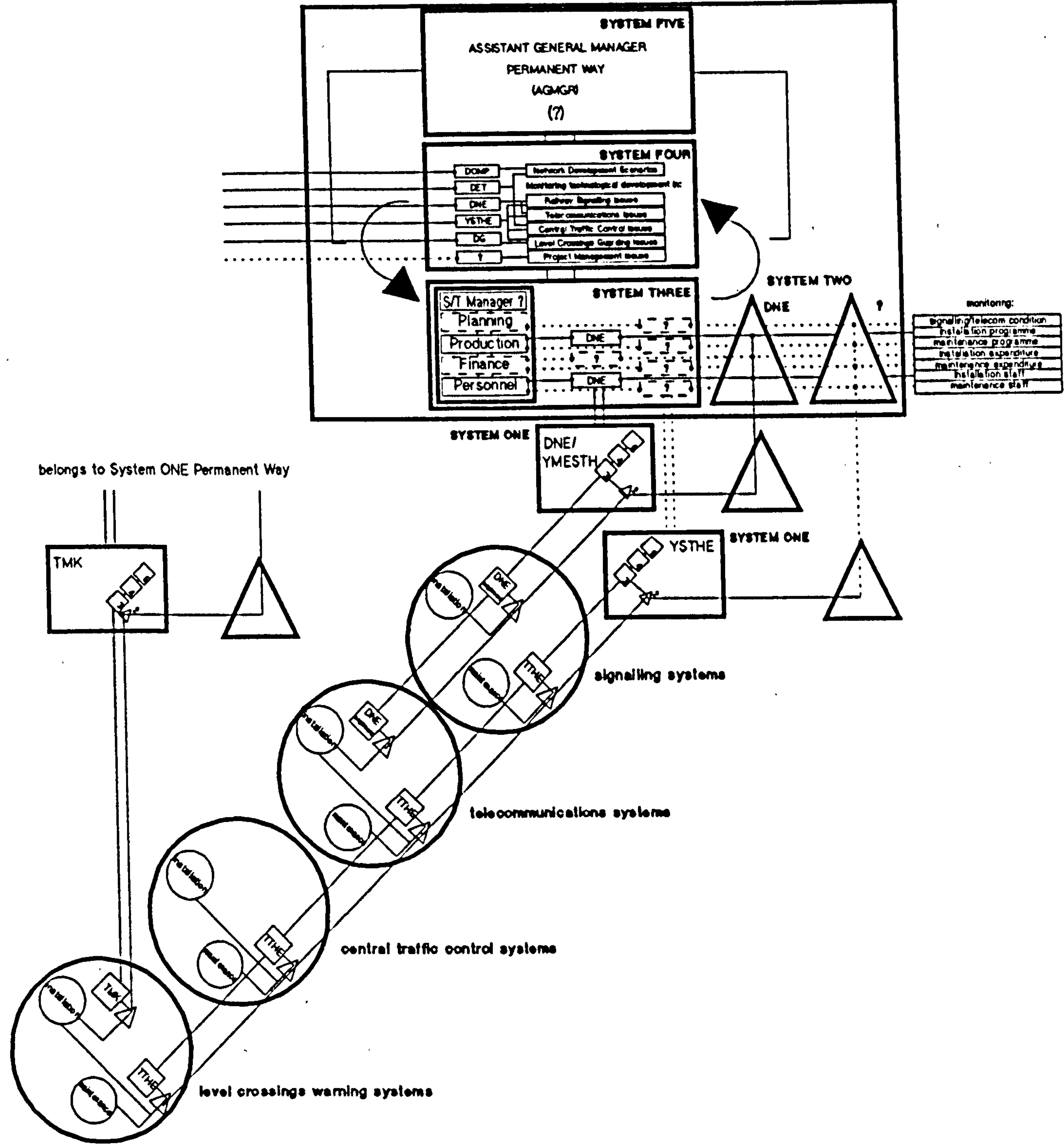


Figure 35: Recursion No.2: System ONE Signalling and Telecommunications

10.3.4.3. Annual Programming

Annual maintenance plans (nos. 142-145) are prepared by YSTHE.

New systems installation plans are either prepared by DNE (telecommunications, no.147) or DG (levels crossings warning systems). The absence of a unit accountable for signalling and CTC systems installation plans preparation (nos. 146, 148) favours the argument expressed by the corporate manager interviewed; i.e., that such plans are contained within the tender, and, in the end, are prepared by the manufacturer.

10.3.4.4. Performance Monitoring

The condition of the technological systems and the quality of maintenance works (nos. 150-153) is clearly a job of YSTHE (*criterion a*). In what relates to level crossings systems, accountability is less precisely allocated (*criterion c*), because, as discussed, permanent way units are also involved.

However, it is peculiar that the only unit to assess the quality of works is the unit undertaking these works. This implies ineffective control and reduced performance standards.

New projects are formally supervised by DNE/YMESTH (no.154). Besides the precise accountability allocation (*criterion a*), the arguments provided in previous paragraphs should also be considered.

Maintenance materials/equipment stock control (nos. 160-162) is clearly allocated to YSTHE (*criterion a*).

Finally, to what relates to sub-systemic finance (nos. 156-159) and personnel (nos. 163-168), either there was no manager accountable or accountability was marginally allocated (*criteria c* and *d*). Explanations of this outcome had been provided when discussing the Permanent Way sub-system.

The emerging picture of the Signalling/Telecommunications sub-system is illustrated in *Figure 35*, in terms of Beer's VSM and may be summarised in the following points:

- (1) The Signalling/Telecommunications system ONE is not realised as such in the case study enterprise. Thus, it lacks the status of a functional department.
- (2) The tasks of this unit are carried out partly by the regional S/T units (TTHE), controlled at national level by the autonomous Signalling/Telecommunications Division (YSTHE), partly by the New Projects S/T Division (DNE/YMESTH) and partly by Permanent Way Units (TMK).
- (3) Systems TWO and THREE of this sub-system do not exist. Part of these duties, to what relates to DNE/YMESTH, are carried by the New Projects Department (DNE). Overall S/T Manager cannot be identified.
- (4) System FOUR duties are undertaken by almost the totality of corporate, P.W., Operations Technical and S/T units (DOMP, DET, DNE, DG, YSTHE). In the absence of organizational clarity system FOUR activities are largely unprogrammed.
- (5) The S/T sub-system lacks also a system FIVE. The Assistant General Manager Permanent Way (AGMGR) was playing for a while this role, but, at the time of the

survey, he had quited this responsibility, overwhelmed by the complexity of the task.

10.3.5. Recursion No.1: Railway Enterprise

Having examined the Systems ONE of the company, i.e., the four elements which produce what the railway enterprise is producing, the discussion may now turn to the next level of recursion and study the THREE-FOUR-FIVE metasystem.

Information concerning accountability allocation at corporate level is provided in *Table E2* and *Figures E4* and *E5* of *Appendix E*. As shown, achieved allocation criteria are, on average, not better than those encountered when examining the four Systems ONE.

10.3.5.1. Relations with the State

This set of activities (nos. 1-5) is the only (together with Rolling Stock sub-system activities) for which accountability was definitely allocated to one unit, in this case, the General Manager. In the Rolling Stock case it was shown that clear accountability allocation does not provide by itself for good results. The same argument also holds here. Unfortunately, the General Manager was not interviewed. Therefore, details on the way in which he discharges accountability for these activities were not recorded. However, this exact allocation validates the respective discussion in *Chapter 8*, concerning the limited role of the Board of the Railways and the type of the actual State/Enterprise relationship.

10.3.5.2. Research and Development

Research and Development, from a corporate viewpoint, refers to:

- possessing a rich picture of the technological capabilities as regards the product of the enterprise. This implies monitoring international trends in the development of the railways and other modes of transport. (no.6)
- obtaining an understanding of the way in which certain characteristics of the physical environment of the company are developing over time, that is, monitoring trends in national development (no.7)
- preparing alternative scenarios of the company's development, related to alternative forecasts concerning the development of the country (no.8).

From these three managerial activities, national development trends monitoring (no.7) is not the duty of any managerial unit. Hence, both the allocation to DOMP of the accountability to monitor technological trends (no.6), and, mainly, the marginal allocation (*criterion d*) to prepare development scenarios (no.8) become self-defeated and pointless.

The answers of corporate managers interviewed to these three questions summarise in great clarity what was attempted to be meant in *Chapter 8*, when discussing the role of system FOUR.

10.3.5.3. Planning/Organizing

Not knowing to which environment the poorly prepared scenarios correspond, it is not strange that

neither the sectors of transport market which the enterprise decides to enter (no.9)

nor the features of services to be offered within these sectors (no.10)

are identified by any sort of accountable manager.

These two answers fully summarise the discussion on the inadequacy of the Sales function, undertaken in details in *Chapter 8*.

Given the above, and still concerning Planning/Organizing corporate activities, the clear allocation to DOMP (*criterion a*) of managerial accountability to identify required investment (no.11) and organizational change (no.12) briefly validates the assumption frequently made up to now, referring to the lack of any realised outcome of technological and organizational innovation.

10.3.5.4. Annual Programming

However, within this context, routine activities like annual Investment Programme (no.13) and Annual Budget (no.14) preparation are clearly allocated (*criterion a*) to DOMP (Department of Planning) and DOY (Department of Finance) respectively.

10.3.5.5. Performance Monitoring

The dual role of DOMP, as discussed in *Chapter 8*, is also reflected in this section. Thus, DOMP is assumed as responsible for monitoring

traffic volume development (no.15),
market share development (no.16),
rate of absorption of investment funds (no.17), and
rate of completion of investment projects (no.18).

In other words DOMP is assumed to be the enterprise's system TWO, as regards both Operations and the development of the modernization project. However, almost all these activities, as *Table E2* indicates, have been allocated by the *criterion c*. Considering that this part of the questionnaire has been answered only by corporate managers (that is, members of Board, Assistants GM and DOMP managers), there does not seem to be any substantial agreement at corporate level as regards DOMP's role.

Accountability for corporate Finance (nos. 19-21) has been allocated to DOY (Department of Finance). Considering both the lack of financial accountability encountered when examining the four systems ONE, and the description of the company's finances as offered in *Chapter 8*, this exact accountability allocation reflects rather an allocation according to functional specialisation than proper carrying out of these activities.

The enterprise/personnel relationship, as regards relations with trade unions (no.22) has been definitely allocated to the AGM Personnel/Finance (*criterion a*). This was also assumed in *Chapter 8* and an explanation was offered. Other indicators of the enterprise/personnel relationship, e.g. absenteeism (no.23) are not subject of any exact managerial monitoring and are rather assumed to be the job of any head of department, though not definitely (*criterion c*).

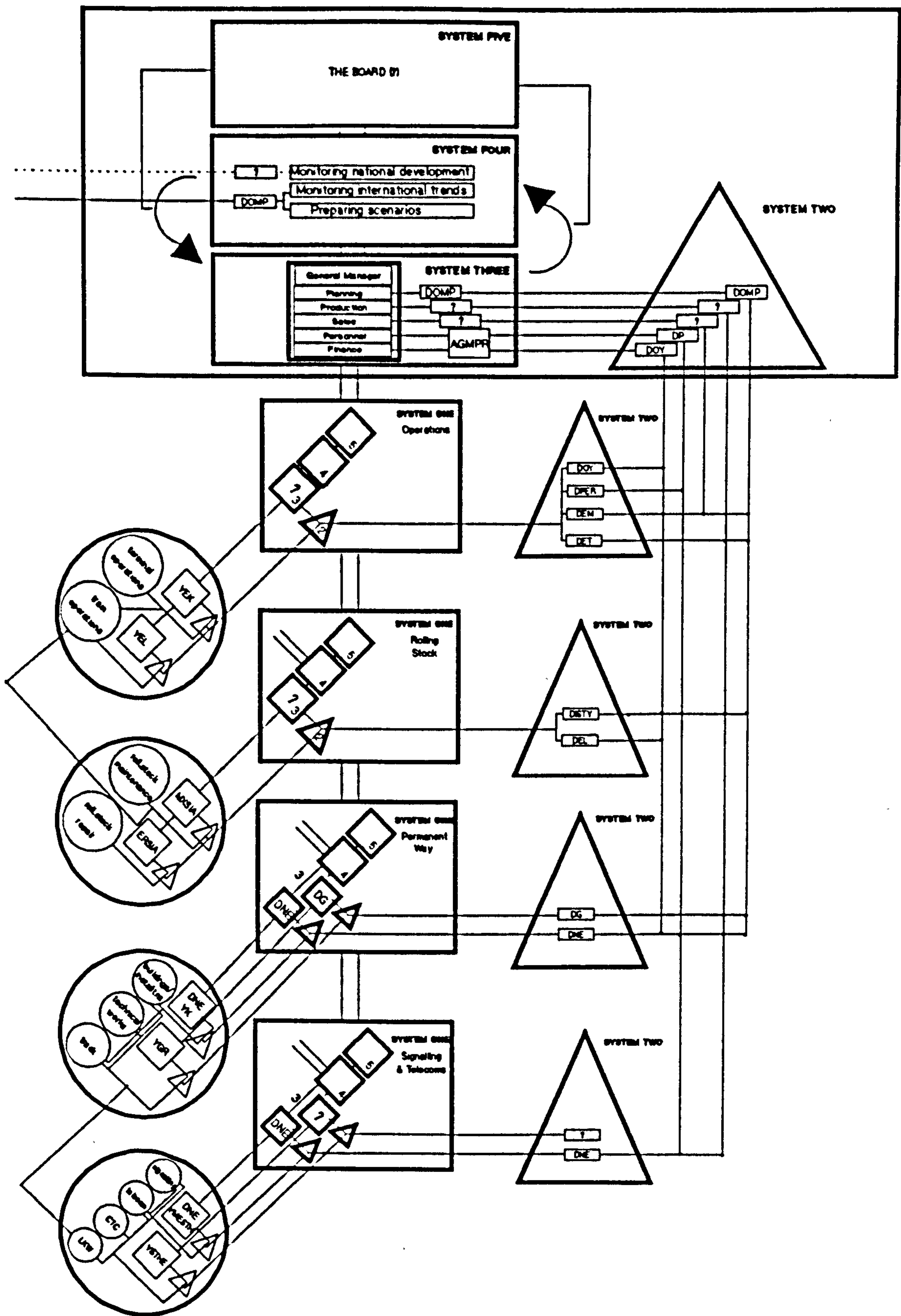


Figure 36: Recursion No.1: Railway Enterprise

10.3.6. Conclusions on Accountability Allocation

The findings of the accountability allocation phase of this thesis are summarised in the VSM of the enterprise in *Figure 36*. This illustration is almost identical to the description provided during the 'ethnographic-type' analysis undertaken in *Chapter 8*. Therefore, there is no reason to reproduce here the conclusions contained in the Synopsis of that chapter.

10.4. INFORMATION FLOWS

10.4.1. Introduction

The identification of the actual management control structure in the under-study enterprise as illustrated in the previous section (Accountability Allocation) has given the opportunity to demonstrate weaknesses and faults in the organizational design. In general, no major differences between the organization, as perceived in terms of the descriptive study (*Chapter 8*) and as emerging from managers' responses were encountered. This is quite natural, because 'who is actually doing what' is not a secret to anyone participating in an organization for a long period. However, what is difficult to achieve by means of 'observing' an organization is the actual way in which any unit carries out the managerial tasks it is assumed to perform. This implies information handling. The final part of the VSM structuring deals, therefore, with the examination of the information network.

Section Four of the survey questionnaire has provided the basis for data collection for this subtheme. The thus constructed data base is displayed in *Appendix D (Table D8)*. On the basis of this information, twenty information flows diagrams were constructed and are displayed in *Appendix E (Figures E14 to E33)*. That is, there are four diagrams corresponding to the four Types of Managerial Activities (Research and Development, Planning/Organizing, Annual Programming, Performance Monitoring) for each of the five components of the Railway Enterprise already discussed (Corporate, Operations, Rolling Stock Permanent Way, Signalling/Telecommunications). These diagrams may assist in understanding the type of information connections that each unit of the enterprise maintains with the enterprise and the environment. In fact, they constitute the only way to understand the enterprise/environment interaction as explained by the managers themselves, since, the up to now study, apart from assuming a type of interaction did not possess the information required in order to evaluate this interaction.

Before proceeding in an interpretation of this diagrams, it should be stated that they provide only recorded flows. That is, where a manager was not interviewed, the respective flows are missing. In fact, the most important missing information is this which relates to the activities allocated to the General Manager and to the Assistant General Manager Operations (AGMEK).

A second point which must be stated is that the recorded information flows were not cross-validated; i.e., the diagrams contain all information flows declared by the managers, as contained in *Table D8 (Appendix D)*, without attempting to ensure whether the information a unit declares that sends is actually understood at the other end of the flow as received. The reason why this cross-validation was not undertaken is that, in order to properly decide which flows actually exist and which not, a further series of interviews should be required, otherwise any decision should be either arbitrary or result to a poor picture.

Before departing in an examination of this material, which will proceed in the same way as previously, i.e., when discussing accountability allocation, the following points should be made as regards the general layout of these twenty diagrams and the way in which the discussion proceeds.

The right-hand part of the diagrams, i.e., the railway enterprise, provides an illustration of the organization both in terms of formal structure and recursive levels, as discussed in *Chapter 8 (Figure 31)*. However, as proved by the accountability allocation section of this chapter, the intermediate level corresponding to regional management (recursive level 2 in the diagrams) does not actually exist.

The left-side part of the diagram (the environment) provides environmental elements resulting from managerial answers. That is, the specific elements were neither *a priori* hypothesised, nor the managers were in any way guided towards them. They correspond to answers to questions 15.1.1 and 15.4.1 of *Section Four* of the *Survey Questionnaire (Appendix C)*, where information origins/destinations were requested under the general heading 'outside the railways'.

Finally, frequent references are made to *Table D8 (Appendix D)*, which displays the data of this part of the questionnaire. The table extends over 19 pages and classifies information flows in terms of activity, respondent, origin/destination and flows characteristics (form, frequency, quality) under a coding, explained in the last page of the table.

10.4.2. Information Flows: System ONE Operations

Figures E18 to E21 correspond to recorded information flows related to activities of the System ONE Operations.

Research and Development activities (*Figure E18*) are mainly undertaken by the Department of Planning (DOMP) and the Department of Operations Technical (DET). These two units, as illustrated in the diagram, are those which maintain contacts with the railway environment, and this has also been illustrated in the VSM of this system (*Figure 32*). The system FOUR informational activities of the Operations Commercial Department (DEM), also hypothesised in *Figure 32*, were not validated, since the only manager interviewed as regards this unit, i.e., the head of the department (DEM), did not answer the last part of the questionnaire.

Both DOMP and DET are assumed to maintain contacts with both the environment and the 'functional' organization (DEL, DISTY, DPER, DEM, DG, DNE, YSTHE). However, as regards the environment, the principle managerial unit of this system ONE, i.e., the Department of Operations Technical (DET), maintains exclusively 'technological' relations with the international railway context (UIC normes, standards etc., railway literature). However, even this limited information exchange (*Table D8, activities 24 and 27, respondent 30*) has neither periodicity (*frequency=7*, i.e., 'whenever happens') nor is assessed to be of adequate quality (*3='almost adequate'*). DOMP seems to maintain more frequent relations with the railway environment. However the information processing capacity of this unit is questionable, especially when considering the arguments provided in *Chapter 8*.

Figure E19 depicts information flows associated with Planning/Organizing activities of the Operations sub-system (*Survey questionnaire, Appendix C, activities nos. 28-33*). DET seems again to be the central information node. However, this self-claimed central role becomes again very doubtful, when considering that:

accountability for these activities has been allocated to DET under a less precise criterion (usually by *criterion c*), and

the frequency of the resulting information flows, as regards DET, is always of the 'whenever happens' type.

The same diagram illustrates an information link developing between the Regional Division of Operations (YEK) and the Rolling Stock Department (DISTY), i.e., outside the formal structure, in order to overcome organizational deficiencies, i.e., the allocation of accountability for part of activities of the Operations sub-system to the Rolling Stock sub-system.

Similar links are depicted in *Figure E20* (Operations, Annual Programming), between YEK/DISTY and Regional Managers (DPER)/depots (MXSIA). As regards information flows in this area, associated with the implied central role of DET, the remarks made previously with respect to the frequency (and hence the reliability) of the flows still hold, as *Table D8* indicates.

Concerning performance monitoring activities, *Figure E21* illustrates, for the first time as regards this sub-system, the informational significance of the regional structure (DPER and, mainly, YEK). Besides the fact that, here, the only perceived link of the Regional Division (YEK) with the environment was identified (relating to answers to Press publications concerning, probably, inadequate performance), the diagram illustrates the development of a horizontal information network. This network, centering around YEK, embraces the operating functional units (YGR, YEL, YSTHE, DISTY). This sort of geographical integration, achieved informally in practice, since no more the Region contains all functional units, illustrates a problem resulting from the intended vertical design and demands a kind of solution.

The same diagram illustrates the actual content of the activities of the Operations sub-system, which, as discussed in other sections, is not reflected in the organizational design. Thus, certain types of information flows develop between alternative recursive levels, in order to tackle day-to-day problems of the system ONE Operations (e.g. YEK/YEL, YEK/DISTY, DPER/MXSIA, KGPA/MXSIA).

10.4.3. Information Flows: System ONE Rolling Stock

Figure E22 illustrates the sort of organizational simplicity initially assumed when discussing the VSM of this sub-system. Two organizational units engage in Traction and Rolling Stock Research and Development activities:

the headquarters Department of Traction (DEL), engaging in monitoring international trends in Traction and Rolling Stock issues and in preparing alternative scenarios for future decisions of the enterprise concerning the fleet; and

the Rolling Stock Repair/Maintenance Department (DISTY), mainly interested in repair/maintenance issues, the study and decisions on which are inevitably related with the former kind of activities.

Both DEL and DISTY maintain information exchange with the Operations Technical Department (DET), since, in the end, decisions concerning rolling stock acquisition and scheduling have to conform to requirements of the Operations sub-system.

Both DEL and DISTY have to acquire technical information from a technological environment, which, since Rolling Stock manufacturing industry does not exist within the

country, involves exclusively international publications, journeys abroad and information exchange with manufacturers.

Recently, under State's bilateral agreements with German Democratic Republic, a manufacturing industry is setting up, utilizing the installations of the bankrupt, and hence nationalised, Elefsis Shipyards in the Athens area. This decision had a two-fold task:

to guarantee employment of the numerous staff of the shipyards, and

to, gradually, assist in the building of a domestic railway manufacturing industry.

Much of the work associated with studying and supervising these contracts is undertaken by a unit of the Department of Traction (DEL), which was set up specifically for this reason and which is referred to within this thesis as DEL/YM294. Thus, increased Research and Development needs have arisen, very doubtfully fulfilled by the actual organization of DEL.

The relatively uncomplicated nature of the Rolling Stock sub-system, implied by *Figure E22*, has to be rejected, when considering the whole set of information flows associated with its functioning. Thus, *Figures 23, 24 and 25*, illustrate the direct relation of the Departments of Purchases (DIP) and Stores (DAP) with a lot of managerial activity concerning this sub-system. They also indicate that the decision, made in the early seventies, to separate organizationally managerial responsibility for spares, materials, and equipment purchase from managerial activities related to the utilization of these spares, materials and equipment was not a wise one. The division, at a later stage, of the thus formed department of materials (DYL) into Purchases (DIP) and Stores (DAP) was further decreasing effectiveness. Interaction with this units takes place at both top level (DISTY) and implementation (depots, workshops). It should also be noted that:

Since managers from DIP and DAP departments were not interviewed, their inevitable interactions with the environment (i.e., market and manufacturers) is not displayed in the diagram.

The diagram is quite simplistic to what relates with the enterprise/government interaction, as regards this sub-system. The DISTY/government information flow depicted in *Figure 23* is actually a much complicated one. It also involves DIP and DAP and the volumes of state's rules and regulations governing the process of contract allocation, qualitative and quantitative control of the order, custom clearance, government's permission for imported goods, legislation for the protection and encouraging of domestic production, etc.

Figure 25 illustrates the actual network of information flows for the monitoring of the performance of this sub-system. The complexity of the diagram reflects the failure of the control of the implementation function. Note, that the 'producing' units i.e. the depots (MXSIA) and the workshops (ERSIA) are subject to any kind of interventions. Contrary to their relatives in other functional areas (e.g., YEK/EPITH/KGPA in Operations, YGR/TM.GR in Permanent WAY, YSTHE/TTHE in Signalling/Telecommunications), which, as a rule, apart from 'horizontal', i.e., local interactions, communicate vertically almost exclusively with the unit to which they report, depots and workshops actually 'report' to the totality of the vertical structure. Thus, apart from their 'official boss', that is, DISTY, they maintain direct relations with DOMP, DEL, DIP, DAP, DOY, the Assistant General Manager Traction (AGMEL), and the General Manager himself. A comment on this last intervention was provided in *Chapter 8*, as an explicit statement of organizational failure.

10.4.4. Information Flows: System ONE Permanent Way

Information flows associated with Research and Development activities of this sub-system, depicted in *Figure E26*, involve:

the Operations Technical Department (DET), since decisions on Permanent Way and Installations issues relate with the functioning and the performance of the Operations sub-system; and

the two functional departments, i.e., the Permanent Way Department (DG) and the New Projects Department (DNE), which share between them responsibilities for activities in a way, discussed in details in *Chapter 8*.

DET's environment scanning activities, as *Table D8* indicates, relate only to terminals' issues (no. 90) and are quite limited, both in variety, frequency and quality.

Contrary, the two functional units in the Permanent Way area (i.e., DG and DNE) maintain more adequate contacts. In many respects, the P.W. function of the enterprise possesses a much more complete picture of the technological environment, than any other part of the company. As stated, this reflects both:

the traditional attention paid by the enterprise to the Permanent Way sub-system, and

the relative technological simplicity of this sub-system in comparison to the three other functions.

Planning/Organizing activities center around the Permanent Way Department (DG) as *Figure E27* shows, and this has also derived from the descriptive study. Two further notes should be made on this diagram, as they also relate to the description provided:

the first is that no information exchange between the New Projects Department (DNE) and the functioning units (YGR) has been recorded at the planning stage. This reflects both the vertical division of duties discussed earlier and the non-participative character of planning activities.

the second illustrates the absence of a system THREE for this function. The Assistant GM Permanent Way (AGMGR) is shown as attempting an integration between the, formally reporting to Regions (DPER), P.W. Divisions (YGR) and the Permanent Way headquarters structure.

Annual Programming information flows are illustrated in *Figure E28* and refer to activities nos. 106-109, i.e., to the preparation of the annual maintenance/constructions plans and the purchase of materials/equipment required. The diagram shows that these activities are somehow integrated within the P.W. function, though this integration refers mainly to the preliminary plan's preparation, i.e., to the one which is subject to government's approval. After government's opinion on the budget has been taken into account, usually resulting to truncations, the thus produced final budget may not involve similar participation. This subject is examined in *Chapter 11*.

What is also indicated by this diagram is that P.W. maintenance/constructions requirements do not reflect any sort of actual needs as realised by the Operations system, unless the P.W./Operations link is an indirect one, involving the Department of Planning (DOMP). However, as illustrated in *Table D8*, DOMP's participation in this set of activities refers only to no.107 (annual new constructions programme) and involves a

once-every-six-months formal exchange of written information with production and headquarters departments.

Finally, performance monitoring activities (nos. 110-120) center around the functioning units (YGR) and are largely self-contained within the Permanent Way sub-system. Some sort of 'external' assessment implied by the DPER/YGR and DOMP/YGR links exaggerates visually the reality. In fact, as shown in *Table D8*, the regional manager (DPER) receives information from P.W. divisions (YGR) only in what relates to subcontracted projects within the region (no.113), whereas DOMP's information exchange is also limited to new constructions (nos.115, 118).

Note that the doubts concerning the monitoring of the P.W. activities from the Operations sub-system (no. 55), assigned marginally to DET (*criterion d*) are validated in this diagram, since no information link has been recorded.

10.4.5. Information Flows: System ONE Signalling and Telecommunications

Figure E30 depicts Research and Development information flows concerning the Signalling/Telecommunications sub-system and corresponding to activities nos. 121-125. The diagram illustrates the dispersion of tasks as a result of the lack of recognition of this sub-system as a system ONE in its own right. *Table D8* signifies the resulting 'anarchical' type of the enterprise/environment interaction in this area, in terms of frequency and assessed quality of information transmitted.

The inadequate planning/organizing and annual programming information exchange is depicted in *Figures E31* and *E32* respectively. Note the absence of DOMP in planning activities in this area. Note also the lack of corporate involvement, signifying the absence of a sort of functional system FIVE.

Finally, the performance monitoring information network, though poor, is complicated because:

S/T activities are shared between S/T and P.W. units, and

S/T activities are directly related to Operations.

Performance measurement of this sub-system does not reach the corporate structure (DOMP, AGMs, GM), since the only such flow recorded refers to the DNE/AGMGR interaction, concerning new projects and dating back to the phase when AGMGR had responsibility over this function.

10.4.6. Information Flows: Corporate Level

Figures E14 to *E17* provide information flows at corporate level, corresponding to activities nos. 1-23. Indeed, since the General Manager was not interviewed, and since, as shown, he personally holds accountability for many of the activities in this area, the diagrams provide an incomplete picture. However, even this incomplete picture allows to draw a general conclusion concerning the role of the Department of Planning (DOMP). Information flows in all four diagrams center around this Department. Thus, DOMP seems to hold within the company a large part of system FOUR (as *Figure E14* indicates), system THREE (*Figures E15, E16*) and system TWO (*Figure E17*) roles. Details of the limited capacity of DOMP to fulfill the requirements of a so complex task have been provided in earlier parts of the thesis. *Table D8* illustrates this limited capacity in terms of actual information exchange.

The same diagrams illustrate the absence of the three functional AGMs from corporate level activities. Thus, their not inclusion in the 3-4-5 part of the corporate VSM (*Figure 36*) is justified, since they exhaust their managerial activity within the respective functional area.

10.4.7. Conclusions on the Information Network

At first, it should be stated that this brief description of information exchange within the case study enterprise was not meant to produce a complete analysis, though much of the material required for such an analysis has been collected during this research and is contained in *Table D8*.

Main objective of this part was to further test the VSM structure of the enterprise, as conceived in *Chapter 8* and assessed in the 'accountability allocation' phase. Thus, the following additional conclusions may derive from this brief examination of the information flows network and further enrich the management cybernetic analysis of the railway company.

- (1) The enterprise is very much inwards oriented. Much of its information exchange activity is consumed within the organizational structure, without significant relation with the environment in which the company is embedded. A main reason producing this outcome is the irrelevant organizational structure. Thus, since the great part of this structure, above the third recursive level, has neither clearly defined responsibilities nor duties, it attempts to justify its existence by devising and requesting formal informational exchange, which is not 'information' under a strict definition of this term, in that it is not utilized in the making of any decisions. This thus reproduced bureaucratic behaviour seriously influences the productive part of the enterprise, i.e., its implementation units. A tradition to neglect 'external' signals develops and is readily identified in the way in which these units too perceive their relation with the environment.
- (2) The specific elements of the environment identified by the interviewed managers as origins/destinations of information flows further justify the argument provided above. From the eight quoted elements, three are exclusively functional/technological (seminars/education, UIC/Railways/conferences, Railway literature), and one is imposed by the very character of the enterprise (Government and Public Sector). From the remaining four,

interaction with the mass media is exclusively defensive, i.e., attempts to apologise or to disprove remarks on dimensions of poor performance,

one is again technological (trade/manufacturers) and refers to the acquisition of materials, spares and equipment, and

the last two, which for any functioning enterprise constitute the focus of interest, i.e., customers and competitors, have not received any serious attention. Thus, for example, the customers/enterprise interaction as emerging from the data contained in *Table D8* is limited to an abstract DET/customers interaction related to the activity of timetable preparation. Even this limited interaction is of the 'whenever happens' type, since, as has also been shown in *Chapter 8*, the company does not engage in any sort of market research activities.

- (3) A final point which should be made relates to the informational role of the Department of Planning (DOMP). For certain historical reasons, discussed mainly in *Chapter 7*, DOMP has acquired within the company a status of the type of '*brain of the firm*'. The performance of the enterprise over the years has demonstrated the inadequacy of this '*brain*'. The '*information flows*' diagrams in this section assist in interpreting the reasons of this inadequacy. It is virtually impossible for one organizational unit to act as the collector and disseminator of any sort of information demanded at corporate level, and, at the same time as a processor of this information for both future, long-term and operational activities. Beyond the enormous variety handling capacity implied by this ambitious task, this arrangement violates cybernetic principles.

First, it introduces the concept of '*planning specialists*' within the company and constrains the autonomy of the sub-systems at both regional and functional basis.

Second, it does not allow for an independent validation of decisions made. Since DOMP collects the environmental information, DOMP prepares the plans and DOMP assesses the results of operations (inevitably influenced by the plans), no one else in the enterprise knows whether undesirable output is the outcome of wrong interpretation of environmental signals, of poor planning based on correct interpretation, or of operational inability to implement rational plans.

10.5. SUMMARY OF THE VSM ANALYSIS OF THE ENTERPRISE

The management cybernetics analysis of the enterprise, initially undertaken in *Chapter 8* and further discussed here, has provided the opportunity to identify certain origins of poor performance in the inappropriate organizational structure. Many of the diagnostic prescriptions contained in the VSM literature and discussed in *Chapter 4* have proved useful in this study. In summary:

- (1) The implementation function of the enterprise has not been properly conceived. The following serious mistakes in articulating the different levels of recursion have been identified, so that the company is not logically organised at each of its levels of operation.

There is a confusion as to what constitutes the second level of recursion as regards the Operations and Permanent Way sub-systems. Thus, though officially a regional structure is supposed to exist, the study has shown that these two sub-systems are in fact organised vertically functionally.

Activities normally belonging to the Operations system are in fact undertaken within mainly the Rolling Stock (train cleaning, servicing) or the Permanent Way (level crossings keeping) systems ONE.

The Signalling and Telecommunications system is not recognised as such. Therefore, it is not treated as a viable system in its own right and lacks a localised system ONE management to attend to its affairs.

Much of the organizational confusion in the Permanent Way and Signalling/Telecommunications sub-systems is related to the existence and functioning of the New Projects Department.

- (2) The ability of the Systems ONE of the enterprise to operate successfully is threatened by the absence of all the necessary five functions of every system ONE. Thus:

Systems TWO at sub-systemic level were not at all established.

System THREE duties, in the absence of organizational clarity were in most cases undertaken by the functional AGMs, who, at the same time, were playing a system FIVE role within the functional sub-system.

Consequently, no actual distinction of duties within the sub-system's 3-4-5 metasystem exists. Therefore, functional systems FOUR were equally unorganised and ineffective.

- (3) At corporate level, System TWO was not at all established. Therefore, co-ordination between the various activities of the systems ONE was in jeopardy.
- (4) Corporate System FOUR was weak. Its communications with both the parts of the enterprise and the environment were not adequate. Further, since corporate system FOUR (DOMP) was, organizationally, reporting to the formal system THREE figurehead (GM), the balancing of the future/present interaction was achieved at the expense of the future.
- (5) System's FOUR structural inability to provide the enterprise with alternative dimensions of future of both the enterprise and the environment has facilitated the system THREE-FIVE overlap. This overlap was expressed in the figure of the General Manager, who was also the Chairman of the Board.
- (6) In no case the 'formal' system FIVE, i.e. the Board, represented what Beer calls "*the essential qualities of the whole system*" to the wider systems of which the railway enterprise is part. Conversely, the Board was assumed to represent within the enterprise the sort of reality perceived at the higher level of recursion, attenuated through the 'filter' of political relationship.
- (7) 'Synergy' and 'interactivity' within the metasystem THREE-FOUR-FIVE were achieved by means of the more obvious and least effective way. That is, by the system THREE-FIVE overlap and the placement of system FOUR under the control of system THREE. Thus, whatever metasystemic interaction required, was taking place within the dominant figure, i.e., the General Manager/Chairman.
- (8) Almost the totality of the organizational structure above level 3 was pathologically autopoietic, i.e., it continued to produce these aspects of the organization which were essential to its identity, at the expense of the company as a whole and without promoting the implementation function.

Concluding, using VSM terminology, the under study enterprise possessed a lot of the characteristics of a not viable system. Paraphrasing Beer's words, the fact that the railway enterprise is there does not prove that it is effectively there. It operates at the margins of viability at such a big cost, that it has become less and less viable in front of everyone's eyes.

It seems, therefore, vital for the company to undergo an organizational redesign. However, though the rationale of the cybernetic model employed implies both a structural and cultural redesign, this is not explicitly provided in the VSM diagram. An impression might be gained that by restructuring the organization the problems would be resolved.

Though such an approach constitutes an abuse of the model, the model itself does not possess mechanisms to resist this abuse.

Hopefully, the preliminary study has highlighted the influence that the overall social and cultural context exerts on the enterprise and, consequently, the large degree to which this context is responsible for jeopardised viability. This piece of work is, thus, saved the trouble of arriving at partial explanations of organizational failure.

The last part of the management cybernetics study of the enterprise, will, therefore, deal with the cultural background. Unless an appropriate organizational culture exists, any organizational redesign, however sophisticated, will result to limited improvements.

10.6. FOOTNOTES

1. Alternative uses of this kind of '*variety engineering*' tables, either for the allocation of managerial discretion or for the, related, design of management information systems are provided in:

R.Espejo, 1980: "Information and Management: The Cybernetics of a Small Company", in Lucas et al. (eds.): *The Information Systems Environment* (North-Holland Publishing, Amsterdam), pp.291-310.

R.Espejo, 1983: "Strategies for Information Management", *Cybernetics and Systems*, vol.14, pp.315-341.

CHAPTER 11

MANAGERIAL COHESIVENESS

11.1. INTRODUCTION

In previous parts of this thesis (*Chapters 8 and 10*), the VSM of the under-study enterprise has been constructed and various diagnostic points have been made from a management cybernetics viewpoint, concerning the organizational structure. However, as stated in *Chapter 8*, even if an organizational integration was achieved, if the company as a whole does not have a capacity to assess whether it is 'doing' the right things, long-term viability and effectiveness are in danger. Moreover, the preliminary study (*Chapter 8*) has hypothesised a strong relationship between the ineffective organizational structure and the overall organizational culture in the case-study example, and, attempting to identify the background of this culture, has indicated the influence of the 'public enterprise' characteristic, as perceived at a level of development defined by, and in turn defining, the company, the country, the government, and their interrelations. An examination of this culture was, thus, decided and the concept of managerial cohesiveness has been introduced. In *Chapter 9*, cohesiveness has been defined as a function of managerial agreement on key issues, assumed to reflect the organizational culture. Both dimensions of managerial cohesiveness are of interest in this study, i.e., the extent and the content of cohesiveness. These dimensions are examined by analysing the findings of the first part of the survey questionnaire.

11.2. TESTING COHESIVENESS

11.2.1. The Managerial Structure as One Sample

A first obvious way of testing managerial cohesiveness is to consider the managerial structure as one sample and to examine the rate of dispersion of managerial opinions in respect to the several questions posed. This involves an interpretation of the frequency distributions of responses.

Figures 37 and 38 illustrate these distributions, as regards the 49 variables under examination (variables OBJECT1 to REASON9). *Table 21* provides the arithmetic values of related descriptive statistics (frequency values, mean, standard error, standard deviation).

As shown in both the diagrams and *Table 21*, managerial agreement on issues examined varies from almost unanimous agreement (e.g., task3-std.dev.=0.452, task6-std.dev.=0.580) to significant dispersion of responses (e.g., contr3-std.dev.=1.919, reason5-std.dev.=1.903). The recorded disagreement may be attributed to several factors, four of which are of interest in this study, mainly because they are objectively defined. These four independent variables (managerial age, level, function, and jobtype) define alternative subgroupings of the managerial structure, within which a more detailed analysis will be performed for the evaluation of managerial cohesiveness.

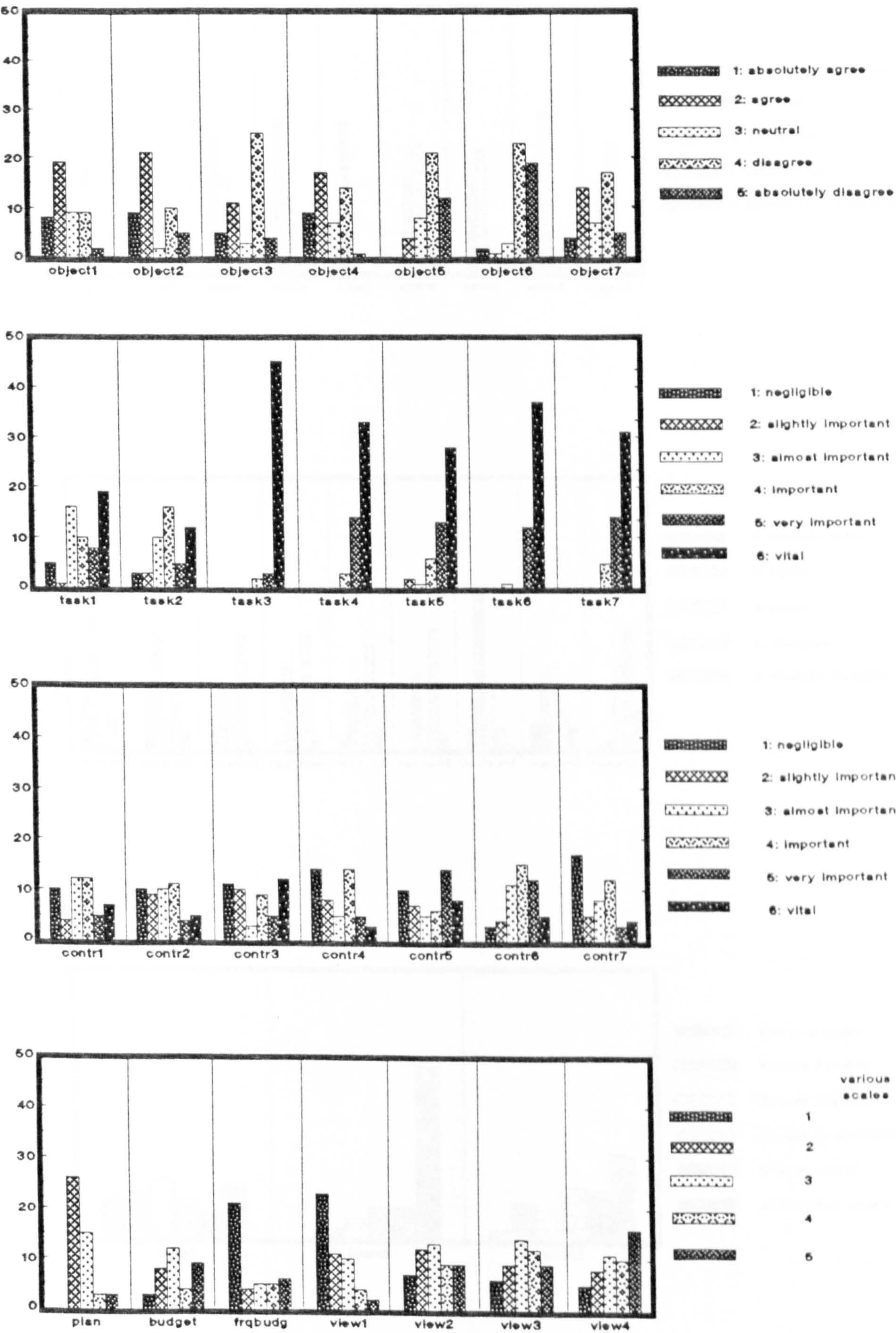


Figure 37: Frequencies of Managers' Responses: Variables OBJECT1 to VIEW4

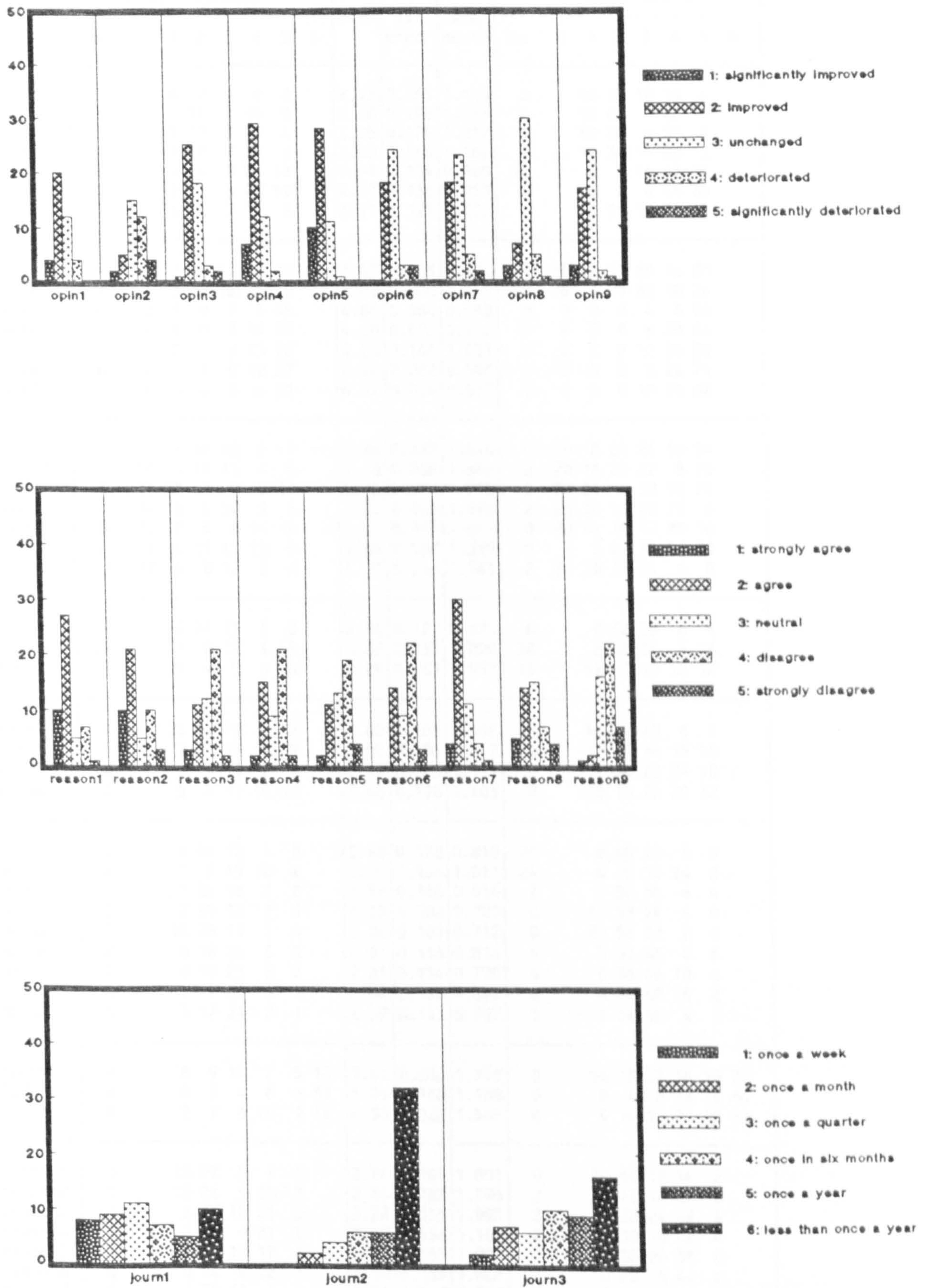


Figure 38: Frequencies of Managers' Responses: Variables OPIN1 to REASON9

variable	survey responses								mean	std error	std devtn	% distribution							
	na	0	1	2	3	4	5	6				na	0	1	2	3	4	5	6
object1	3		8	19	9	9	2		2.53	0.163	1.120	6	16	38	18	18	4		
object2	3		9	21	2	10	5		2.60	0.192	1.313	6	18	42	4	20	10		
object3	0		5	11	3	25	4		3.25	0.175	1.212	4	10	22	6	50	8		
object4	2		9	17	7	14	1		2.60	0.168	1.162	4	18	34	14	28	2		
object5	5		0	4	8	21	12		3.91	0.134	0.900	10	0	8	16	42	24		
object6	2		2	1	3	23	19		4.17	0.138	0.953	4	4	2	6	46	38		
object7	3		4	14	7	17	5		3.11	0.175	1.202	6	8	28	14	34	10		
task1	1	5	1	6	10	8	19		3.47	0.233	1.634	2	10	2	12	20	16	38	
task2	1	3	3	10	16	5	12		3.08	0.208	1.455	2	6	6	20	32	10	24	
task3	0	0	0	0	2	3	45		4.86	0.064	0.452	0	0	0	0	4	6	90	
task4	0	0	0	0	3	14	33		4.60	0.086	0.606	0	0	0	0	6	28	66	
task5	0	0	2	1	6	13	28		4.28	0.146	1.031	0	0	4	2	12	26	56	
task6	0	0	0	1	0	12	37		4.70	0.082	0.580	0	0	0	2	0	24	74	
task7	0	0	0	0	5	14	31		4.52	0.096	0.677	0	0	0	0	10	28	62	
contr1	0	10	4	12	12	5	7		2.38	0.232	1.640	0	20	8	24	24	10	14	
contr2	1	10	9	10	11	4	5		2.18	0.235	1.662	2	20	18	20	22	8	10	
contr3	0	11	10	3	9	5	12		2.46	0.271	1.919	0	22	20	6	18	10	24	
contr4	1	14	8	5	14	5	3		2.02	0.240	1.696	2	28	16	10	28	10	6	
contr5	0	10	7	5	6	14	8		2.62	0.257	1.817	0	20	14	10	12	28	16	
contr6	0	3	4	11	15	12	5		2.88	0.187	1.319	0	6	8	22	30	24	10	
contr7	0	17	5	8	12	3	4		1.90	0.246	1.741	2	34	10	16	24	6	8	
plan	3		0	26	15	3	3		2.64	0.127	0.870	6	0	52	30	6	6		
budget	14		3	8	12	4	9		3.22	0.215	1.290	28	6	16	24	8	18		
frqbudg	9		21	4	5	5	6		2.29	0.243	1.553	18	42	8	10	10	12		
view1	0		23	11	10	4	2		2.02	0.165	1.169	0	46	22	20	8	4		
view2	0		7	12	13	9	9		3.02	0.186	1.317	0	14	24	26	18	18		
view3	0		6	9	14	12	9		3.16	0.186	1.315	0	12	18	28	24	18		
view4	0		5	8	11	10	16		3.46	0.198	1.403	0	10	16	22	20	32		
opin1	10		4	20	12	4	0		2.40	0.128	0.810	20	8	40	20	8	0		
opin2	12		2	5	15	12	4		3.29	0.164	1.011	24	4	10	30	24	8		
opin3	1		1	25	18	3	2		2.59	0.116	0.814	2	2	50	36	6	4		
opin4	0		7	29	12	2	0		2.18	0.102	0.720	0	14	58	24	4	0		
opin5	0		10	28	11	1	0		2.06	0.101	0.712	0	20	56	22	2	0		
opin6	2		0	18	24	3	3		2.81	0.118	0.816	4	0	36	48	6	6		
opin7	2		0	18	23	5	2		2.81	0.114	0.790	4	0	36	46	10	4		
opin8	4		3	7	30	5	1		2.94	0.130	0.895	8	6	14	60	10	2		
opin9	3		3	17	24	2	1		2.67	0.131	0.907	6	6	34	48	4	2		
journ1	0		8	9	11	7	5	10	3.44	0.246	1.740	0	16	18	22	14	10	20	
journ2	0		0	2	4	6	6	32	5.24	0.168	1.188	0	0	4	8	12	12	64	
journ3	0		2	7	6	10	9	16	4.30	0.222	1.568	0	4	14	12	20	18	32	
reason1	0	10	27	5	7	1			2.24	0.142	1.001	0	20	54	10	14	2		
reason2	1	10	21	5	10	3			2.56	0.183	1.296	2	20	42	10	20	6		
reason3	1	3	11	12	21	2			3.22	0.155	1.093	2	6	22	24	42	4		
reason4	1	2	15	9	21	2			3.18	0.156	1.101	2	4	30	18	42	4		
reason5	1	2	11	13	19	4			3.30	0.155	1.903	2	4	22	26	38	8		
reason6	2	0	14	9	22	3			3.40	0.154	1.088	4	0	28	18	44	6		
reason7	0	4	30	11	4	1			2.36	0.117	0.827	0	8	60	22	8	2		
reason8	5	5	14	15	7	4			3.12	0.203	1.438	10	10	28	30	14	8		
reason9	2	1	2	16	22	7			3.76	0.136	0.960	4	2	4	32	44	14		

Table 21: Descriptive Statistics of Managers' Responses

11.2.2. Contrasting Subgroups of the Managerial Structure

The background of the statistical analysis performed in this section has been provided in *Chapter 9*. Since the purpose of the field study was to collect information to be utilized in two rather distinct topics, i.e., managerial cohesiveness statistical tests and actual VSM construction, where the principle criterion for interviewees' selection was to satisfy the requirements of the latter, a modification of subgroups within independent variables was, after data collection, required, to provide for meaningful statistical tests, by producing subcategories of significant size. Thus,

The five subgroups of variable managerial age, which in fact turned out to be four, since no manager interviewed was less than 30 years old (subgroup 1), were recoded into two groups, i.e., younger managers (subgroups 2 and 3) and older managers (subgroups 4 and 5).

Subgroups 1 (top management) and 2 (heads of departments) of independent variable managerial level were aggregated into one, and

Subgroups 1 (operations) and 4 (signalling/telecommunications) of independent variable managerial function were also aggregated.

However, descriptive statistics for the initial more detailed subgroupings are also provided in *Appendix F* (mean values and graphs).

After recoding, two-sample median tests were performed on the dichotomous variables age and jobtype, and k-sample tests on variables level (three subgroups) and function (four subgroups). The results of these tests are displayed in subsequent tables of *Appendix F*.

Further, wherever the existence of a significant association was revealed in the non-dichotomous variables, the whole set of necessary pairwise comparisons was undertaken (in the form of two-sample median tests), to reveal subpopulations in disagreement. These comparisons are also displayed in *Appendix F*.

Thus, in a total of 49 variables (object1 to reason9) representing questions 3.1 to 12.9 of the survey questionnaire, *Table 22* summarises association recorded between these variables, and the four independent variables (i.e., managerial age, level, function and jobtype).

On the basis of the revealed existence of association, further tests were undertaken to measure the degree of this association. Since the common measure of correlation, i.e., Pearson's product-moment correlation coefficient, could not be employed in this study, as it assumes normality of distributions and measurement on an interval scale, non-parametric tests were used. Thus,

for variables where measurement was achieved at an ordinal scale, that is, all dependent variables and independent variables "age", "level", and "jobtype", the degree of association (i.e., managerial disagreement) was tested by employing Kendall's rank correlation coefficient, corrected for tied ranks (tau-b) ¹, and

for variable "function" (where the scale 1 to 5 is only nominal), the contingency coefficient c was employed ².

The results of these degree of association tests and their significance are displayed in *Tables 23-26*.

dependent variable	subpopulations contrasted	independent variable										
		age	level			function					jobtype	
		2+3	1+2	1+2	3	1+4	1+4	1+4	2	2	3	1
		----- 4+5	--- 3	--- 4	--- 4	--- 2	--- 3	--- 5	--- 3	--- 5	--- 5	----- 2
object 1		*		**	*						**	**
object 2												
object 3												
object 4				*								
object 5			**									
object 6			**									
object 7												
task 1												
task 2												
task 3												
task 4												
task 5												
task 6												
task 7												
contr 1												
contr 2												
contr 3						**			**	**		
contr 4												
contr 5												
contr 6												
contr 7												
plan		*										
budget							**		**			*
freqbudg												
view 1									*		*	**
view 2												
view 3												
view 4												
opin 1												*
opin 2												*
opin 3												*
opin 4		*										
opin 5												
opin 6												
opin 7												
opin 8												
opin 9												
journ 1												
journ 2												
journ 3												
reason 1												
reason 2												
reason 3		**										**
reason 4		**										
reason 5												
reason 6												
reason 7			**									
reason 8												
reason 9		**										

*: association significant at 90 % confidence level.

**: association significant at 95 % confidence level.

Table 22: Summary of Managerial Disagreement

dependent variable	independent variable	subpopulations contrasted	Kendall's tau-b	significance
object1	age	2+3 to 4+5	-0.37329	0.0028 *
plan		2+3 to 4+5	-0.36430	0.0048 *
opin4		2+3 to 4+5	-0.33692	0.0064 *
reason3		2+3 to 4+5	0.34166	0.0046 *
reason4		2+3 to 4+5	0.25820	0.0252 *
reason9		2+3 to 4+5	-0.30951	0.0098 *

*: significant association at 95 % confidence level.

Table 23: Managerial Disagreement by Managerial Age

dependent variable	independent variable	subpopulations contrasted	Kendall's tau-b	significance
object1	level	1+2 to 4	0.48418	0.0074 *
object1		3 to 4	0.30719	0.0243 *
object4		1+2 to 4	-0.51362	0.0053 *
object5		1+2 to 3	-0.44344	0.0061 *
object6		1+2 to 3	-0.42282	0.0069 *
reason7		1+2 to 3	-0.26235	0.0593

*: significant association at 95 % confidence level.

Table 24: Managerial Disagreement by Managerial Level

dependent variable	independent variable	subpopulations contrasted	Kendall's tau-b	significance
object1	jobtype	1 to 2	0.34144	0.0056 *
freqbudg		1 to 2	-0.31442	0.0153 *
view1		1 to 2	0.30174	0.0110 *
opin1		1 to 2	0.30203	0.0223 *
opin3		1 to 2	0.28183	0.0203 *
opin5		1 to 2	0.15419	0.1275
reason3		1 to 2	-0.37217	0.0023 *

*: significant association at 95 % confidence level.

Table 25: Managerial Disagreement by Managerial Jobtype

dependent variable	independent variable	subpopulations contrasted	contingency coefficient	d.f.	2 x	significance
object1	function	3 to 5	0.52086	4	10.7967	< 0.05 *
contr3		2 to 1+4	0.57382	5	10.3091	> 0.05
contr3		2 to 3	0.55944	5	12.7558	< 0.05 *
contr3		2 to 5	0.63722	5	14.3565	< 0.05 *
budget		3 to 1+4	0.51756	4	8.0492	> 0.05
budget		3 to 2	0.64570	4	17.8755	< 0.05 *
view1		3 to 2	0.45050	4	7.1299	> 0.05
view1		3 to 5	0.53034	4	11.3490	< 0.05 *

*: significant association at 95 % confidence level.

Table 26: Managerial Disagreement by Managerial Function

11.3. ASSESSING COHESIVENESS

In order to assess whether recorded disagreement challenges managerial cohesiveness the following considerations should be made:

- (1) A correlation coefficient does not give directly anything like a percentage of relationship. We cannot say that a tau-b of 0.50 indicates two times the relationship that is indicated by a tau-b of 0.25. Nor can we say that an increase in correlation from 0.40 to 0.60 is equivalent to an increase from 0.70 to 0.90. The coefficient of correlation is an index number, not a measurement on a linear scale of equal units. 3
- (2) The examination of managerial agreement involved the utilization of several five-interval (and one six-interval) scales. Apparently, searching for disagreement involves the interpretation of statistically recorded disagreement in terms of its natural meaning.

Thus, critical disagreement, i.e., disagreement challenging managerial cohesiveness, will be defined as any statistically recorded disagreement between two sub-populations with magnitude at least equal to 1.5. scale interval. That is, two groups are assumed to disagree, when one tends to *agree strongly* (value 1) and the other to be *neutral* (3), or one *agrees* (2) and the other *disagrees* (4). Lesser managerial disagreement statistically recorded, though amenable to further examination, may not be considered as threatening managerial cohesiveness.

11.3.1. Hypotheses Related to the Objectives of the Enterprise

Table 27 summarises recorded disagreement, concerning variables object1 to object7, which relate to the seven stated reasons of the existence of OSE as a state-owned railway enterprise.

dependent variable	i n d e p e n d e n t v a r i a b l e																					
	age		level				function								jobtype							
	2+3	4+5	1+2	3	1+2	4	3	4	1+4	2	1+4	3	1+4	5	2	3	2	5	3	5	1	2
object1	-0.373				0.484		0.307												0.521		0.341	
object2																						
object3																						
object4					-0.514																	
object5			-0.443																			
object6			-0.423																			
object7																						

Table 27: Managerial Disagreement on the Objectives of the Railway Enterprise

As indicated by this table, no disagreement was recorded for variables object2, object3, and object7. Table F1 (Appendix F) shows that

Managers' opinions concerning variable object2 (*"OSE exists mainly in order to serve transportation needs of the lower income classes"*) concentrate in the interval from 2 (agree) to 3 (neutral), with mean value 2.60.

Managers' opinions concerning variable object3 (*"OSE exists mainly in order to serve excess transport demand during peak periods"*) concentrate in the interval from 2.75 to 3.50, with mean value 3.25, and

Managers' opinions concerning variable object7 (*"OSE exists mainly in order to assist in tackling some sort of wider national problem in future"*) concentrate in the interval from 2.50 to 3.24, with mean value 3.11.

Moderate disagreement has been recorded, as regards the remaining four variables of this section. Thus:

Managers' opinions concerning variable object1 (*"OSE exists mainly in order to offer railway services better than those to be offered by a private railway enterprise"*) differ by age, managerial level and jobtype. Older managers tend to agree, whereas younger managers tend to be neutral, the overall mean value lying in between (2.53). Similarly there is a rate of decrease of agreement going down from top management (1.83) to heads of departments (2.33), to divisional management (2.37) and to area management (3.06). Finally, headquarters managers tend to agree with this reason of existence (2.05) whereas production managers tend to be neutral (2.86).

Managers' opinions concerning variable object4 (*"OSE exists mainly in order to help the State in achieving wider policy goals"*) are differentiated by managerial level: thus, while lower management agrees that this is why OSE exists (2.00), top managent tends to disagree (3.33). Mean value again is somewhere in between (2.60).

Managers' opinions concerning variable object5 (*"OSE exists mainly in order to maintain a complex of relations associated with interests of individuals"*) differ by managerial level and function. Lower management lies between neutrality and disagreement. Upper management between disagreement and strong disagreement. Equally, rolling stock, permanent way and signalling management do not oppose this option as strongly as operations management and other (i.e. mainly corporate) management. Mean value for this variable is 3.91.

Managers' opinions concerning variable object6 (*"OSE exists mainly in order to assure the survival of railway as a means of transport"*) are slightly differentiated by level: upper management strongly disagrees (4.50-4.71) whereas lower management disagrees (4.00). Mean value is 4.17.

Concluding, no major difference in opinions between two subgroups, either by age, or level, or function, or jobtype, has been recorded for any of the seven variables of this subtheme. In general, the major null hypothesis stating that managers agree on the reasons of OSE's existence may not be rejected.

11.3.2. Hypotheses Related to the Goals of the Enterprise

No managerial disagreement has been recorded as regards the seven variables which constitute this subtheme, i.e. variables task1 to task7.

Similarly, statistically significant disagreement as regards units' contribution in achieving the above goals was only recorded in variable contr3 (*contribution in improving service reliability*), with respect to subgrouping by function. Thus, corporate management and permanent way management assess their contribution as being not as important as that of operations, rolling stock, and signalling/telecommunications. This is a quite rational assumption.

11.3.3. Hypotheses Related to Planning and Budgeting Features

As regards variable plan (*"which way you think planning is organised in OSE ?"*), a moderate disagreement has been revealed between younger and older managers. However, considering more detailed subgrouping by age (*Table F6, Appendix F*), while managers more than 40 years old hold opinions between intervals 2 (*"planning adapting to changing conditions"*) and 3 (*"imperfect planning, becoming non implementable"*), with respective mean values for age groups 3, 4, and 5 being 2.69, 2.39, and 2.25, younger managers, less than 40 years of age hold opinions beyond interval 4 (*"no planning: everyone tries to serve company's interest as he realises it"*), with a mean value of 4.25.

Managers' opinions on OSE's planning process are not differentiated by managerial level, function or jobtype, the values concentrating in the interval between 2.00 and 3.00.

Significant disagreement was revealed as regards variable budget (*"which way you participate in the preparation of your unit's budget?"*) by managerial function. Managers of operations, signalling, and rolling stock units claim participation in budget preparation in a way different from that of permanent way managers. According to *Table F1*, while permanent way managers confess a rather formal participation in budget preparation (somewhere between answers 2 and 3, with mean value 2.53), the other functional managers tend to realise their participation as more integrated and 'democratic' (mean values 4.00, 4.13, 4.00 respectively).

Finally, concerning variable freqbudg (*"how often is your opinion asked before your unit's budget is amended?"*), some disagreement has been recorded by managerial jobtype.

Thus, managers of headquarters units are more frequently asked than operations managers (respective values 2.94 and 1.88, *Table F1*). Besides other implications, this finding questions the participative nature of functional budgeting, as implied by most answers in the question of the previous paragraph.

Overall, the major statistical hypothesis in this section, stating that railway managers agree on the features and their participation in the planning process, has to be rejected. Critical disagreement has been recorded, which will be discussed in a next section.

11.3.4. Hypotheses Related to Corporate Views at Managerial Levels

The questions in this topic were meant to be seen as an identity exercise. According to the statistical analysis, significant disagreement concerning variables *view2*, *view3*, and *view4*, (which, in turn, represent the view that the sample believes that managerial levels 2 (heads of departments), 3 (heads of divisions) and 4 (area managers) hold for the company, was not recorded. *Table F1* shows that respective scores for variables *view2*, *view3*, and *view4* were 3.02, 3.16, and 3.46; i.e., according to the rationale of question no.9 of the questionnaire, that these three managerial levels have been assessed as viewing the company neither '*holistically*', as value 1 implies, nor '*reductionistically*' (implied by value 5), but rather in the middle (value 3), with a slightly increasing narrowing of the perspective going down the hierarchy. This is again a rational assumption, considering the formal structure and functioning of the under-study enterprise.

On the contrary, *Tables 25* and *26* have revealed a disagreement concerning variable *view1* (which is, how managers believe that top management view the company), not by managerial level, as might be expected, but by jobtype and function. Headquarters' managers tend to assess top management's view more '*holistic*' (1.52) than production managers do (2.38). On the other hand, permanent way managers (mean value 2.61) believe top management to be less properly oriented than other functional groups, namely rolling stock (1.40) and other (1.45), do.

11.3.5. Hypotheses Related to Performance Assessment

Performance assessment is illustrated by variables *opin1* to *opin9*. At first, concerning overall performance expressed by variables *opin1* (*traffic volume*), *opin2* (*market share*) and *opin3* (*service reliability*), *Table 25* has revealed moderate disagreement in variables *opin1* and *opin3* by jobtype. Headquarters' managers tend to be closer to reality (which is that neither traffic volume nor service reliability has improved over the last three years) than production managers, and this might be an indication of inadequate information flow within the company, as regards evaluation of performance.

No disagreement has been recorded relatively to the performance of the rolling stock subsystem (variables *opin6* and *opin7*) and to terminal operations (variables *opin8* and *opin9*). They are believed as not having shown any improvement, since mean values are very close to 3 (2.81, 2.81, 2.94, 2.67).

Finally, as regards the performance of the permanent way sub-system, there is disagreement by age (variable *opin4*) and by jobtype (variable *opin5*). Thus, younger managers tend not to find any improvement in track quality concerning train punctuality (mean value 2.83), whereas the rest find there is improvement (mean values 2.29, 1.91, 2.25). Furthermore, more production than headquarters managers find an improved impact of

the quality of track on the quality of journey, though this is not clearly indicated in terms of mean values (1.95 and 2.14 respectively).

Concluding, since critical disagreement has not been recorded, the null hypothesis, stating that railway managers agree in assessing railway performance, may not be rejected.

11.3.6. Hypotheses Related to 'First-Hand' Information

Variables *journ1*, *journ2*, and *journ3* where meant to reveal whether opinions expressed by managers relatively to performance assessment were based on a personal knowledge of the real conditions of the network. No significant differences concerning the frequencies of travelling in various parts of the network were recorded. However, and this is revealing, it seems that when managers assessed performance in the previous section, they tend to have in mind the main line of the network, since, on average, they travel on this line approximately once every three months (mean value 3.44) compared to less than a year travelling to North Greece lines (5.24) and less than twice a year on the narrow gauge network (4.30). Provided that the mean values mentioned include managers of the Athens and Peloponnese Regional Departments (whereas North Greece managers are not represented, since, as explained in *Chapter 9*, they were excluded from the survey), the real picture may be obtained by comparing mean values of headquarters managers, i.e., excluding regional structure. Again (*Table F1*, *journ1* to *journ3* by jobtype), headquarters management is significantly more concerned with the main line (mean value 3.62), than with either the Peloponnese (4.43), or North Greece (4.76).

11.3.7. Hypotheses Related to Performance Constraints

Table 28 summarises the ranking of various possible reasons constraining performance improvement, as assessed by managers interviewed.

rank	variable	reason constraining better performance	mean value
1	reason1	Old technological equipment	2.24
2	reason7	Absence of incentives	2.36
3	reason2	State's interventions	2.56
4	reason8	Irresponsibility of trade unions	3.12
5	reason4	Lack of control	3.18
6	reason3	Lack of planning	3.22
7	reason5	Limited capacity of managers	3.30
8	reason6	Indifference of operating staff	3.40
9	reason9	Pro-workers legislation	3.76

Table 28: Managers' Ranking of Reasons Constraining Performance Improvement

Nine statements were provided by the questionnaire as possible reasons, and they were given the variable names reason1 to reason9.

Tables 23-26 reveal no disagreement concerning variables reason1 (*old technological equipment*), reason2 (*state interventions*), reason5 (*limited capacity of managers*), reason6 (*indifference of operating staff*), and reason8 (*irresponsibility of trade unions*). On the other hand, disagreement has been recorded concerning variables reason3 by age and jobtype, reason4 and reason9 by age, and reason7 by level. Thus:

Younger managers assign to the *lack of planning* (reason3) some reasoning for poor performance (mean values 2.67 and 2.88), whereas older managers tend to disagree (3.52 and 3.75). In turn, production managers are more willing than their headquarters colleagues to identify a reason in the lack of planning (2.86 to 3.71).

Similarly, there is a belief between young managers that *lack of control* (reason4) is a reason of poor performance (2.17). This belief decreases inversely with the age (3.18, 3.39, 3.50).

On the other hand, smaller ages do not favour *pro-worker legislation* (reason9) as a cause (4.17). Here the older the manager, the less he disagrees (4.06, 3.57, 3.00), but in no case he goes further than neutral.

Finally, *lack of incentives* (reason7) is seen as a fundamental reason by managers of levels 2 and 3 (mean values 2.14 and 2.15). The fact that lower management (level 4) has not yet gone very close in identifying this reason (mean 2.53) probably is an indicator of recently entering the managerial structure. Similarly, top management was not expected to find this as a strong cause (mean 2.83), since, either they have been externally appointed to their present positions or they have been promoted from the hierarchical structure, i.e., in their point of view, good job is always rewarded.

In general, the null hypothesis stating that railway managers agree on the reasons constraining performance improvement may not be rejected, besides minor differences in managerial opinions.

11.3.8. Hypotheses Related to Methods for Improving Performance

Managers' rank orders of methods for improving performance are displayed in Table F12. They were asked to rank seven stated methods as means of achieving six stated goals. Table 29 summarises the findings.

The emerging need to improve the planning process within the case-study enterprise is impressive. Planning is seen as the primary method to solve organizational problems and this is not at all far from reality. Similarly impressive is the recognition of the need for intensive staff training. In practice, as railway modernization has been seen as involving mainly the completion of a series of civil engineering projects, very little has been done to educate staff either on requirements, procedures, and details of complex operations, or on the actual or future utilization of technological innovations.

The table is also revealing as regards managers' understanding that, without improved planning and education at first, and reorganization/effective control consequently, very little can be achieved by measures aiming at either replacings of people in the top of organizational pyramids, or at improving work conditions and providing salary increases.

method	mean rank	improved quality of services	optimum resource utilization	improved sub-systems cooperation	improved sub-system rolling stock	improved sub-system permanent way	improved sub-system signall. & telecm
1. improved planning	1.33	2	1	2	1	1	1
2. staff training	2.00	1	2	3	2	2	2
3. reorganization	3.00	4	4	1	3	3	3
4. effective control	3.67	3	3	4	4	4	4
5. change unit heads	5.83	7	7	5	6	5	5
5. improved work conditions	5.83	6	5	6	5	7	6
7. salary increases	6.33	5	6	7	7	6	7

Table 29: Managers' Ranking of Methods for Improving Performance

11.3.9. Concluding on Managerial Cohesiveness

Overall, the statistical analysis did not reveal critical disagreement on the issues examined, apart from issues related with the planning/budgeting process. Managers seem to hold similar views on principle characteristics of the railway enterprise, such as objectives, importance of several goals, performance evaluation, reasons constraining and methods to be adopted for performance improvement.

However, whether the recorded agreement implies cohesiveness towards viability and development or a shared view of a declining enterprise has to be examined by interpreting the meaning of managerial responses.

11.4. INTERPRETING COHESIVENESS

11.4.1. Corporate Objectives of the Enterprise

Table 30 provides mean ranks and mean values for the seven possible objectives of the enterprise, as included in the questionnaire. It is interesting that none of these

rank	variable	o b j e c t i v e	mean value
1	object1	to offer services better than private railway	2.53
2*	object2	to serve transport needs of lower incomes	2.60
2*	object4	to help state in achieving wider goals	2.60
4	object7	to assist in tackling future national problem	3.11
5	object3	to serve excess demand during peak periods	3.25
6	object5	to maintain complex of interests of individuals	3.91
7	object6	to assist survival of outdated transport mode	4.17

*: tied rank

Table 30: Managers' Ranking of Various Objectives

explanations has been adopted by the managers as a justification of OSE's existence as a public railway enterprise. To summarise this finding, the words of one of top managers interviewed may be used. In his opinion:

"None of these objectives explain or justify the public ownership of the railways. OSE has, for a long time, functioned as a state-owned enterprise under certain historical conditions. Successive governments have found the enterprise within the public sector and had left it there, not in order to seek some kind of objectives, but because they never bothered to consider either its future or the needs of a national transport system".

Within this lack of realisation of the reasons of OSE's existence, managers, on average, come closer to adopt the first objective (*to offer services better than private railway*) as an explanation. However, even in this case,

managers are closer to neutrality than to agreement (mean 2.53), and

the mean value obtained is an average resulting from significant disagreement between subgroups.

As explained by several of the managers interviewed, in the case of the poor-performing Greek Railway, "offering services better than those to be offered by a private firm" should be taken to mean, that, if private, OSE would have closed down most of the railway lines, the operation of which cannot be justified on commercial grounds. Since in this category belong the Peloponnese network (with the exception of the Athens-Patras line), the Thessaly line, the North-West Greece lines, and the totality of branch lines, with the exception of the Inoi-Khalkis branch, offering 'better' railway services may be interpreted as offering today's services, as contrasted to their abolition.

This perception of 'public interest' is also reflected in managers' second rank of corporate objectives. Here, tied at mean value 2.60, two 'social' justifications were provided:

to serve transport need of lower incomes, implying that these needs are served under the present level of service and that they should be put in danger by privatisation and, consequently, closure of clearly non-viable commercially lines.

to help state in achieving wider policy goals, implying that the most obvious wider goal achieved through the existence and functioning of OSE, i.e., the maintenance of employment, should also be endangered by a private railway, seeking optimum financial performance under commercial criteria.

Managers' unwillingness to recognise other than external social objectives is also illustrated in Table 31, which provides mean ranks and mean values of certain operational goals.

rank	variable	goal	mean value
1	task3	to improve service reliability	4.86
2	task6	to improve quality of services	4.70
3	task4	to increase traffic volume	4.60
4	task7	to increase market share	4.52
5	task5	to reduce journey times	4.28
6	task1	to reduce total expenditure	3.47
7	task2	to reduce staff expenditure	3.08

Table 31: Managers' Ranking of Various Tasks

The least important goal, according to managers' responses, is the reduction of staff expenditure. The second least important is the reduction of overall expenditure. It seems that in managers' point of view there is no strong connection between the developing modernization programme and financial efficiency. However, apart from speed increases and service reliability improvements, a major task of a railway modernization project is to permit rationalization of staff numbers, since, traditionally, slack resources within railway enterprises have been of great magnitude. Thus, though the labour-intensive character of the railway industry is unambiguous, a 18:21 ratio of labour to overall expenses (as shown in Chapter 8) does not reveal an effective serving of the social (not to mention the commercial) interest.

The primary importance assigned by the managers to train punctuality improvement and to other improvements of quality of services obviously relates to today's low standards of output, especially when considering the wider context of railway and other activities (European Community).

Traffic volume and market share increases have also been assessed as very important goals to be sought. However, these two goals are those in which managers, on average, find their contribution less significant, as shown in *Table 32*.

rank	variable	contribution	mean value
1	contr6	in improving quality of services	2.88
2	contr5	in reducing journey times	2.62
3	contr3	in improving service reliability	2.46
4	contr1	in reducing total expenditure	2.38
5	contr2	in reducing staff expenditure	2.18
6	contr4	in increasing traffic volume	2.02
7	contr7	in increasing market share	1.90

Table 32: Managers' Ranking of Contribution in Achieving Various Tasks

Since, as already stated, apart from variable *contr3* (*improving service reliability*), no other disagreement has been recorded for the variables in this table, the low mean values shown correspond, in general, to overall trends. However, even by referring to the more specific values of *Table F1*, the highest achieved mean values for these variables are:

contribution in traffic volume increase (*contr4*): 2.88,

contribution in market share increase (*contr7*): 3.00,

corresponding to operations and signalling managers respectively.

Concluding, the smallest overall mean value recorded when assessing the importance of operational goals (3.08, corresponding to staff expenditure reduction, *Table 31*) is larger than the bigger value obtained when assessing, on the same scale, units' contribution in achieving these goals (2.88, corresponding to quality of services improvement, *Table 32*).

It may well be, that achieving such corporate goals implies systemic synergy; that is, no unit or sub-system is able to achieve such goals by its own. However the existence of this synergy is questioned when no managerial group, either in terms of age, or level, or function, or jobtype, identifies its central role in the pursuit of any of the listed operational goals. Recall, that mean values correspond to a six-interval scale from '0' = '*negligible*' to '5' = '*vital*'. On this scale, only two functional groups, i.e., rolling stock managers as regards contribution in improving service reliability (*contr3*), and signalling managers as regards contribution in reducing journey times (*contr5*), assess their contribution as being very important (respective mean values 4.20 and 4.33).

11.4.2. Conclusions on the Objectives and Goals of the Enterprise

Three principle conclusions may be drawn from the interpretation of responses to the first three sets of questions:

- (1) Managers' ranking of reasons of OSE's existence is consistent with the character of the enterprise, as provided in *Chapter 7*, and as further discussed in *Chapter 8*. OSE has always been used as a vehicle for the pursuit of external objectives, mainly employment maintenance. Consequently, managers realise their company as being more a social policy tool than an enterprise with its own goals.
- (2) Given the above, and in the absence of a clear direction to pursue financial efficiency, managers fail to recognize the importance of sound financial performance. This is compatible with the argument provided in *Chapter 5* on public managers' inability to operate commercially. However, in a society where
 - resources are limited; and
 - alternative criteria for judging the performance of the public enterprise do not exist,

failing to improve financial results leads inevitably to cuts in investment funds and to threatening the viability of the public enterprise, usually via technological underdevelopment.

- (3) The lack of bottom-line responsibility discussed in *Chapter 8* is very clearly reflected in the way in which managers assess their units' contribution in achieving goals. Either the only person responsible for overall performance is the general manager himself (which the thesis cannot assess, since, unfortunately, the GM was not interviewed), or no one within the enterprise is responsible. There seems to be an urgent need to redefine duties and accountability, i.e., organizational structure.

11.4.3. Planning, Budgeting, Organizing

In *Chapter 8*, when discussing the cybernetics of the case-study enterprise, it was shown that planning within Greek Railways constitutes a formal, annual exercise, not expected to be validated during the implementation process. This is exactly reflected in the responses of the younger managers (variable plan, age group 2, *Table F1*). Top management (level 1) and area management (level 4) also come close to this view. Intermediate managerial levels, i.e., those mostly responsible for planning, either do not recognise this reality, or do not want to accept it, as it signifies their failure. An indirect indication of lower management's disbelief in the functioning of the bureaucratic structure is contained in *Table 33*, which provides ranks of views of various levels as assessed by each managerial level (variables view1 to view4). *Rank 1* is taken to indicate the view closer to 'holistic'. An important finding of this table, indicating also a substantial deviation from mean ranks (first column) is that area managers assess themselves as possessing the second most 'holistic' view of the company, after top management.

Another indication of a poor planning/budgeting process, and consequently of inadequate management control (since one can control only whatever has been planned) is provided by the examination of managers' responses to variable freqbudg (*how frequently is your opinion asked when your unit's budget is amended ?*).

Tactical planning within Greek Railways is an imposed procedure, meant to produce two annual budgets; one reflecting the expected financial results and a second containing annual investment expenditure. Both budgets are submitted to the Government to gain approval. However, both because

mean rank	this level's -----> rank of the view of this level v	top management	heads of departments	heads of divisions	area managers
1	top management	1	1	1	1
2	managers of headquarters departments	2	3	2	3
3	regional managers and regional divisions managers	3	2	3	4
4	area managers	4	4	4	2

Table 33: Ranks of Views of Managerial Levels by Managerial Level

- budgets are poorly prepared and inadequately justified, and
- government's approval is usually not an argument of sound budget preparation, but of wider policy issues (inflation control policy, balance of payments restrictions, etc.),

budget cuts are requested, which may involve either the limitation of investment projects, or restrictions in seasonal personnel recruitment etc. Thus, a reformation of initial budgets follows, almost every year. As *Table F1* shows, this process, which in fact produces exactly what could be supposed to be the definite annual programme (i.e., after government's opinion has been taken into account), is limited to top management and heads of departments. Divisions and Area Managers (Levels 3 and 4) less than rarely are asked to express their views (mean values 1.93 both). Hence the perception that "plans" are unimplementable.

However, still concerning planning, a contradiction might be identified when comparing the results in *Table 27* (managers' ranking of reasons constraining performance improvement) and *Table 28* (managers' ranking of methods for improving performance). Managers' answers in the reasons constraining performance improvement assign to lack of planning (reason3) a mean value of 3.22 (that is, between neutrality and disagreement), the closer to agreement value (2.67, belonging to young managers) implying neutrality. On the contrary, when searching for methods to improve performance (*Table 28*), planning is always assessed as the best, or second best, method available. The reader is asked to pay some closer attention to the questions producing these phenomenically contradicting responses. In the first case (reasons constraining), managers were asked to identify lack of planning as a reason. Their spontaneous response was: "*Lack of planning ? There cannot be such a reason! We are overloaded with plans!*". In the second case (methods assisting),

Improved planning was proposed. Apparently, improved planning was thought as having nothing to do with today's procedures and was assessed as the best method to improve performance.

11.4.4. Feasibility of Performance Improvement

Discussion of this topic also involves examination of the findings of *Tables 27 and 28*. Starting with performance constraints (*Table 27*), it should be remembered that responses were obtained on a five-interval scale, where "1" = "strongly agree" and "5" = "strongly disagree". The closer-to-agreement reason constraining performance improvement was thought to be the old technological equipment (reason1). It was ranked first within all subgroupings (*Table F1*), except

older managers (age group 5), having experienced two more serious, in their point of view, reasons, i.e., absence of incentives (reason7) and trade unions interventions (reason8).

divisions' managers (level group 3) and permanent way managers (function group3), identifying also absence of incentives and state's interventions (reason2).

These four reasons were agreed upon, though for one of them (trade unions' irresponsibility) mean value implies neutrality (3.12). From them, the plans and the functioning of the Greek Railways are directed towards tackling the first, i.e., old technology. This is the true meaning of technological modernization. However, improved performance cannot be achieved by merely introducing modern technology. The tackling of the other three identified principle reasons is required.

11.4.4.1. Lack of Incentives and Railway Performance

The introduction of 'performance improvement'-related incentives within a state-owned railway enterprise like the Greek Railway, as it is today, is arguable.

Financial incentives imply a manager's control over resources, bottom-line responsibilities for results, and integrated planning against which these results will be judged. None of these requirements exist within the under-study enterprise. Even overcoming these problems, it is not readily realisable in which way could a manager be financially rewarded for the performance of a part of an enterprise, which produces, by its very nature, a deficit.

Non-financial incentives could take either the form of status within the company (implying promotion not by seniority but by assessment of the actual capacity of managers) or offering opportunities for an exciting career (opportunities to broaden one's knowledge, to travel abroad, etc.). Promotion 'by selection', is not restricted by OSE's legislation and, indeed, is the only formal way to reach top hierarchical positions (e.g., head of department). However, again, when bottom-line responsibilities are not clear, there is no method to assess, unless someone is exceptionally good. This is why in middle and lower managerial positions, where promotion may be achieved either by seniority or by selection, being 'selected' is interpreted by the colleagues as being a function of maintaining personal contacts either with top management or with other power centres. On the other hand, there are very few posts within a railway (e.g., corporate planning, international relations) in which an opportunity for managerial career could be assumed an incentive.

11.4.4.2. State's Interventions and Railway Performance

By the same token, to assume that the State will refrain from intervening in matters concerning the state-owned railway would be very simplistic. Moreover, when a railway like OSE does not serve any kind of 'public interest' within the transport system, which could not be served by a private enterprise (e.g., by maintaining a network of urban and suburban services, relieving the roads of conurbations from congestion, or by providing the only means of linkage to isolated communities, or by taking freight off motorways), it is very difficult to realise any other reason for state-ownership apart from making use of this ability to intervene, in order to serve macro-policy issues, more or less successfully.

However, the type of interventionism implied by managerial responses does not relate mainly to government's initiatives at the macro-economic level but to day-to-day interventions in operational matters. Such interventions, remnants of conditions of the past, when the railway was run officially as a government department, originate in a controversial legislation, the details of which have remained unchanged, mainly because no one attempted this kind of change, or, when attempted, was overwhelmed by the complexity of the task. Elements of this legislation imposing government's participation in internal decisions such as organizational structure, materials purchase, personnel training, etc., do not add anything either to a more effective control of the enterprise or to a more efficient use of national resources.

11.4.4.3. Trade-Unionism and Railway Performance

Finally, the problem of trade unions within a public enterprise is difficult to tackle and, indeed, it is questionable whether a limitation of their role should be pursued. By definition, a trade union aims at safeguarding the rights of its members, most valuable of which is the right to work. In the country in which the case-study enterprise is embedded (and probably not only there), two are the focal points of criticism, as regards the trade unions behaviour in a public enterprise context:

either they are accused for having a narrow perspective and ignoring the interests of the society, when they take very seriously their role as safeguards,

or they are asked to mind their own business, i.e., to focus narrowly on the interests of their members, when they aim at wider societal changes.

The answer to the question of what constitutes a proper role of a trade union is beyond the ambitions of this thesis. This topic, as well as the previous one, i.e., State's interventionism, are elements of analysis at a higher level of recursion, that is, the level at which the political, social and cultural characteristics of a country and its perspective of the future are defined. On such issues there is no wider consensus, neither between nations nor within a country. Therefore, to attempt to define a policy towards trade unions at a railway enterprise level would be both arbitrary, as it implies a certain perception of social reality obtained from a particular socio-political viewpoint, and reductionistic, as it assumes that indeed it is feasible to tackle effectively broad social issues at an enterprise micro-level.

An abstract remark would be that a management's better understanding of the fears and the problems of the working people solves problems before they result to conflict, i.e., industrial action. However, it should also be noted that, in many cases, the management of the public enterprise does not have discretion to satisfy labour's demands, even when it feels that they are rational and justified.

Overall, the public enterprise/personnel homeostasis is difficult to achieve, as, to a large degree, it is influenced by characteristics of higher recursive levels.

11.4.5. Conclusions on the Feasibility of Improved Performance

It has been shown that, apart from partially tackling the new technology issue, the management of Greek Railways has difficulties in confronting the other reasons constraining performance improvement, within the existing framework of wider concepts in the country. Assuming that this framework is not expected to be, shortly, radically changed, the last question of this section of the questionnaire asked managers to rank several methods of improving performance.

Table 23 provides rank orders of such methods, where performance improvement was subdivided into six sub-goals. The impressive emerging need to improve planning, being almost in any case selected as the principle method to be adopted, has already been discussed. The second need for intensive staff training has also been presented. Methods ranked third and fourth, i.e., reorganization and effective control, may be seen as related between them, and, further, related to improved planning.

However, what is also interesting and reflecting either the thoughtfulness or the pessimism of managers interviewed, is that they do not trust either managerial changes or salary increases to substantially help in improving performance. The exact order of mean ranks provided by the respondents is indicative of a kind of crisis in the under-study enterprise, since in a moderately performing company, managers should be expected to propose methods to improve results in exactly the inverse order.

Probably this is a symptom of a wider crisis concerning the country in which the under-study company is embedded. However, if this is not the case, managers' proposals should be rapidly implemented, by diverting limited funds, from the construction projects area towards the improvement of planning process and the intensive training of personnel, including managers themselves.

11.5. ORGANIZATIONAL CULTURE AS A FACTOR GOVERNING EFFECTIVENESS

This chapter has attempted to evaluate the influence of the organizational culture on the performance of the enterprise. It has been shown that, overall, managers share the same perception of the enterprise, and the reasons of its poor performance. In other words, managerial cohesiveness exists. However this 'cohesiveness' is not of a positive nature. It rather reflects a common belief in the non-feasibility of change. This climate does not facilitate organizational improvement and constitutes a serious obstacle to attempts implying revival via an organizational redesign.

Any attempt to tackle future challenges must inevitably involve a 're-education' of the human factor of the enterprise on the key-issues of its identity. The task is overwhelming as this identity is mainly defined by the characteristic of public ownership, and, therefore, directly associated with overall conditions in the country. The type of motivation required has to be provided by a higher level of recursion, but it is arguable whether this higher level has this ability.

In some cases it has been proposed that rather than attempting to solve the complex public enterprise problem it is better to dissolve it. The remedy of this dissolution has been identified in privatisation. Besides opinions expressed in Chapter 5 suggesting the need for a regulated railway environment, the poor technological standards, the low

market share, and the overall sociopolitical context of the case study enterprise do not favour such a solution. Therefore, the difficult route of pursuing technological and cultural innovation has to be followed under the existing set of relations. This piece of work will have achieved its ambitions if, apart from facilitating the clarification of theoretical management control issues, has provided any help to the railway enterprise in which it originated.

11.6. FOOTNOTES

1. For any given pair of cases with measurements on variables x and y , Kendall's rank correlation coefficient (τ_b) is provided by the formula:

$$\tau_b = \frac{P - Q}{\sqrt{(P + Q + T_x)(P + Q + T_y)}}, \text{ where}$$

P is the number of concordant pairs (both variables for one case are higher, or both are lower, than the corresponding values for the other case), for all distinct pairs of observation,

Q is the number of discordant pairs,

T_x is the number of pairs tied on x but not on y , and

T_y is the number of pairs tied on y but not on x .

2. Pearson's contingency coefficient c has been defined as

$$c = \sqrt{\frac{x^2}{x^2 + N}}, \text{ where}$$

N is the size of the sample.

3. J.P. Guilford, 1965: *Fundamental Statistics in Psychology and Education*, Fourth Edition (McGraw-Hill, New York), page 103.

CHAPTER 12

CONCLUSIONS

12.1. INTRODUCTION

The objectives of this thesis, as set in *Chapter 1*, were:

To identify structural and cultural causes of ineffectiveness in a state-owned railway enterprise, in the light of the management cybernetics area of knowledge.

To assess the capacity of this area of knowledge, especially in its abstract and coded form (VSM), to provide adequate explanations of organizational performance and organizational failure.

This final chapter provides conclusions drawn from the project undertaken as regards these objectives.

12.2. CONCLUSIONS ON THE CASE STUDY ENTERPRISE

Several structural and cultural causes of ineffectiveness have been identified, in the light of the methodology employed. However, many times throughout this thesis, negative features of the enterprise have been shown as strongly associated with the environment of the railway, especially with the characteristic of state ownership. Therefore, before arriving at a final assessment, it might be useful to provide a few further notes about this environment. However, though it is likely (and detectable) that this environment influences the "purpose" related aspect of Greek Railways, the details of this influence are not endogeneous to the study. The support of the ethnographic study cannot be claimed in the same way as it was for the discussion on the internal workings of the organization. Thus, instead of introducing a subjective interpretation of this environment, the view of the top management of the enterprise will be employed. This view, though subjective too and probably not representative of the managerial structure, is of importance, since it belongs to the acting General Manager of the enterprise.

12.2.1. Fundamental Characteristics of the Environment of the Enterprise

In an early paper (January 1983), soon after the change in government (October 1981), the then Deputy Governor of the Greek Railways Dr Christos Papageorgiou, who returned to the enterprise as General Manager in August 1988, attempted to summarise his one year's experience within the company and to provide both some explanations of ineffectiveness and guidelines for future improvements. The following analysis draws very much upon his views. ¹

The Greek Railway is embedded in a society which, beyond its overall description as a western society, possesses some idiosyncratic characteristics: it is a society to the reproduction of which the role of central authority and of the state (with the whole spectrum of public enterprises, banks and organizations under its control)

implies a mechanistically modelled organization, structured hierarchically and controlled centrally by a completely autonomous authority which can affect any part of the system without being affected by any of them. A social system conceived in terms of a mechanistic model can only operate effectively in a static environment. The rapidly changing environment of social systems poses to the organizations the requirement of continuous adaptation and learning. This implies the readiness, the willingness, and the ability to change. An organizational model based on the traditional mechanistic analogy lacks these qualities.

The requirements from an organizational model based on an integrated perception of the management control process have been discussed by Jackson (1988). The model should support the *"technical"*, the *"practical"* and the *"emancipatory"* interests, as defined in *Chapter 1* and as further discussed in the last section of this chapter.

12.2.2. Chapter 2: Questioning the Adequacy of the Prevailing Paradigm

Chapter 2 has provided details on the *"official"* perception of the management control issue which, in general, is based on the three-levelled analysis of managerial decision making (Anthony, 1965) and the distinction between programmable and non-programmable decisions (Simon, 1960). The instability of the prevailing paradigm in management is demonstrated in terms of a review of the literature on management information systems, as perceived, designed and utilized within this paradigm. The widespread dissatisfaction associated with the performance of conventional management information systems may not only be attributed to technical problems. It is likely that this dissatisfaction is associated with the very role of management as perceived within the traditional school. Argyris (1980) has suggested that solutions derived from conventional explanations may contain inner contradictions which will produce negative results. Argyris (1977) has demonstrated that the type of information system that managers require is one that:

- Contains abstract, quantitative descriptions of key performance indicators.
- Represents stable variance.
- Represents the results or outputs of complex processes, and not the processes themselves.
- Contains explicitly rational logic in that it attempts to satisfy the logical systematic rules for defining categories, making inferences, and confirming or disconfirming evaluations publicly.
- Excludes as much as possible tacit knowledge and tacit processes.

A realisation of the management control process via an information system of this kind is constrained by the hierarchical power structure of a mechanistically conceptualised organization under the influence of the prevailing paradigm. Alternative models should be employed. An interpretation of the enterprise in cybernetic terms is a first candidate, since, in general, Argyris's suggestions on the characteristics of a management control system are perceived as implying features of a cybernetic system.

12.2.3. Chapters 3 and 4: A Cybernetic Approach to Management

Chapter 3 has discussed the application of cybernetics in managerial situations. The characteristics of cybernetic systems are complexity, probabilism, and self-organization (Beer, 1962). These are also characteristics of social organizations. The chapter has discussed these characteristics as well as methods employed by cybernetics in order to deal with them.

An attempt to avoid a narrow conceptualization of social reality in terms of mechanistic modelling could result in an alternative kind of analogical modelling,

organismic modelling, which, though demonstrating some advantages over the traditional model, does not fulfill the requirements from an organizational model as set in *Chapter 1*. This has been the case of traditional cybernetic approaches to managerial situations which seek to understand the human organization as an organism feeding on information. A major difference between traditional and managerial cybernetics is that though the former has evolved in the tradition of positivism the latter has had to evolve taking into account the purposeful and intentional nature of human beings. The view of current managerial cybernetics, as discussed by Espejo (1987), is that social structures do have a great influence in the creation of reality by individuals, and, therefore, that reality is not simply created by individuals. The human organizations are not independent of the communities of individuals defining them.

From this cybernetic viewpoint, management processes are not necessarily pyramidal power structures. Neither human situations are objectively defined, in that their boundaries are shared by the concerned people and the only problem is to devise the optimum methods of achieving the desirable results. The complexity of the contemporary world and the rapidly changing environment demonstrate that the management problem is more that of working out what to do to maintain stability in interpersonal interactions than that of achieving well-defined results.

The organizational model that supports, and is in turn supported by, contemporary managerial cybernetics, i.e. Beer's Model of the Viable System, was presented in *Chapter 4*. The evaluation of this model, in a state-owned railway context, constitutes one of the objectives of this thesis and as such is separately discussed in the last section of this chapter.

12.3. ON THE MANAGEMENT OF A STATE-OWNED RAILWAY ENTERPRISE

12.3.1. Chapter 5: Railway Enterprise and Public Ownership

Subject matter of this thesis has been the testing, against each other, of a non-traditional organizational model and a state-owned railway enterprise. *Chapter 5* introduces the examination of the second half of this test by examining the characteristic of state-ownership in a railway context.

Besides contemporary moves towards deregulation, a first conclusion is that state regulation of railway activities is justified in financial terms, because of the very characteristics of the industry (Keeler, 1983). The extent of this regulation between the extremes of a nationalised infrastructure on which private railway companies operate, as proposed by Wyckoff (1973), and a nationalised railway system, as almost exclusively employed in Europe (both East and West) and in many other countries in the world, is a result of certain historical, social and political conditions. In general, state ownership is assumed to promote the efficient operation of the enterprise respectively to what Nove (1973) calls "*public interest under nationalization*".

An explicit definition of "*public interest*" has not been attempted in this thesis. Through the review of related literature it has been shown that a universal agreement upon its content probably does not exist. An examination of the objectives of several public railways identified alternative dimensions of public interest such as:

Conformance with macro-policy objectives and contribution to the efficient allocation of resources.

Offering of services under consideration of social needs of local, regional and national communities.

Promotion of the human quality of those who constitute the enterprise, etc.

The concept of public interest and, consequently, the objectives of a state-owned railway, become even less comprehensible by the imposition of the requirement to operate on a strict commercial basis. The chapter has shown that the management of a state-owned enterprise is in a comparative disadvantage to that of a private firm as regards both the definition of its role and the criteria against which the performance will be judged.

12.3.2. Chapter 6: Cybernetic Modelling of the Railway Enterprise

The discussion on state-owned railways which started in *Chapter 5* with the issue of state ownership focuses in *Chapter 6* on the functional element of the enterprise. Since, up to now, the project had been perceived as a mutual test against each other of a railway company and an organizational model via the construction and discussion of the VSM of the enterprise, this chapter aims at conceiving the general case of a railway in terms of the model's principles. This implies identification of the recursive structure.

Though literature on VSM application assigns major difficulties in identifying elements of systems TWO and FOUR within the under-study organization, in this project, problems were encountered from the very beginning; i.e., while attempting to identify systems ONE. Consequently, considerable time was spent on the pursuit of this task. According to Beer, experience suggests that it may be difficult to decide which chain of systems someone wants to model. He calls each chain of systems which embed each other a '*recursive dimension*'. Any viable system exists in a variety of recursive dimensions. However, it seems that the selection of a '*recursive dimension*' can only be made after deciding on the viewpoint. That is, after considering on behalf of whom the organization is being investigated. The organizational modelling as undertaken in this thesis corresponds to an examination of the enterprise from within, i.e., from the enterprise's point of view. Alternative models of the same enterprise, corresponding to different viewpoints may also be set up in terms of the VSM. Indeed, an alternative '*recursive dimension*' was initially assumed appropriate for the purposes of this thesis and is summarised in *Figure 37*.

This approach is much more service oriented, focuses on the product, and treats each scheduled train as a viable system in its own right. However, this type of modelling did not fit the actual characteristics of the under study enterprise, where, for stated reasons, implementation activities are not mainly service oriented, as the company virtually undergoes a phase of reconstruction. In addition, this recursive dimension implies a strong linkage between planning activities and service output, where the completion of modernization projects in any part of the network is associated in detail with the impact on the rail services offered. Apparently, this view facilitates the understanding of how things '*should be*' and might serve as a model for the Production or the Sales managers of any railway enterprise, or, more specifically, the Greek Railway, whenever this company decides to employ this kind of corporate executives.

However, and this is a very substantial advantage of Beer's model, whichever recursive dimension is adopted, the logic of the VSM proves helpful. In the example, even at the fifth level of recursion, when examining the System ONE "*05.12 intercity train from a to b within Region A*", systems ONE to FIVE may be easily identified and analysed.

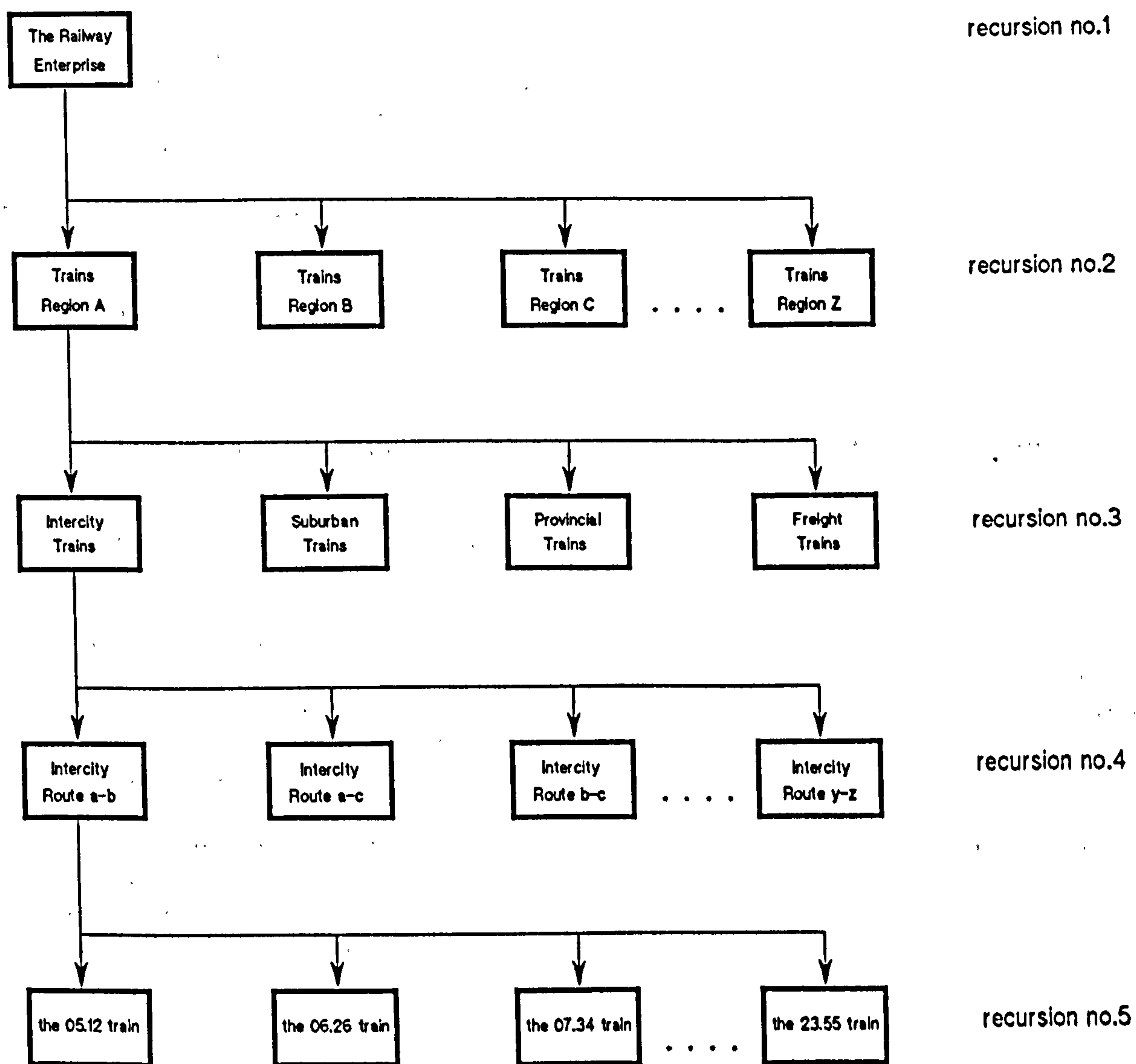


Figure 37: Alternative 'Recursive Dimension' of the Railway Enterprise

The selected 'recursive dimension' interprets the railway enterprise as consisting of four main sub-systems, i.e., operations, rolling stock, permanent way, and signalling/telecommunications. A division of these major sub-systems into further viable components has been offered down to the fourth level of recursion.

The chapter has discussed the cases when these four subsystems appear as components of the enterprise at the first or second recursive levels, that is, whether the enterprise is set up functionally or possesses a regional structure. The resulting cybernetic models are illustrated and certain organizational consequences are discussed. The effective management of the enterprise has been presented as an argument of accountability for managerial activities over four broad areas -Research and Development, Planning/Organizing, Annual Programming, and Performance Monitoring- extending over four managerial contents -Production, Sales, Finance, and Personnel- within each system at any recursive level. A fifth managerial area, Relations with the State, has been identified at

the first recursive level with the duty to maintain the homeostasis between the enterprise and its institutional environment. The resulting list of managerial activities was assumed to constitute the basis of the survey questionnaire. The interviewees would be requested to indicate the accountable manager for each of the listed activities, enabling thus the construction of the actual VSM of the enterprise.

12.3.3. Chapter 7: Setting Up the Case Study

Background information concerning the specific railway enterprise which would be tested against the cybernetic model, i.e. the Greek Railways Organization (OSE-CH), has been provided in *Chapter 7*. The following conclusions directly relate to the objectives of this project:

The ownership of the enterprise by the state has not originated in the pursuit of public interest. The main part of the network was constructed and owned by the state, during the early stages of the independence of the country, mainly due to the unwillingness of private capital to invest. Similarly, privately owned secondary branches went gradually public through bankruptcies.

Specific historical and other conditions obstructed both the expansion of the network and its integration within the system of social activities. Consequently, dimensions of public interest usually served by a railway such as commuter services, substantial freight traffic and provincial/rural passenger transportation are missing in the case study.

The poor condition of the network, as assessed within the national and international contexts of activities, has placed disproportionate emphasis on the technological modernization, during the whole post-war period. The completion of the implied large-scale technical projects is continuously delayed mainly due to State's difficulties in maintaining a constant flow of the substantial funding required. Consequently, the extensive technological modernization instead of being perceived as a required stage of the company's development tends to be understood as the objective of the enterprise.

The emphasis on engineering projects as well as other reasons associated with state ownership have historically influenced the development of the organizational structure.

Specific criteria for the assessment of the performance of the enterprise have not been set up by the state/owner. The enterprise is mainly judged on the magnitude of the annual deficit it constantly produces and on its contribution in the achievement of national development goals, to be demonstrated by the each time ruling party, in terms of investment in infrastructure.

12.4. ON THE DESIGN AND REDESIGN OF THE SURVEY

12.4.1. Chapter 8: Realisation of the Limitations of Beer's Model

A preliminary study of the specific railway enterprise was undertaken in *Chapter 8*, aiming at facilitating the design of the survey concerned with the identification of the actual VSM by:

diagnosing principle causes of ineffectiveness in the formal structure; and

deciding whether the survey layout would be based on a functional or regional interpretation of the organization.

The material for this study has been provided both by the documentation supporting the formal organization and by the author's participation with the company over a long period. The subsequent detailed description has demonstrated the influence of the non-rational organization on the performance of the enterprise. However, though it might be argued that constraints are imposed upon the mental states and actions available to individuals by an inadequate formal organization, *Chapters 7 and 8* demonstrated that this structure is, in turn, the product of a culture, reflecting both the historical development of the enterprise and certain features of public ownership. Some limitations of the VSM methodology, as initially perceived, became apparent and were summarised in the following dilemma:

if all information required for a proper identification of the VSM of the enterprise, i.e., accountability for activities as well as information flows, has been collected; and

if, consequently, a detailed analysis of this material has been undertaken, that is, the actual VSM has been set up, and the faults and weaknesses of the organizational structure have been demonstrated,

is the emerging picture of the enterprise adequate ?

If, further, the enterprise adopts the recommendations of this study concerning organizational structure, and proceeds in an organizational rearrangement,

is there a guarantee that the enterprise will, thus, become more efficient and effective ?

12.4.2. Chapter 9: Ineffectiveness as an Argument of Structure and Culture

Probably, the answer to the above question is no, because though the VSM deals explicitly with the organizational structure, it implies an organizational culture which is neither readily recognisable by someone utilizing the model, nor set as a prerequisite to its application. Beer (1985) has, somehow, acknowledged the fact:

"Please do not expect this brief manual to reflect on matters of psychology, of social anthropology, of industrial relations, and so on. It is not that they are excluded, not that I disregard them. A lot is implicit in this book that derives from these fields; and even I have written about them in detail elsewhere. But we cannot tackle everything at once".

The perceived limited capacity of the model, in its adopted functional version, to account for all assumed major causes of ineffectiveness dictated a modification of the design of the survey. The recursive structure of the enterprise, as set up in *Chapter 6* and examined in *Chapter 8* as well as the resulted set of managerial activities at various levels and areas would assist in obtaining managerial responses enabling the identification of the actual organization. Thus, structural causes of ineffectiveness would hopefully become apparent.

However, a certain methodology should develop, in order to assist a more comprehensive understanding of the specific organizational culture which, nevertheless, could partially and indirectly derive from an interpretation of the specific structural arrangements. As

discussed in *Chapter 9*, the culture of the enterprise was expected to be reflected in survey responses on questions concerning:

- the reason(s) of the company's existence;
- specific goals to be sought;
- the internal character of the enterprise (planning, budgeting, participation);
- the assessment of the performance of the enterprise;
- the reasons constraining performance improvement; and
- the methods to be employed in order to improve performance.

12.5. ON THE CAUSES OF INEFFECTIVENESS IN THE STATE-OWNED RAILWAY

12.5.1. Chapter 10: Diagnosing Structural Causes of Ineffectiveness

The VSM analysis of the enterprise, both in its preliminary (*Chapter 8*) and survey phase (*Chapter 10*), identified certain origins of poor performance in the inappropriate organizational structure. Many of the diagnostic prescriptions contained in the VSM literature and discussed in *Chapter 4* proved to hold. The need for an organizational redesign seems to be vital.

However, though the rationale of the cybernetic model implied both a structural and cultural redesign, this was not explicitly provided in the VSM diagrams. An impression might be gained that by restructuring the organization the problems would be resolved. Though such an approach constitutes an abuse of the model, the model could not resist this abuse. The final part of the project dealt, therefore, with the organizational culture under the impression that unless an appropriate culture existed, any structural redesign, however sophisticated, would result in limited improvement.

12.5.2. Chapter 11: The Impact of Culture on Effectiveness

Within this thesis, fundamental dimensions of a certain organizational culture were expected to derive from managerial responses to questions concerning the identity of the enterprise. As the survey sample covered a major part of the managerial structure in the first four managerial levels and all functional areas, a first indication of the existence of a certain culture would derive from the rate of agreement of managers on the specific questions asked. In other words, lesser disagreement would be indicative of the dominance of a certain culture on the human element of the enterprise. This concept of dominance (and, consequently, of minor disagreement) has been defined in this project as managerial cohesiveness. The extent of cohesiveness provides the indication of the dominance of a certain culture. The content of this cohesiveness characterises the culture.

In general, the managerial structure of the case-study enterprise, either examined as whole or in terms of managerial age, level, or function, proved cohesive. That is, a dominant culture existed.

However, the examination of the content of this agreement was indicative of a common-belief in the non-feasibility of change rather than of a shared perspective of a positive nature.

12.5.3. Conclusions

The example in this thesis has demonstrated that major causes of ineffectiveness of a state-owned railway are rather associated with the 'public enterprise' than with the 'functional' characteristic. Any attempt to tackle ineffectiveness should, therefore,

reexamine the state/enterprise relationship. In Western Europe, this reexamination seems to result in a tendency for state-owned railways operating under strict 'commercial criteria' and producing social services at an extent and a cost negotiated and, finally, decided at a higher level of recursion. The financial remuneration for any sort of social service produced by the railway is an obligation for the State. The normalised railway accounts should reflect this remuneration. Besides this arrangement, the enterprise should be freed by constraints and allowed to operate as an autonomous undertaking.

However, the way in which a State/Railway relationship of this kind should be achieved will be ultimately decided by the State. Therefore, the solution of structural and cultural organizational problems to a large degree is not in the hands of the enterprise.

As regards the case-study enterprise, there are not significant indications that an intention to reexamine the details of this relationship really exists. Therefore, it would be rational to assume that significant improvement of the performance should not be expected, or that any improvement would be achieved at a disproportionate cost.

12.6. ON THE USEFULNESS OF THE MANAGEMENT CYBERNETICS MODEL

In *Chapter 1*, three requirements were set against which the usefulness of an organizational model could be judged:

- (1) the model should serve the '*technical interest*', by providing principles which can become the basis for an efficient and effective design of goal-seeking systems;
- (2) the model should also seek to support the '*practical interest*', by facilitating debate about purposes and providing mechanisms through which genuinely shared purposes can emerge; and
- (3) the model should support the '*emancipatory interest*', by permitting reflection on whose purposes are actually served and how purposes are in fact derived.

This final section of the thesis concludes on the evaluation of Beer's Model of the Viable System against these requirements.

12.6.1. VSM and the 'Technical Interest'

The first requirement against which the validity of the model should be judged, is whether it provides principles which can become the basis for an efficient and effective design of goal-seeking systems, in this case railway enterprises.

- (1) A first advantage of the model which has already been discussed in this chapter, is its generality. The model is set up in a way which does not imply a particular structure. It is concerned with what defines a system and enables it to maintain its identity, rather than with the various relations between components integrating particular parts of the organization. The applicability of the model at alternative 'recursive dimensions' is an important feature deserving to be tested in practice. That is, studies of one organization in alternative recursive dimensions should be undertaken to demonstrate whether fundamental characteristics (for example, components of Checkland's methodology "*root definitions*") are filtered out or underestimated when adopting a certain '*recursive dimension*'.

- (2) The model has also the ability to deal with organizations possessing parts which are both vertically and horizontally interdependent. The enterprise modelled in this thesis offers a good example, since it contained parts integrating both horizontally (regionally) and vertically (functionally). The elimination of the regional structure in the revised model of the enterprise (in the light of the survey findings) should not be considered as either a weakness of the model or a misuse, since it exactly corresponds to the way in which the management of the enterprise decided to cope with the centralization versus decentralization issue. Railway enterprises may exist in even more than two organizational dimensions, as the recent example of BR demonstrates (regional, functional and product structures), and be modelled in terms of the VSM, according to the command, co-ordination and control chains which will be entered in the model.
- (3) Another advantage of the model's structure is the use it makes of the notion of recursion. The recursive structure of the model, apart from facilitating its use in systems and subsystems within the enterprise, introduces the concept of subsystemic autonomy in such a clarity that in some way obliges the management of a wider system to recognise both the prerequisites and the consequences of any decision it makes regarding the distribution of managerial power within the system. Especially in public interest state-owned enterprises, where the pursuit of profitability does not serve as the explicit major objective of the enterprise and where people, mainly at middle and lower managerial levels are largely freed from the "fear of the boss", the limitations in autonomy and managerial discretion of subunits are to a large degree responsible for the loss of any interest in the job and for the consequent deterioration of systemic performance. It is arguable whether any other conceived organizational model makes this truth more explicit, and in terms as easily conceived as the information processing capacity of the average human brain. Though, probably, no one in the enterprise can work out the exact size of this capacity in bits/sec, it is well understood that hardly any manager can satisfactorily fulfill many of the requirements imposed on him arbitrarily by the formal organization chart.
- (4) By emphasising the autonomy of the subsystems and by suggesting allocation of discretion to the units which 'produce the company', VSM offers also a rational explanation for the metasystemic role of coordination, control, intelligence and policy functions. In the case-study, the continuous involvement of almost everyone in day-to-day operational matters, apart from not at all assisting in the improvement of operational performance, has been shown as resulting in the reduction of the capacity to coordinate and control, and, even more, to plan for the future or to produce policy. More rationally organised enterprises do exist. However, many examples of the violation of subsystemic autonomy may be identified within anyone's environment.
- (5) The model offers also a representation of the organization in close interrelationship with its environment. Though this capacity of the model was not utilized in the VSM diagrams of *Chapter 10*, because emphasis was placed there in the internal structure, subsequent information flows diagrams in *Appendix E* illustrate both the actual interactions with the environment and the type of these interactions. On the example, the company does not seem to control the future, because, though extended over a whole country, it seeks to interact with its environment almost exclusively at the first level of recursion, i.e., at headquarters level. Further, this interaction does not prove effective, as basically it is not understood as related to fundamental components of the environment such as customers and competitors.

The application of the model within this thesis has demonstrated its value as a diagnostic tool. The rationale of the model could equally apply both to the whole of the enterprise and to an information flow (homeostatic loop) between any pair of organizational or environmental units. It can, therefore, be argued that the Viable

System's Model provides a useful management tool that may be successfully employed in the service of the 'technical interest', that is, in order to identify and to propose specific improvements in the functioning of an organization.

However, as already stated, this was only possible after deciding on the '*recursive dimension*'. As Jackson (1988) puts it, "*in terms of Checkland's (1981) 'soft systems methodology', applying the VSM amounts to taking one out of the multitude of possible perceptions of a system (one 'root definition'), modelling it, and 'diagnosing' the system on the basis of the results obtained*". In Chapter 4, when discussing critiques to Beer's model, it was noted that according to Checkland (1980), any enterprise set up to carry out some purposeful activity may in part be regarded as a machine. But since its components can attribute meaning to their situation, it will have to be regarded as many other things as well: social grouping, appreciative system, power struggle.

As discussed in Chapter 3, a difference between the cybernetic view of the organization and alternative perspectives is that the former, though providing a less rich picture than a detailed descriptive analysis, is more effectively directed towards the promotion of organizational change. It seems therefore that a successful application of the model depends very much upon the choice of the relevant recursive dimension. A recommendation has been offered that modelling of certain organizations at alternative recursive dimensions should be undertaken, in order to further test the validity of the model. This was not done within this thesis, because the insights not directly gained by the construction of the VSM at the functional recursive dimension were sought in the examination of the organizational culture on more traditional grounds.

12.6.2. VSM and the 'Practical Interest'

A further dimension of the model's evaluation examines whether the model facilitates debate about purposes and provides mechanisms through which genuinely shared purposes can emerge.

- (1) It may be argued that the structure of the model itself both demonstrates the necessity for shared purposes and provides mechanisms through which they can emerge, by advocating the need to pay attention to the different functions that the organization has to fulfill. The unfolding of the systemic complexity of the enterprise, in the way shown in Chapter 6, and the systematic association of overall performance with the capabilities of the sub-systems, as discussed in Chapter 4, define feasible purposes and, therefore, facilitate the formulation of shared perceptions and goals. On the example of this thesis, the implication of the lack of such mechanisms has been demonstrated mainly within the first part of the 'managerial cohesiveness' exercise. However, it may also derive from a careful examination of the actual VSM of the company, especially when considering the quality of planning and environment scanning at both subsystemic and systemic levels.
- (2) The same issue, i.e., the promotion of shared purposes, is further advocated by the model in terms of the decentralization of control. The systems ONE of the enterprise are subject to corporate constraints only to the degree required for overall systemic cohesion and viability. This constraint rather than limiting liberty facilitates it, because if less control was exercised, the result would not be greater freedom for the parts, but anarchy. In the extreme, the VSM strongly implies employees' involvement in the determination of overall purposes. This is the only way to convince the parts that the system is serving their purposes and that they are going to benefit by seeking its viability.

However, the model does not possess mechanisms to effectively resist a misuse. That is, though it advocates decentralized control and shared perspective, it may be employed and increase the effectiveness of organizations not possessing these qualities. On the example of this thesis, the increased effectiveness of a national railway system may be viewed as a benefit for the society, in many respects. However, this may not be the case when the effectiveness of social systems, with undesirable characteristics, is increased by the model's application. Two extremely opposite examples of the model's application for the improvement of the effectiveness of social systems with not universally desired characteristics may be offered:

The first refers to the well known application of management cybernetics for the regulation of the national economy on behalf of the socialist government in Chile (*Chapter 4*).

The second refers to the less known example of cybernetic modelling, in VSM terms, of the logistics command of the United States Air Force (Tripp et al., *Chapter 4*).

In general, not many people would find desirable the increased effectiveness of both systems in the examples offered. It is known that the metasystems of these two systems themselves, i.e. the Chilean and the American parliamentary governments, both identified in each other a threat to its own viability. It is also known that this threat became reality for one of them.

12.6.3. VSM and the 'Emancipatory Interest'

The last requirement against which the model should be judged is whether it permits reflection on whose purposes are actually served and how purposes are in fact derived. The model may not be viewed as satisfying this requirement.

Within this thesis, in the parts dedicated to a VSM analysis of the enterprise, i.e., mainly in *Chapters 8 and 10*, a deliberate attempt has been made to provide explanations of situations only in terms of the model's principles. Thus, in general, most justifications have been offered in terms of the variety handling capacity, and this is very obvious in the 3-4-5 metasytem analysis of the ethnographic study. Since variety, as discussed in *Chapter 3*, is just an information-theoretic measure of complexity, it refers, as pointed by Ulrich (1981), to *"the number of distinguishable states that a system or its output can assume at the syntactic level"*. This kind of explanation leads, probably, to the view that 'good' management is the one that establishes requisite variety between itself and the operations and between the enterprise and the environment, and nothing more. This view is not compatible with the previous discussion, i.e. that good management must also be concerned with the nature of the purposes served and the meaning and significance of these purposes for the participants in the enterprise.

Jackson (1988) argues that the substitution of a '*semantic-pragmatic*' criterion of good management by a '*syntactic*' one, as discussed by Ulrich (1981), is general throughout cybernetics and seriously constrains theoretical development and practical relevance. He suggests that the formulation of a '*semantic-pragmatic*' criterion of good management has to be achieved outside cybernetics, because *"only on the basis of the meaning and significance of purposes for concerned individuals can decisions be taken which impose limitations on their autonomy"*.

The inadequacy of the model to satisfy this third requirement does not imply that within traditional management the issue is tackled in a way promoting the '*emancipatory interest*'. In the example of the railway enterprise, the problem of how much autonomy to grant to the parts is resolved as a matter of 'managerial' convenience, at the top of the enterprise.

12.6.4. Overall Assessment

Certain advantages and shortcomings of the model have been demonstrated by its application in this thesis. The overall conclusion may be that though successfully covering a major part of the organizational reality the model places the source of viability of an organization in its structural arrangements rather than in its corporate culture. A danger exists, that attempts to implement recommendations for change stemming from a thus partial understanding of the enterprise may indeed lead to more undesirable consequences. Therefore, certain methodologies should develop which, while making use of the advantages of the model, will be able to improve its deficiencies. Within this thesis, an example of a methodology of this kind has been offered in terms of the analysis undertaken in *Chapter 11*, aiming at assessing organizational culture by interpreting managerial answers to questions concerning the identity of the enterprise. It was shown that it is more likely for an organizational problem to be of a cultural origin and not the other way round. However, a proper tackling of cultural problems inevitably involves organizational redesign. To this end the Viable System's Model makes a unique contribution.

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An Evaluation of Management Cybernetics
in a Public Enterprise

Volume 2:
Appendices

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APPENDIX A

ELEMENTS OF BEER'S MODEL OF THE VIABLE SYSTEM (VSM)

A.1. ICONIC REPRESENTATION - DIAGRAMMATIC CONVENTIONS

The model consists of five elements (Systems ONE to FIVE), which can be labelled implementation, co-ordination, operational control, intelligence and policy. ¹

Figure A1 depicts the iconic representation of the model of any viable system. The five interacting subsystems are labelled ONE, TWO, etc. In the figure two Systems ONE are shown (there could be more), each of which contains a complete viable system displayed at a 45 degrees angle.

The whole-page viable system is shown as interacting in a precisely defined way with its environment, through its Systems ONE and System FOUR, and not otherwise. In the same way, the embedded viable systems are shown as interacting in exactly the same way with local environments, that are specific to each of them, although they are (inevitably) subsets of the total environment.

Beer stresses that the topology of recursion demands an exact replica in each case. In the iconic representation (*Figure A1*) the only discrepancy is that in the second System ONE, the connection between its System 4 and its sub-environment has not been completed, for obvious graphical reasons.

Whenever a line appears that is delimited at each end by a dot, a homeostatic relationship is intended. That is, each of these lines stands for a pair of arrows (homeostatic loop). Two directional arrows in the environmental areas also indicate homeostasis. Beer (1979) argues that to each of these homeostats (which, practically, are hundreds in any viable system concerned) the following principles of organization must apply:

The first principle of organization:

Managerial, operational and environmental varieties, diffusing through an institutional system, tend to equate; they should be designed to do so with minimum damage to people and to cost. ²

The second principle of organization:

The four directional channels carrying information between the management unit, the operation and the environment ³ must each have a higher capacity to transmit a

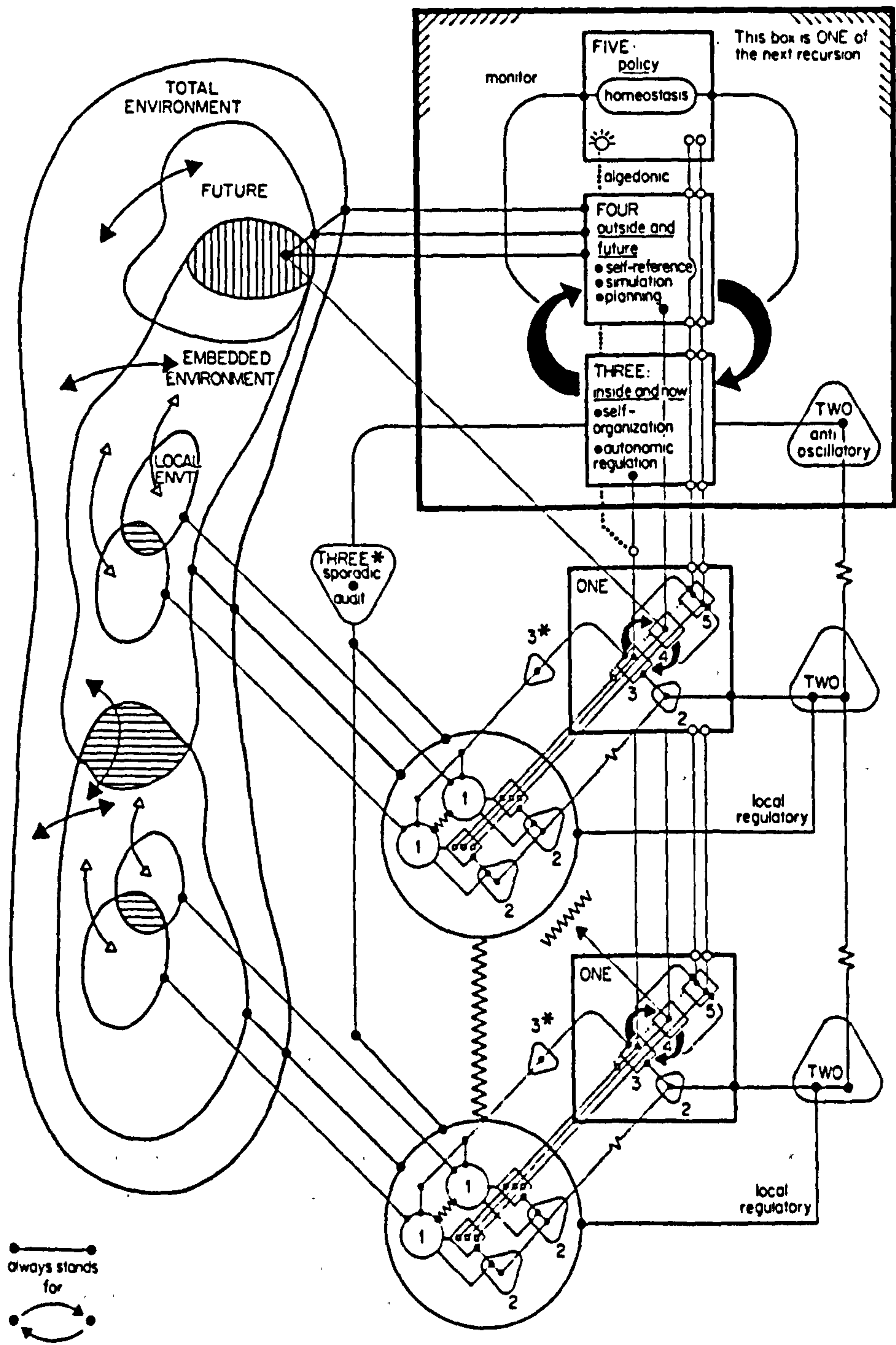


Figure A1: Beer's Model of the Viable System (VSM)

given amount of information relevant to variety selection in a given time, than the originating sub-system has to generate it in that time. ⁴

The third principle of organization:

Wherever the information carried on a channel capable of distinguishing a given variety crosses a boundary, it undergoes transduction; the variety of the transducer must be at least equivalent to the variety of the channel. ⁵

The fourth principle of organization:

The operation of the first three principles must be cyclically maintained through time without hiatus or lags. ⁶

A.2. THE ORGANIZATION OF THE VIABLE SYSTEM

A.2.1. System ONE

The first sub-system of any viable system, according to Beer, consists of those elements that produce it. These elements are themselves viable systems. Systems of increasing complexity are nested within each other to produce the whole. Hence Beer's theorem of recursion: *"In a recursive organizational structure, any viable system contains, and is contained in, a viable system"*. ⁷

Beer (1985) insists that systems ONE are producers of the organization and not just adjuncts to it, however important. ⁸

According to Beer, the beginnings of a theory of autonomy and de-centralization lie in the fact that the management of the Viable System under study (the Senior Management) is, in principle, unable to entertain the variety generated by any one of its subsidiary viable systems that constitute System ONE.

The fundamental variety balancers in a modern organization, shown diagrammatically in *Figure A2*, are:

Legal and Corporate Requirements, i.e. variety attenuators that signify the identity of subsidiaries as corporate entities.

The Resource Bargain, i.e. the 'deal' by which some degree of autonomy is agreed between the Senior Management and the Systems ONE. The homeostatic loop sketched in the diagram indicates that a dynamic process is involved. It is essentially attenuative because it excludes a huge range of alternatives. However, in some instances it can provide amplification (e.g., by superior knowledge or unexpected financing).

Accountability, i.e. responsibility for resources provided in terms of variety engineering. ⁹

Management in System ONE is charged with conducting its operations according to a Resource Bargain agreed with Senior Management. Then the transmission of plans, programmes and procedures to the operational circle should be regarded as an act of regulation.

This regulation,

- amplifies managerial variety (the basic details of the Resource Bargain must be elaborated);
- attenuates operational variety (operational variety must be harnessed to agreed objectives).

Thus, the Regulatory Centre, the activities of which are marked diagrammatically by a triangle, is the focus of homeostasis between management and operations.

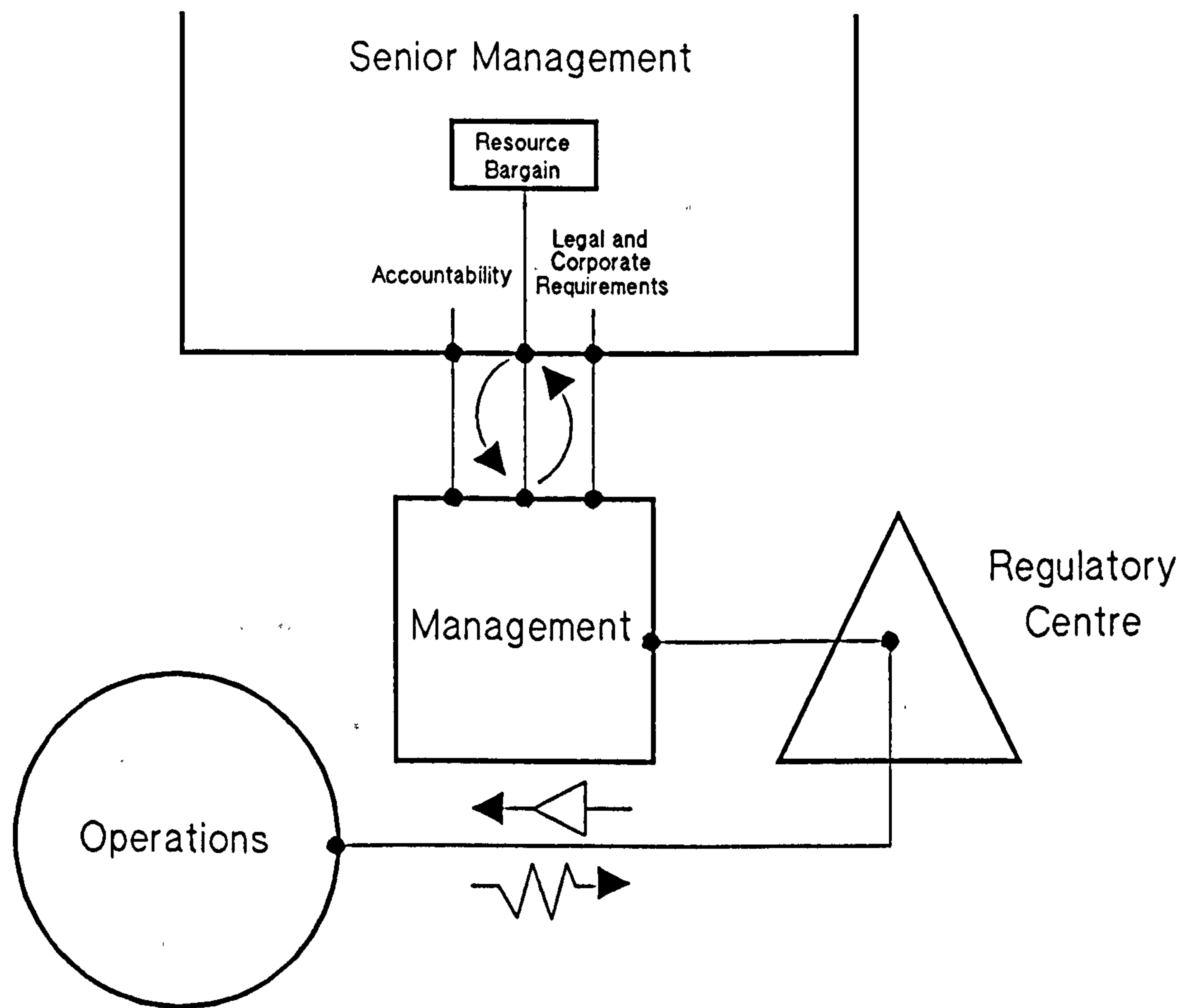


Figure A2: Fundamental Variety Balancers

A.2.2. System TWO

System TWO is the viable system's anti-oscillatory device for System ONE. Beer (1985) argues that it is almost totally misunderstood and under-represented in contemporary management technique. *"It is always present, or the organization would shake itself to pieces. But because it is not properly handled, enterprises come very close to disintegration"*. 10

The maintenance of balance in Systems ONE is threatened by the disbalance induced by inter-elemental oscillation, which the Senior Management does not command the Requisite Variety to resolve by dictat on the central axis.

System TWO does not lie on the central command axis. Its function is not to command, but to damp oscillations.

System TWO is the Regulatory Centre for the Viable System under study. Unlike the regulatory centres on the horizontal axes of Systems ONE, it is in touch with System ONE as a complete entity.

Each System ONE is served by more than one System TWO (or System TWO has more than one functions), because there are always several oscillatory sources. System TWO depends on Senior Management, since it deals with the whole of System ONE.

Figure A3 focuses on the functions and the relationships of System TWO.

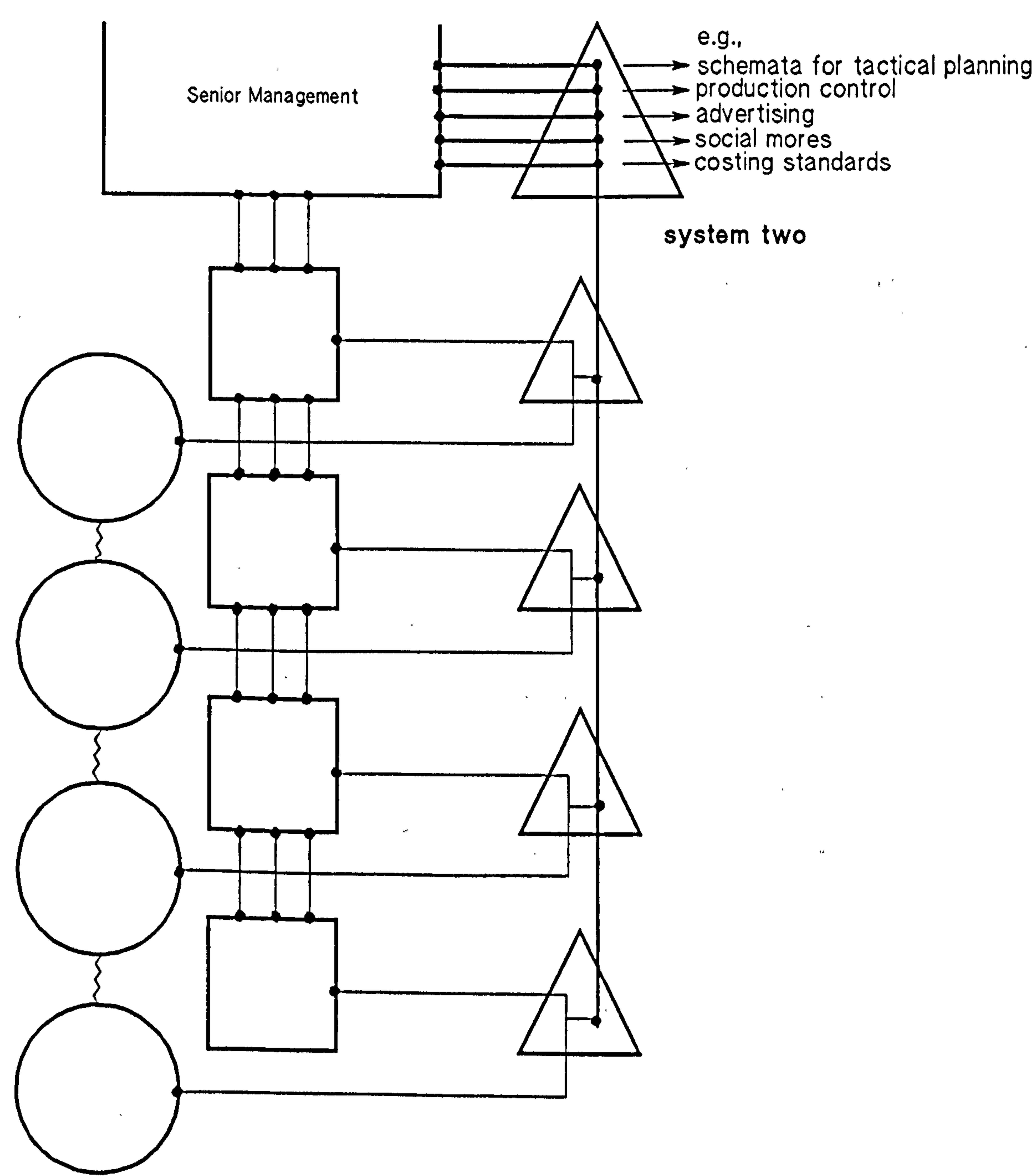


Figure A3: System TWO: Anti-Oscillatory

A.2.3. System THREE-*

Up to now, five vertical channels have been mentioned:

- the Corporate Intervention (Legal & Corporate Requirements),
- the Resource Bargain,
- Operational (sqiggly-line) linkages,
- Environmental intersects, and
- System TWO (anti-oscillation).

All of them are filters of variety, from which the first, the second and the fifth have been specially designed to filter management information.

A danger exists that what the management most needs to know is filtered out (by the use of totals, averages and so on).

Beer (1985) argues that *"poor managements, having too little insight or training, or suffering from 'corporate paranoia' that has them feeling constantly threatened, disregard the filters, and try to restore Requisite Variety on the central axis. That is, they disregard the resource bargain (where in principle the homeostatic message upward needs to be only 'OK'), and invigilate the horizontal activities with all the zeal of an Inquisition".* ¹¹

There is a whole set of acceptable management practices that do not involve this centralisation of manifest power, which (properly designed) are capable of generating enormous variety. Such mechanisms work sporadically and (by agreement with System ONE management) penetrate straight to the operations themselves. These procedures, which may generically be called 'audits' constitute the System THREE-* (three-star).

System THREE-* is depicted in *Figure A4* as the sixth vertical channel.

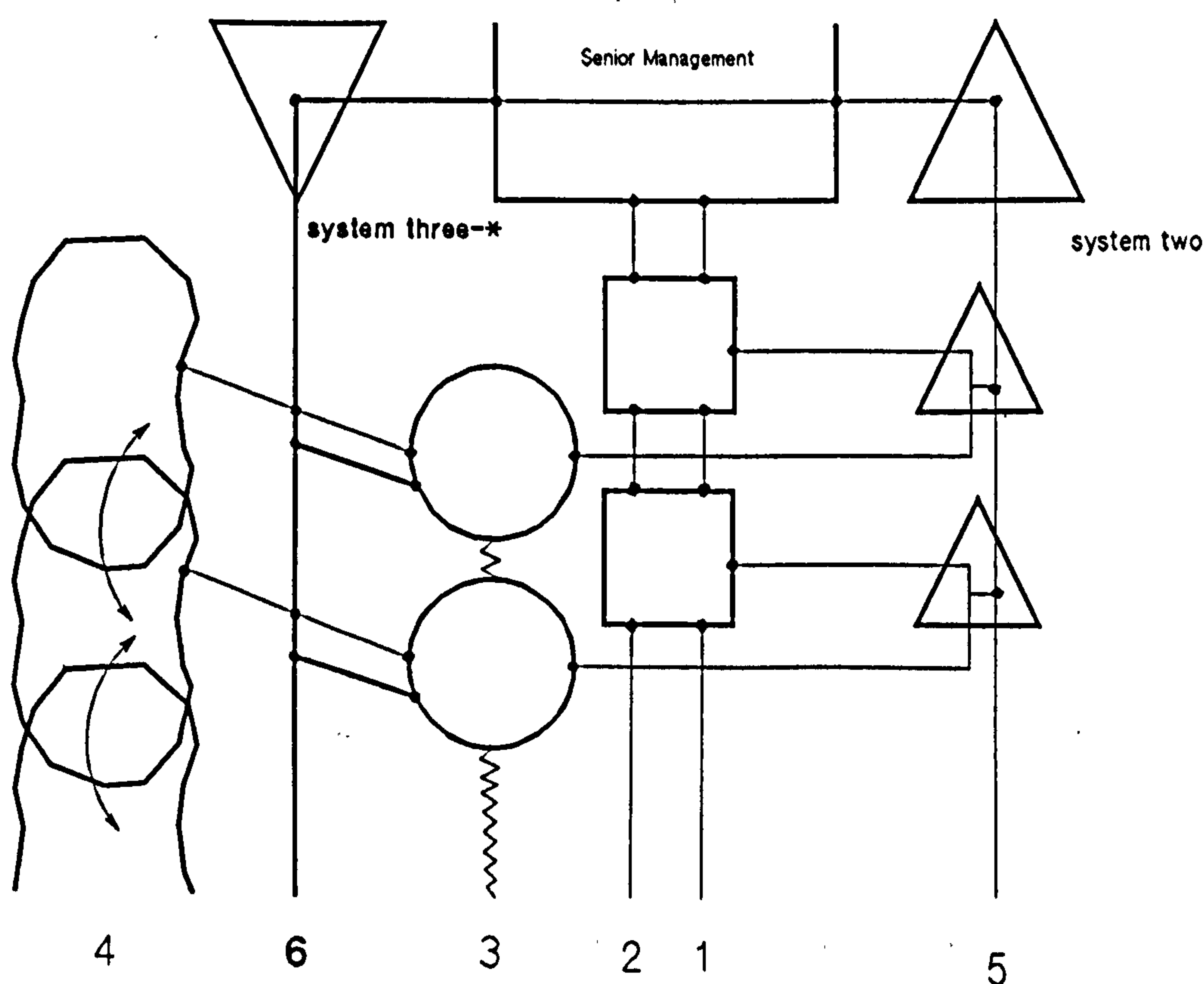


Figure A4: SystemTHREE-*: Sporadic Audit

A.2.4. System THREE

Beer (1985) states that, in discussing the viable system, the notion of hierarchy cannot be altogether escaped, although the whole analysis constantly reveals the equivalent importance of the five major sub-systems. The reason is the existence in all viable systems of an equation of power. *"The will for survival seems to be what governs this situation. And whether we look at animals, in which the brain 'commands' the nervous system and (in man at least) 'masterminds' the will to survive, or at social institutions, acknowledged hierarchies emerge".* ¹²

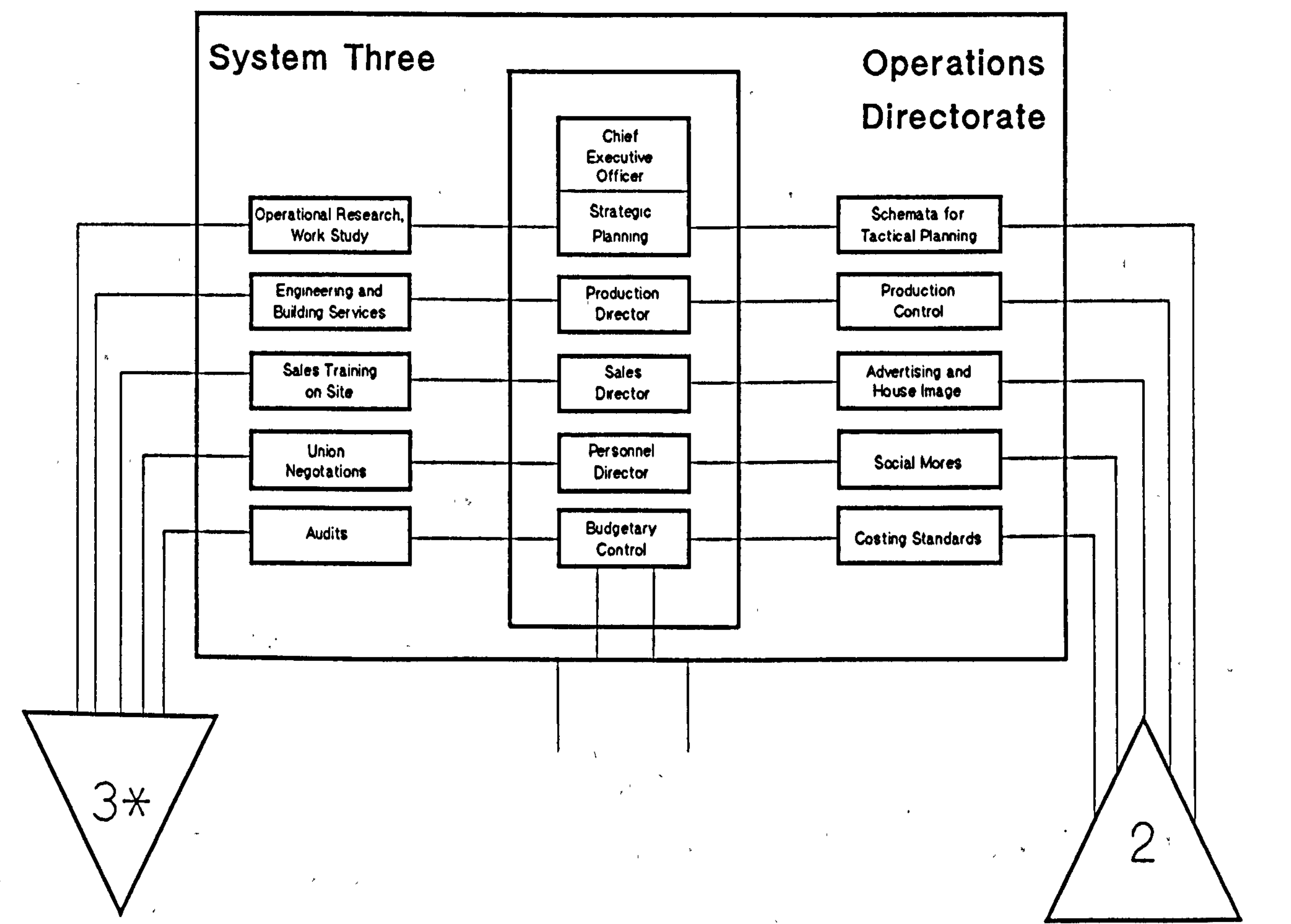


Figure A5: System THREE and its Supportive Management

It has been shown that:

System ONE and not 'Senior Management' produces the viable system.

A System TWO would be needed to damp the oscillatory behaviour, inherent in the structure of System ONE.

Then, the role of System THREE is to observe the ONE-TWO complex. This role is a necessary condition for viability, and is graphically depicted in Figure A5.

Beer (1985) argues that feelings of oppression are very real when System's ONE variety so much needed to provide requisite variety on the horizontal axis is, or even feels as if it is, wholly absorbed by System THREE. In such case, it would be better to replace the System ONE management by a computer, because it is not free to face variety with its own creative variety, but has to pretend that the 'world' is really the outcome of a simple formula. *"And this is just what is happening -from the management of the economy, to the lack of choice in consumer goods- in contemporary Western society".* ¹³

Beer's definition of autonomy derives from this relationship between Systems ONE and THREE:

When we know what is the purpose of the system, which is, what the system does,

after convergence between System THREE
and System ONE (Strategic Planning),

then we may also know the criteria for distinguishing possible states, i.e., how to measure variety.

This will then tell us how much variety the First Axiom ¹⁴ must necessarily handle,

and it will determine the minimum variety on the vertical command axis transmitting regulation that guarantees cohesion in the viable system.

Autonomy means the freedom remaining to the management on the horizontal axis to manage. ¹⁵

Beer calls the part of the viable system studied up to know, i.e. the 3-2-1 of the viable system, 'autonomic management' of the organization. They are capable of optimising the productive performance of the enterprise within an established framework and maintaining internal stability without reference to higher management levels. Autonomic management does not, however, possess an overall view of the organization's environment and is therefore incapable of reviewing corporate strategy and reacting to threats and opportunities in the organization's environment. This is where Systems FOUR and FIVE come in.

A.2.5. System FOUR

System THREE has been discriminated as responsible for inside-and-now. System FOUR deals with the outside-and-then. System FOUR provides also self-awareness for the viable system. In order to do that, System FOUR must hold a model of itself embodied in a model of the whole viable system (*Figure A6*).

Thus:

The account of the inside-and-now is filtered upward via System THREE.

The System FOUR model of itself arrives in a model of the whole of System FOUR.

System FOUR of the viable system contains a model of that System FOUR, which contains a recursive model indefinitely.

It is just the infinite regression of self-images that seems to hold the key to the characteristic self-awareness of viable systems. ¹⁶

Beer argues that the **THREE-FOUR** homeostat (depicted by two arrows in *Figure A7*) must also obey the four principles of organization. From the first principle of organization, referring to the equation of variety (*para.A.1*) and the first axiom of management, which is a measure of variety in System **THREE** (*para.A.2.4*), derives the following second axiom of management, concerning the **THREE-FOUR** homeostat:

The Second Axiom of Management:

The variety disposed by System **THREE** resulting from the operation of the First Axiom equals the variety disposed by System **FOUR**. ¹⁷

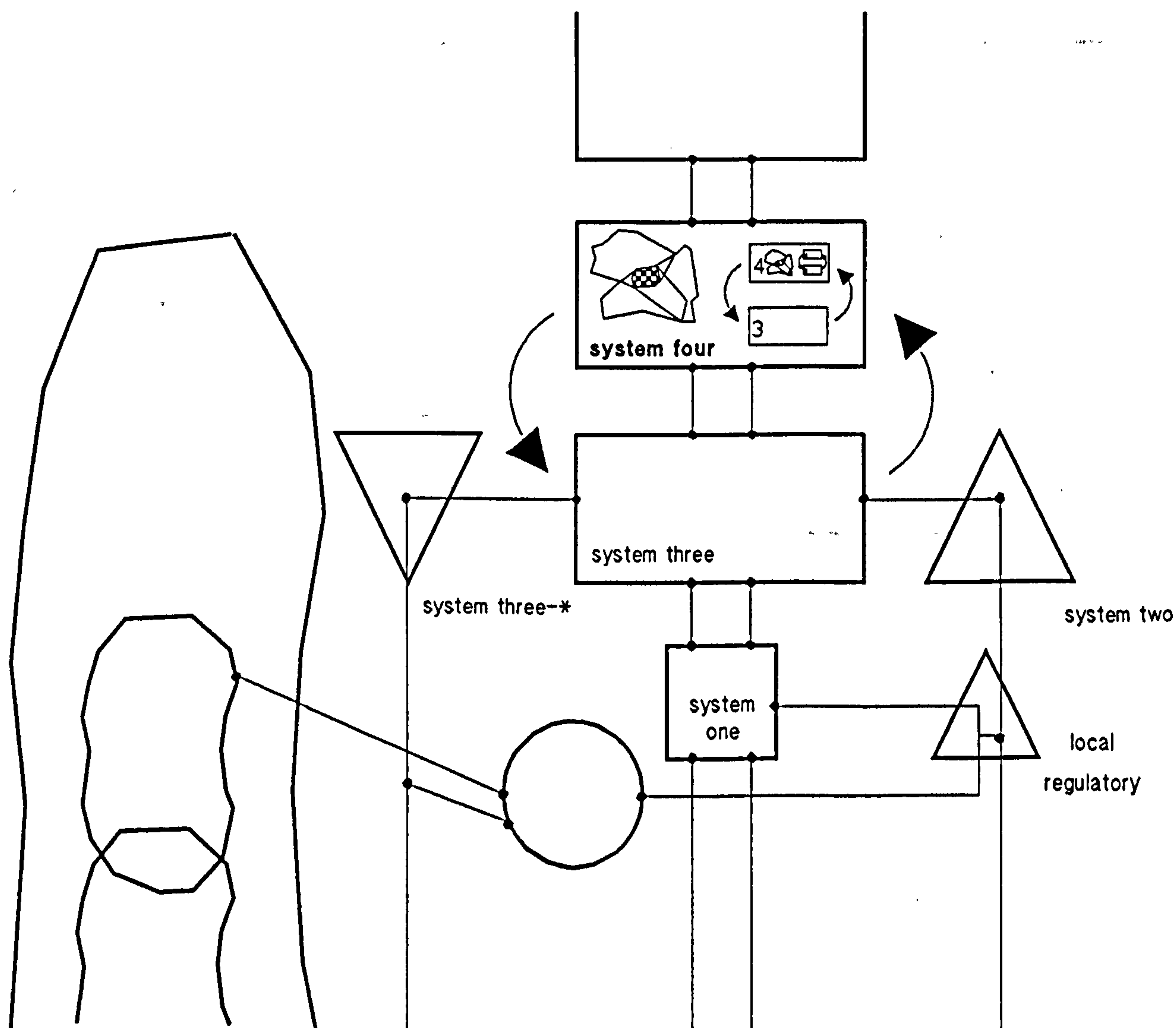


Figure A6: System FOUR: Outside-And-Then

A.2.6. System FIVE

The main functions of System **FIVE** are:

to supply logical closure to the viable system; and

to monitor the **THREE-FOUR** homeostat (*Figure A7*).

The system 3-4-5, dealing with the future, is metasystemic to 3-2-1, hence the phenomenal greater significance of System THREE, as belonging both to the autonomic management (3-2-1) and the metasystem (3-4-5).

Beer argues that even in these days, when a less authoritarian image of management is promoted, mainly by behavioural science, the 'boss' still exists. The heads of enterprise do preserve certain rights of decision.

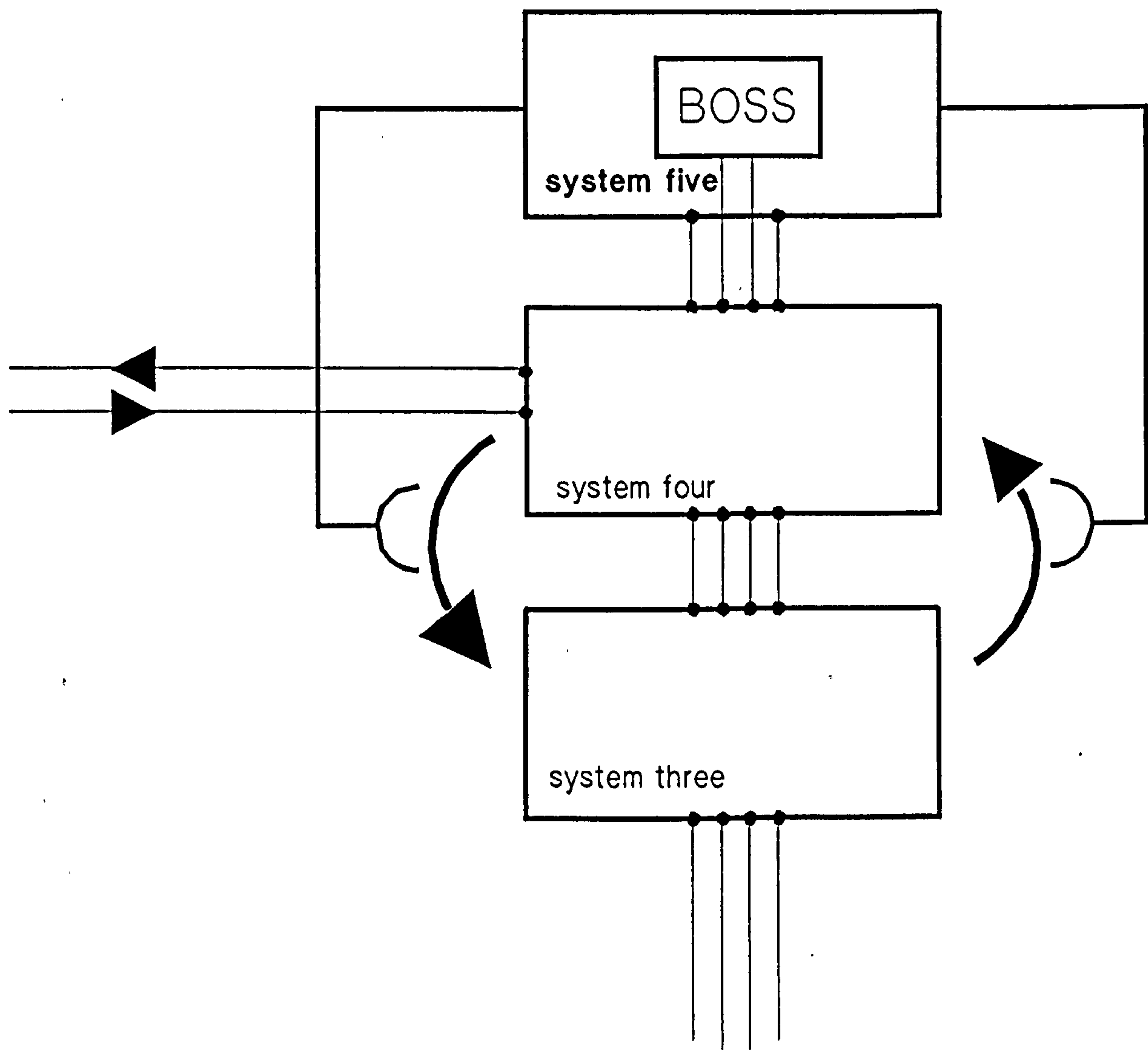


Figure A7: System FIVE: Monitoring the THREE-FOUR Homeostat

Discussing System FIVE, Beer (1985) introduces the concept of 'ethos': "*Ethos is a variety sponge of gigantic capacity*".¹⁸ The 'variety sponge' at System FIVE is 'mopping up' the variety that the homeostasis of ONE-THREE and THREE-FOUR will not have accounted for. Hence the third axiom of management:

Third axiom of management:

The variety disposed by System FIVE equals the residual variety generated by the operation of the Second Axiom.¹⁹

System FIVE 'masterminds' a metasystem called 3-4-5, the outside-and-then management. By shifting the set of recursions one level up, the metasystem 3-4-5 becomes System ONE of the new Viable System. This leads to the Law of Cohesion:

The Law of Cohesion (for multiple recursions of the viable system):

The System ONE variety accessible to System THREE of Recursion x equals the variety disposed by the sum of the metasystems of Recursion y , for every recursive pair. ²⁰

A.3. FOOTNOTES

1. R. Espejo and J.Watt, 1979: "Management Information Systems: A System for Design", *Journal of Cybernetics*, vol.9, pp.259-283.
2. S.Beer, 1979: page 97.
3. Throughout the iconic representation of VSM, a management unit is depicted by a square, operations by a circle and the environment by an amoeba shape.
4. S.Beer, 1979: page 99.
5. S.Beer, 1979: page 101.
6. S.Beer, 1979: page 258.
7. S.Beer, 1979: page 118.
8. *"While the profit centres produce the company, cost control, quality control, management inventory, stock control, all these are obvious examples of homeostatic regulation, and financial accounting generates the balance sheet after all".* (S.Beer, 1985: *Diagnosing the System for Organizations*, Wiley, Chichester, page 9).
9. S.Beer, 1985: pages 37-41.
10. S.Beer, 1985: page 66.
11. S.Beer, 1985: page 82.
12. S.Beer, 1985: page 91.
13. S.Beer, 1985: page 97.
14. The first axiom on management: *"The sum of horizontal variety disposed by n operational elements equals the sum of vertical variety disposed on the six vertical components of corporate cohesion".* (S.Beer, 1979: page 217).
15. S.Beer, 1985: page 102.
16. S.Beer, 1985: page 116.
17. S.Beer, 1979: page 298.
18. S.Beer, 1985: page 125.
19. S.Beer, 1979: page 298.
20. S.Beer, 1979: page 355.

APPENDIX B

GREEK RAILWAYS: ORGANIZATIONAL INFORMATION

The appendix contains:

- Organization charts of the under study enterprise illustrating changes in the period from 1965 up to now (*Figures B1 to B4*). This material is mainly discussed in *Chapters 7 and 8*.
- Recent information on the distribution of employees (*Table B1*) and managers (*Table B2*) within the various parts of the company (*Chapters 7 and 9*).
- Organization charts indicating survey sample within the company (*Figure B5*) and interviewed members of the survey sample (*Figure B6*), as discussed in *Chapter 9*.

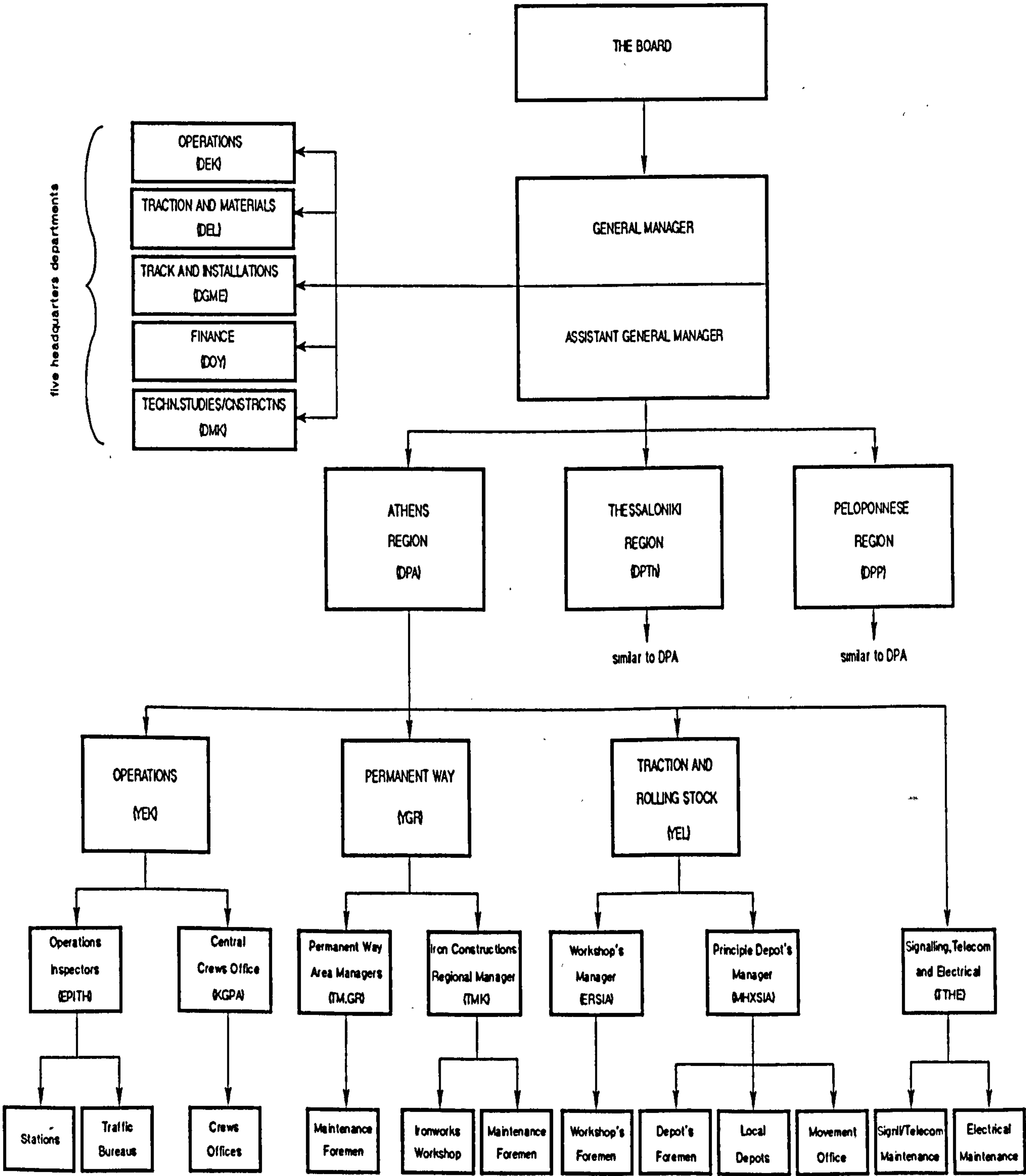


Figure B1: Organizational Structure of Greek Railways (OSE), 1965

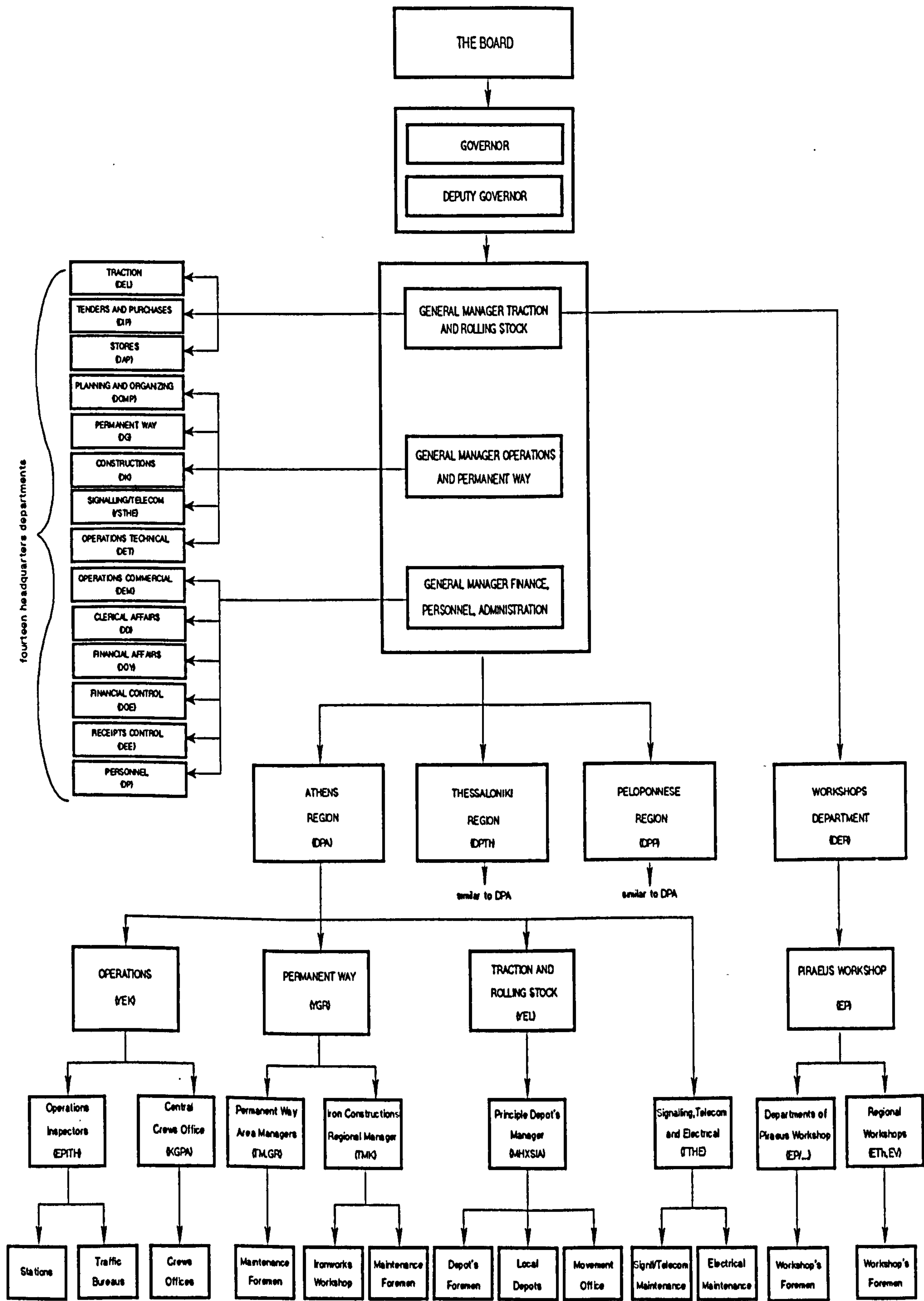


Figure B2: Organizational Structure of Greek Railways (OSE), 1980

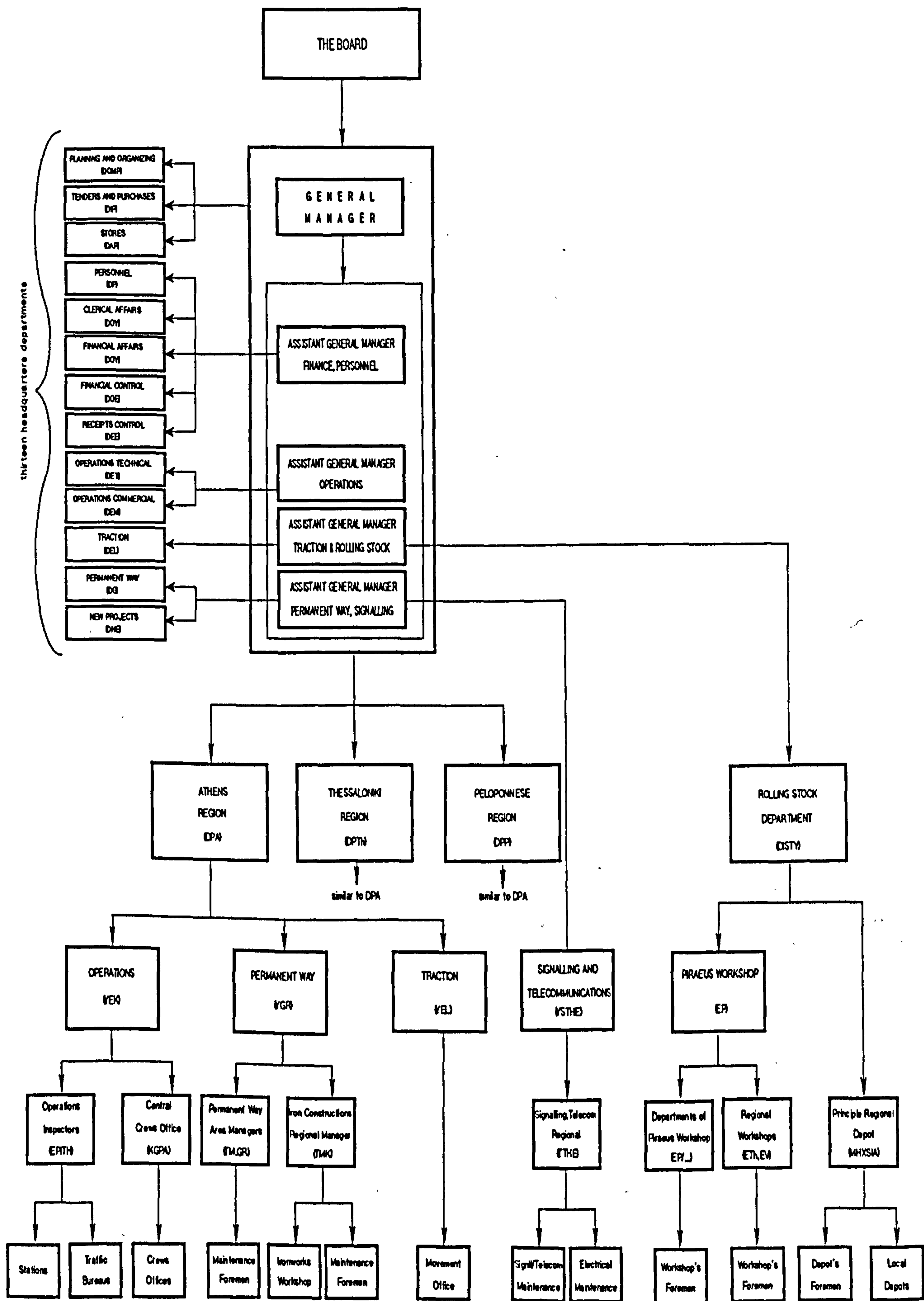


Figure B3: Organizational Structure of Greek Railways (OSE), 1988

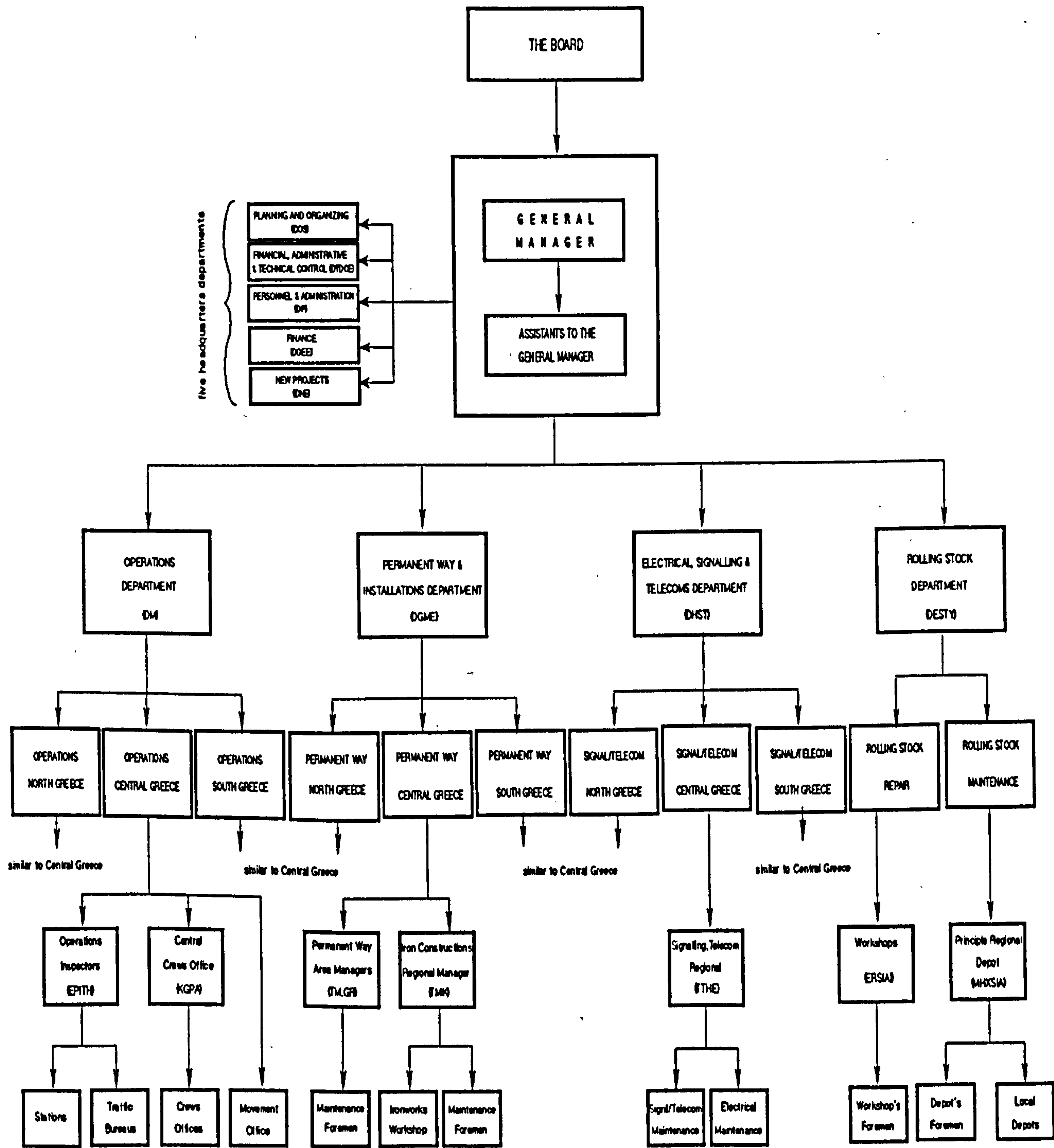


Figure B4: Organizational Structure of Greek Railways, to be introduced in 1989

Department	number of employees		Percentage within		
	Headquarters	Production	Headquarters	Production	Enterprise
DOMP	116		13.20	-	0.94
DEL	14		1.60	-	0.11
DET	25		2.84	-	0.20
DEM	37		4.20	-	0.30
DG	40		4.55	-	0.32
DNE	16		1.82	-	0.13
DOY	111		12.63	-	0.90
DOE	16		1.82	-	0.13
DEE	109		12.40	-	0.88
DIP	51		5.80	-	0.41
DAP	222		25.26	-	1.79
DP	42		4.78	-	0.34
DD	80		9.10	-	0.65
DPA		3 231	-	28.09	26.09
DPT _h		3 480	-	30.25	28.10
DPP		2 746	-	23.87	22.17
DER (DISTY)		1 482	-	12.88	11.97
YSTHE		218	-	1.89	1.76
YA		348	-	3.02	2.81
total: 12 384	879	11 505	100.00	100.00	100.00

Notes: 1. 1982 data.

2. Rolling Stock Maintenance (Depots) personnel is included in Regional Departments, where it belonged at that time.

Table B1: Greek Railways (OSE): Number of Employees by Department

unit	managerial level				total
	1	2	3	4	
	Top Management	Departments	Divisions	Area Units	
Board	9				9
GM & AGM	5				5
DOMP		1	5	2 *	8
DEL		1	1	2 *	4
DET		1	1		2
DEM		1	2		3
DG		1	3		4
DNE		1	4		5
DPA		1	3	11	15
DPT _h		1	3	11	15
DPP		1	3	9	13
DISTY		1	2	6	9
YSTHE		1	3		4
DOY		1	2		3
DOE		1			1
DEE		1	2		3
DIP		1	1		2
DAP		1	1		2
DP		1	2		3
DD		1	1		2
total	14	18	39	41	112

*: Level 4 managers within headquarters Departments have been excluded. Exceptionally, level 4 managers in DOMP and DEL Departments have been recorded, either because they report directly to the Head of Dept, or because the division manager position is vacant.

Table B2: Greek Railways (OSE): Number of Managers by Managerial Level

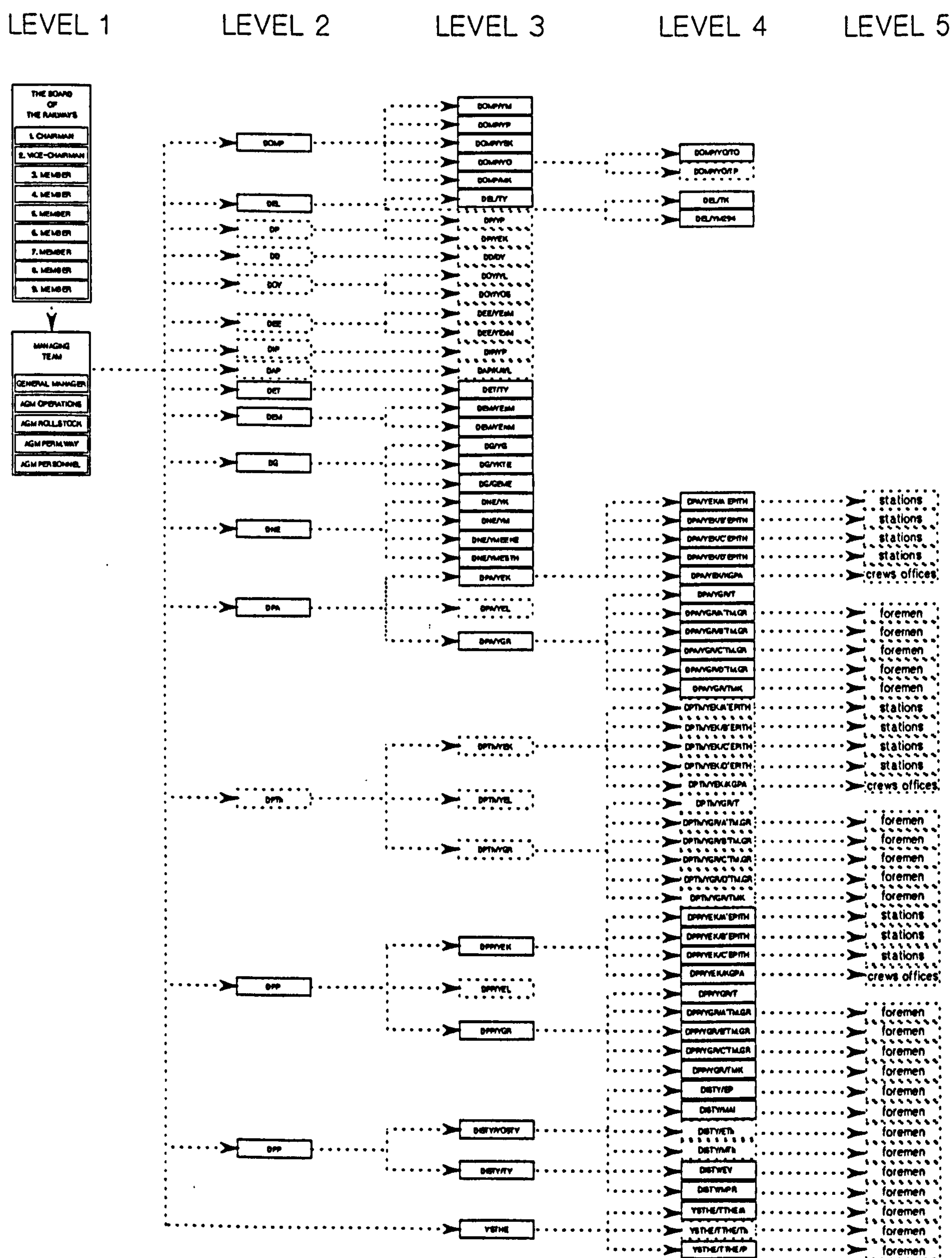


Figure B5: Greek Railways :Organization Chart Showing Managerial Levels 1 to 5
(Bold Type Indicates Members of Sample Population)

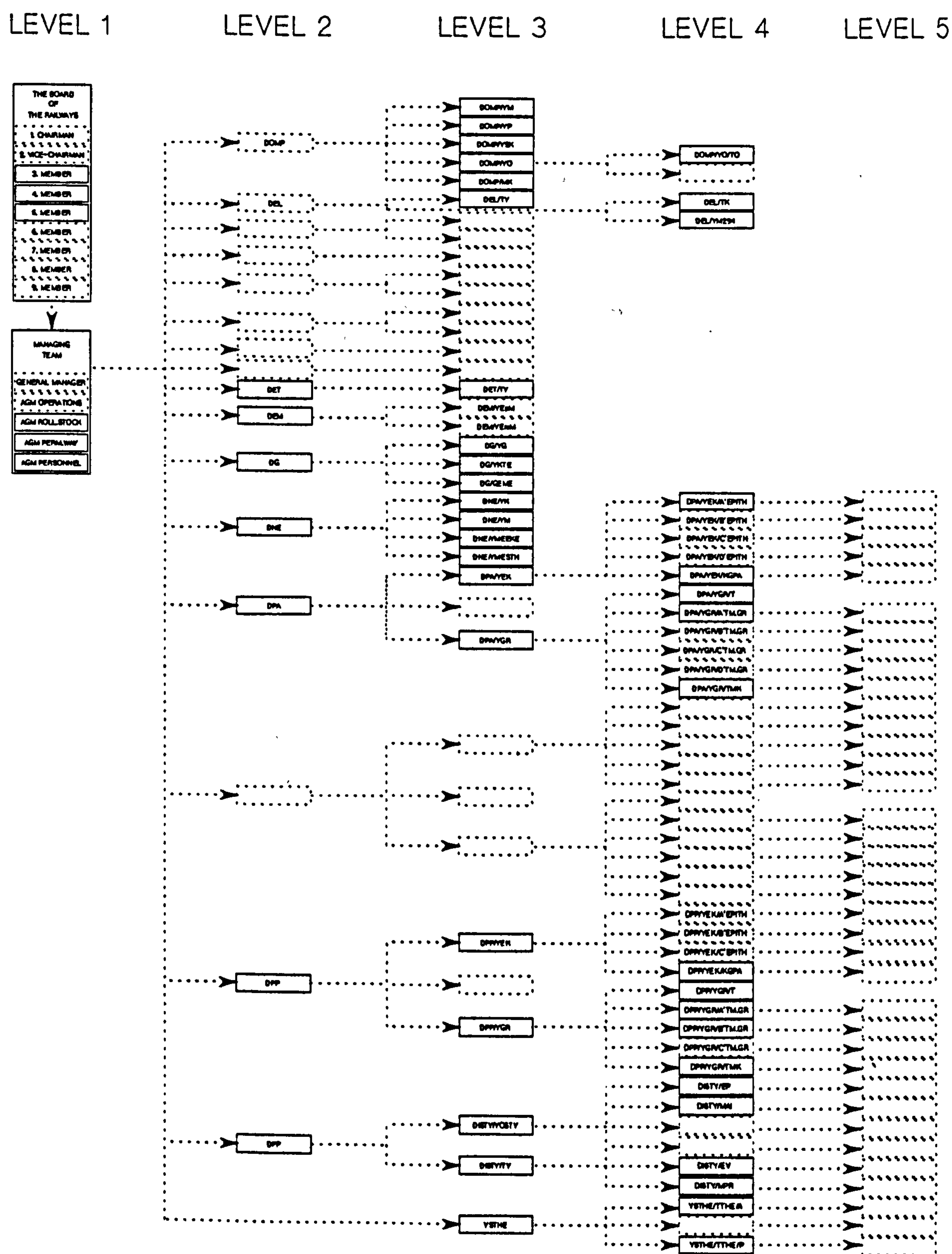


Figure B6: Greek Railways :Organization Chart Showing Managerial Levels 1 to 5
(Bold Type Indicates Interviewed Members of Sample Population)

APPENDIX C

SURVEY QUESTIONNAIRE

The questionnaire presented in the following pages was designed and used in order to collect information utilized in this thesis.

Its rationale is explained in *Chapter 9*. The following notes should be made here:

- **Section One (General Information) and Section Two (General Characteristics of Greek Railways)** were designed to be answered by all respondents.
- **Section Three (Analysis of Activities)** lists a total of 168 managerial activities at various levels and concerning different functions. Therefore, each respondent was requested to answer activities, in front of which a black square was marked. Consequently, each functional group of respondents answered the part of this section, related to its duties. Furthermore, top level management and other corporate level respondents were asked to answer almost the whole list of activities. Finally, for several activities for which, to the interviewer's personal knowledge, there were not clear responsibilities, the question was posed to all respondents assumed to be in some way related with the activity.
- **Section Four (Information Flows)** consists of five pages. However they all refer to one activity. Therefore, each respondent had to fill in as many sets of five pages, as the number of activities for which he had declared responsibility. In practice, each respondent had to fill 6-10 such sets. Frequently, there was a grouping of similar activities in the same set.

SECTION ONE: GENERAL INFORMATION

In this part of the questionnaire information about respondent's characteristics is asked, in terms of age and status within the company.

NAME:

(This survey is not interested in your personal identification; is only interested in problems and views of managers at various company levels. By filling in your name, if you want, you help to guarantee the reliability of this work, as assessed by those who will judge it).

NAME OF THE UNIT WHICH YOU MANAGE:

Leave blank for coding

DEPARTMENT: _____

DIVISION: _____

UNIT: _____

--	--	--	--	--	--	--

1. Age:

	less than 30 years	31-40 years	41-50 years	51-60 years	over 60 years
(Tick the appropriate box)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

2. How long have you been holding this position ?

	less than 1 year	1-3 years	3-5 years	5-10 years	more than 10 years
(Tick the appropriate box)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

3. How much do you agree that each of the following statements expresses the main reason for the existence of OSE ?

strongly agree agree neutral disagree strongly disagree don't answer

1 2 3 4 5 6

- ☐ ☐ ☐ ☐ ☐ ☐

- ☐ ☐ ☐ ☐ ☐ ☐

- ☐ ☐ ☐ ☐ ☐ ☐

- ☐ ☐ ☐ ☐ ☐ ☐

- ☐ ☐ ☐ ☐ ☐ ☐

- ☐ ☐ ☐ ☐ ☐ ☐

- ☐ ☐ ☐ ☐ ☐ ☐

4. How important do you think each of the following goals of OSE's operation is ?

(Ring the appropriate number)

Operational Goal:	don't know	unimportant	slightly important	almost important	important	very important	vital
4.1. To reduce total expenditure:	dn	0	1	2	3	4	5
4.2. To reduce staff expenditure:	dn	0	1	2	3	4	5
4.3. To improve service reliability:	dn	0	1	2	3	4	5
4.4. To increase traffic volume:	dn	0	1	2	3	4	5
4.5. To reduce journey times:	dn	0	1	2	3	4	5
4.6. To improve quality of services:	dn	0	1	2	3	4	5
4.7. To increase market share:	dn	0	1	2	3	4	5

5. How do you assess your unit's contribution in achieving each of the goals mentioned above ?

(Ring the appropriate number)

My unit's contribution in:	don't know	negligible	slightly significant	almost significant	significant	very significant	vital
5.1. Reducing total expenditure:	dn	0	1	2	3	4	5
5.2. Reducing staff expenditure:	dn	0	1	2	3	4	5
5.3. Improving service reliability:	dn	0	1	2	3	4	5
5.4. Increasing traffic volume:	dn	0	1	2	3	4	5
5.5. Reducing journey times:	dn	0	1	2	3	4	5
5.6. Improving quality of services:	dn	0	1	2	3	4	5
5.7. Increasing market share:	dn	0	1	2	3	4	5

6. Which way you think work is organized in OSE ?

(Tick the appropriate box)

There is planning and is strictly implemented.	There is planning adapting to changing conditions.	There is planning but so imperfect, that becomes not implementable.	There is no planning. Everyone tries to serve the interest of the company as he realises it.	There is no planning. Everyone tries to avoiding being charged with duties which are not definitely his responsibility.	Work in OSE is not organized in any of the five mentioned ways.
☐	☐	☐	☐	☐	☐
1	2	3	4	5	6

If you ticked box ☐ 6 , write down which way you think work is organized in OSE:

7. In OSE, every year, a budget is prepared. Which way do you participate in the preparation of your unit's budget ?

(Tick the appropriate box)

I sum up the proposals of the units reporting to me.	I examine the proposals of the units reporting to me and ask for justification of expenses.	I examine the proposals of the units reporting to me in relation with directives from my superiors.	I exhaust the capabilities for discussion between units & superiors, prior to unit's budget preparation.	My unit's budget is the outcome of discussion and agreement between all involved headquarters, regional and supportive units.	I do not participate as implied by any of these mentioned ways.
☐	☐	☐	☐	☐	☐
1	2	3	4	5	6

If you ticked box ☐ 6 , write down which way you participate in your unit's budget preparation:

8. Usually, before being approved, OSE's budget is reformed by the State. How often is your opinion asked, before your unit's budget is amended ?

(Tick the appropriate box)

almost never	rarely	sometimes	often	almost always	don't answer
☐	☐	☐	☐	☐	☐
1	2	3	4	5	6

9. What kind of view do you think that each of the following managerial levels holds for the company ?

(Tick the appropriate box for each managerial level)

	V i e w t h e E n t e r p r i s e a s				
	A whole: They are mainly interested in the performance of the total.	A set of activities in close inter- relationship: the performance of parts is significant to the extent that defines the performance of the total.	A set of activities relatively interrelated: the performance of parts is equally significant as the performance of the total.	A sum of relatively independent activities: They are more interested in the performance of parts than in the performance of the total.	A sum of independent activities: They are only interested in the performance of each part. This will define the performance of the total.
	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
9.1. Top management:	☐	☐	☐	☐	☐
9.2. Functional management:	☐	☐	☐	☐	☐
9.3. Regional management:	☐	☐	☐	☐	☐
9.4. Lower management:	☐	☐	☐	☐	☐

10. Which way do you think that the following characteristics of OSE's operation have developed during the last three years ?

(Tick the appropriate box for each characteristic of OSE's operation).

[illegible]

11. How often have you travelled by train during the last three years ?

(Tick the appropriate box for each part of the network).

[illegible]

(Tick the appropriate box for each statement).

[illegible]

(Rank by writing from 1 to 7 at the respective space. Alternatively, write "there is no way" or "I don't know").

[illegible]

SECTION THREE: ANALYSIS OF ACTIVITIES

14. Listed below are the fundamental activities at the various managerial levels in the railway enterprise. Tick the activities for which you are personally responsible.

(Tick the appropriate box for any activity, to the left of which a ☐ is marked).

14.1. Activities at Corporate Level

activity	I am responsible	responsible is ... (fill in)	don't know who is responsible
	☐ 1	_____ 2	☐ 3
1. Relations with the State			
0 0 1 ☐ Informing the Enterprise on State's requirements from the Railways	☐	_____	☐
0 0 2 ☐ Informing the State on the prerequisites for the fulfillment of these requirements.	☐	_____	☐
0 0 3 ☐ Informing the State on OSE's performance	☐	_____	☐
0 0 4 ☐ Bargaining with the State the funding of the Investment Programme.	☐	_____	☐
0 0 5 ☐ Bargaining with the State the general features of the Annual Budget.	☐	_____	☐
2. Research and Development			
0 0 6 ☐ Monitoring international trends in the development of the railways and other modes of transport.	☐	_____	☐
0 0 7 ☐ Monitoring trends in national development.	☐	_____	☐
0 0 8 ☐ Preparation of alternative scenarios of OSE's development, related to alternative directions of development of the country.	☐	_____	☐
3. Planning-Organizing			
0 0 9 ☐ Identification of sectors of transport market which the enterprise decides to enter, as deriving from the adopted general direction for the development of the company	☐	_____	☐
0 1 0 ☐ Identification of the features of services to be offered, as deriving from the adopted general direction for the development of the company	☐	_____	☐
0 1 1 ☐ Identification of required investment, in order to succeed in entering the above market sectors and in offering the above transport services	☐	_____	☐
0 1 2 ☐ Identification of required organizational changes, in order to succeed in entering the above market sectors and in offering the above transport services.	☐	_____	☐
4. Annual Programming			
0 1 3 ☐ Preparation of the annual investment programme	☐	_____	☐
0 1 4 ☐ Preparation of the annual budget	☐	_____	☐

activity	I am responsible	responsible is ... (fill in)	don't know who is responsible
	☐ 1	_____ 2	☐ 3
5. Performance Monitoring			
0 1 5 ☐ Monitoring the development of traffic volume	☐	_____	☐
0 1 6 ☐ Monitoring the development of market share	☐	_____	☐
Monitoring the development of the investment programme:			
0 1 7 ☐ Monitoring the rate of absorbtion of investment funds.	☐	_____	☐
0 1 8 ☐ Monitoring the rate of completion of investment projects	☐	_____	☐
Monitoring the development of the annual budget:			
0 1 9 ☐ Revenue monitoring	☐	_____	☐
0 2 0 ☐ Expenditure control.	☐	_____	☐
0 2 1 ☐ Cash flow control.	☐	_____	☐
Monitoring the Enterprise-Personnel relationship:			
0 2 2 ☐ Monitoring the relations with the trade unions	☐	_____	☐
0 2 3 ☐ Monitoring absenteeism.	☐	_____	☐

14.2. Activities Related to Railway Operations

activity	I am responsible	responsible is ... (fill in)	don't know who is responsible
	☐ 1	_____ 2	☐ 3
1. Research and Development			
0 2 4 ☐ Monitoring international trends in methods and characteristics of railway operations.	☐	_____	☐
0 2 5 ☐ Monitoring financial activity in the various sectors of the national economy	☐	_____	☐
0 2 6 ☐ Monitoring activities and methods of other transport undertakings	☐	_____	☐
0 2 7 ☐ Identification of alternative possible ways of increasing traffic volume and market share.	☐	_____	☐
2. Planning-Organizing			
0 2 8 ☐ Identification of requirements in new railway installations (or modification/extension of existing).	☐	_____	☐
0 2 9 ☐ Identification of requirements in new rolling stock (or modification/refurbishment of existing).	☐	_____	☐
0 3 0 ☐ Identification of requirements in technical configuration of the track (required axle loads, journey speeds)	☐	_____	☐
0 3 1 ☐ Identification of requirements in line's capacity configuration (single/double, signalling, central traffic control).	☐	_____	☐
0 3 2 ☐ Definition of passenger services characteristics (first/standard class, couchettes/sleeping cars, buffet services, comfort/cleanliness requirements).	☐	_____	☐
0 3 3 ☐ Definition of freight services characteristics (block trains, containerization, combined transport, 'door-to-door' services)	☐	_____	☐
3. Annual Programming			
0 3 4 ☐ Identification of pricing policy and special offers (reductions for specific groups, specific customers, etc.). . . .	☐	_____	☐
0 3 5 ☐ Timetable preparation (timing, train composition, stops)	☐	_____	☐
Definition of requirements from the 'Traction/Rolling Stock' sub-system:			
0 3 6 ☐ Rolling stock availability requirements.	☐	_____	☐
0 3 7 ☐ Rolling stock operationality requirements.	☐	_____	☐
0 3 8 ☐ Rolling stock cleanliness, comfort, etc. requirements.	☐	_____	☐
Definition of requirements from the 'Track and Permanent Installations' sub-system:			
0 3 9 ☐ Track availability requirements	☐	_____	☐
0 4 0 ☐ Track operationality requirements	☐	_____	☐
0 4 1 ☐ Terminals and Installations operationality requirements	☐	_____	☐

Activities Related to Railway Operations (continued)

activity	I am responsible	responsible is ... (fill in)	don't know who is responsible
	☐ 1	_____ 2	☐ 3
Definition of requirements from the 'Signalling and Telecommunications' sub-system:			
0 4 2 ☐ Signalling systems operability requirements	☐	_____	☐
0 4 3 ☐ Telecommunications/radiotelephones systems operability requirements	☐	_____	☐
0 4 4 ☐ Level crossings guarding systems operability requirements	☐	_____	☐
0 4 5 ☐ Central traffic control systems operability requirements	☐	_____	☐

4. Performance Monitoring of the 'Railway Operations' system

0 4 6 ☐ Traffic volume development monitoring by route	☐	_____	☐
0 4 7 ☐ Traffic volume development monitoring by type of traffic (passenger, freight)	☐	_____	☐
0 4 8 ☐ Receipts development monitoring by route	☐	_____	☐
0 4 9 ☐ Receipts development monitoring by type of traffic	☐	_____	☐

Operations expenditure development monitoring:

0 5 0 ☐ Train crews expenditure development	☐	_____	☐
0 5 1 ☐ Terminals/Marshalling crews expenditure development	☐	_____	☐
0 5 2 ☐ Other train operations, terminals and marshalling expenditure (excluding fuelling/lubricating)	☐	_____	☐
0 5 3 ☐ Scheduled reliability monitoring by route	☐	_____	☐
0 5 4 ☐ Monitoring, on behalf of the 'Operations' system, the behaviour of the 'Traction/Rolling Stock' sub-system, in relation to defined requirements	☐	_____	☐
0 5 5 ☐ Monitoring, on behalf of the 'Operations' system, the behaviour of the 'Track and Permanent Installations' sub-system, in relation to defined requirements.	☐	_____	☐
0 5 6 ☐ Monitoring, on behalf of the 'Operations' system, the behaviour of the 'Signalling and Telecommunications' sub-system, in relation to defined requirements.	☐	_____	☐

Monitoring the features of services offered, in relation to planned requirements:

0 5 7 ☐ trains (operability, cleanliness, buffets, couchettes, sleeping cars ,etc.)	☐	_____	☐
0 5 8 ☐ terminals (operability, condition, cleanliness, customers services, etc.).	☐	_____	☐
0 5 9 ☐ Trains crews (appearance, behaviour)	☐	_____	☐
0 6 0 ☐ Terminals staff (appearance, behaviour).	☐	_____	☐

14.3. Activities Related to the 'Traction/Rolling Stock' sub-system

activity	I am responsible	responsible is ... (fill in)	don't know who is responsible
	☐ 1	_____ 2	☐ 3
1. Research and Development			
0 6 1 ☐ Monitoring technological development in railway traction issues	☐	_____	☐
0 6 2 ☐ Monitoring technological development in railway rolling stock issues	☐	_____	☐
0 6 3 ☐ Monitoring technological development in rolling stock repair/maintenance issues.	☐	_____	☐
0 6 4 ☐ Monitoring technological development in rolling stock repair/maintenance installations and equipment issues.	☐	_____	☐
0 6 5 ☐ Preparation of alternative scenarios of traction and rolling stock development in OSE	☐	_____	☐
2. Planning-Organizing			
0 6 6 ☐ Definition of rolling stock repairs issues (methods, timing), by type of rolling stock.	☐	_____	☐
0 6 7 ☐ Definition of rolling stock maintenance issues (methods, timing), by type of rolling stock.	☐	_____	☐
0 6 8 ☐ Definition of requirements in rolling stock repairs installations and equipment.	☐	_____	☐
0 6 9 ☐ Definition of requirements in rolling stock maintenance installations and equipment.	☐	_____	☐
0 7 0 ☐ Definition of requirements in materials/spare parts for rolling stock repairs.	☐	_____	☐
0 7 1 ☐ Definition of requirements in materials/spare parts for rolling stock maintenance.	☐	_____	☐
3. Annual Programming			
0 7 2 ☐ Preparation of the annual rolling stock repairs programme. . . .	☐	_____	☐
0 7 3 ☐ Preparation of the annual rolling stock maintenance programme. .	☐	_____	☐
0 7 4 ☐ Preparation of the annual programme of materials/ spare parts purchases for rolling stock repairs.	☐	_____	☐
0 7 5 ☐ Preparation of the annual programme of materials/spare parts purchases for rolling stock maintenance.	☐	_____	☐
4. Performance Monitoring			
0 7 6 ☐ Repairs quality control by type of rolling stock	☐	_____	☐
0 7 7 ☐ Maintenance quality control by type of rolling stock	☐	_____	☐

Activities Related to the 'Traction/Rolling Stock' sub-system (continued)

activity	I am responsible	responsible is ... (fill in)	don't know who is responsible
	☐ 1	_____ 2	☐ 3
0 7 8 ☐ Monitoring the development of the repairs programme.	☐	_____	☐
0 7 9 ☐ Monitoring the development of the maintenance programme.	☐	_____	☐
0 8 0 ☐ Monitoring the availability of materials/spare parts in workshops	☐	_____	☐
0 8 1 ☐ Monitoring the availability of materials/spare parts in depots .	☐	_____	☐
0 8 2 ☐ Monitoring the quality of sub-contracted work (e.g. vehicle cleaning).	☐	_____	☐
0 8 3 ☐ Monitoring the development of rolling stock repairs expenditure.	☐	_____	☐
0 8 4 ☐ Monitoring the development of roll. stock maintenance expenditure	☐	_____	☐
0 8 5 ☐ Monitoring the development of fuel/lubricants expenditure. . . .	☐	_____	☐
0 8 6 ☐ Monitoring the performance of the rolling stock repairs staff.	☐	_____	☐
0 8 7 ☐ Monitoring the performance of the rolling stock maintenance staff.	☐	_____	☐

14.4. Activities Related to the 'Permanent Way' sub-system

activity	I am responsible ☐ 1	responsible is ... (fill in) _____ 2	don't know who is responsible ☐ 3
1. Research and Development			
0 8 8 ☐ Monitoring technological development in track subgrade and structure issues	☐	_____	☐
0 8 9 ☐ Monitoring technological development in tunnels, bridges and constructions issues	☐	_____	☐
0 9 0 ☐ Monitoring technological development in terminals issues (buildings, accessibility, sidings, track layout).	☐	_____	☐
0 9 1 ☐ Monitoring development in organizing and managing civil engineering projects	☐	_____	☐
2. Planning-Organizing			
0 9 2 ☐ Definition of the track maintenance regime (methods, rules, etc.)	☐	_____	☐
0 9 3 ☐ Definition of the maintenance regime for tunnels, bridges, and constructions (methods, rules, etc.)	☐	_____	☐
0 9 4 ☐ Definition of the maintenance regime for iron constructions (methods, rules, etc.)	☐	_____	☐
0 9 5 ☐ Definition of the terminals maintenance regime (methods, rules, etc.)	☐	_____	☐
0 9 6 ☐ Preparation of studies for track subgrade maintenance/renewal or construction of new subgrade (new lines, doubling, etc.) . . .	☐	_____	☐
0 9 7 ☐ Preparation of studies for track maintenance/renewal or laying of new track (new lines, doubling, etc.).	☐	_____	☐
0 9 8 ☐ Preparation of studies for maintenance/construction of bridges, tunnels and other civil engineering constructions . . .	☐	_____	☐
0 9 9 ☐ Preparation of studies for construction/extention/maintenance of stations and other buildings.	☐	_____	☐
1 0 0 ☐ Identification of requirements in machinery/tools/equipment for track construction/renewal/maintenance	☐	_____	☐
1 0 1 ☐ Identification of requirements in machinery/tools/equipment for tunnels/bridges/etc. construction/maintenance.	☐	_____	☐
1 0 2 ☐ Identification of requirements in machinery/tools/equipment for buildings construction/extention/maintenance	☐	_____	☐
1 0 3 ☐ Identification of requirements in materials for track construction/renewal/maintenance	☐	_____	☐
1 0 4 ☐ Identification of requirements in materials for tunnels/bridges/etc. construction/maintenance.	☐	_____	☐
1 0 5 ☐ Identification of requirements in materials for buildings construction/extention/maintenance	☐	_____	☐
3. Annual Programming			
1 0 6 ☐ Preparation of the annual programme of track and permanent installations renewal/maintenance.	☐	_____	☐
1 0 7 ☐ Preparation of the annual programme of new constructions in track and permanent installations	☐	_____	☐

Activities Related to the 'Permanent Way' sub-system' (continued)

activity	I am responsible	responsible is ... (fill in)	don't know who is responsible
	☐ 1	_____ 2	☐ 3
1 0 8 ☐ Preparation of the annual programme of purchases of machinery/ equipment, for track and installations maintenance/renewal	☐	_____	☐
1 0 9 ☐ Preparation of the annual programme of purchases of materials. for track and installations maintenance/renewal.	☐	_____	☐

4. Performance Monitoring

1 1 0 ☐ Monitoring the condition of the track and the quality of renewal/maintenance works.	☐	_____	☐
1 1 1 ☐ Monitoring the condition of tunnels/bridges/constructions and the quality of renewal/maintenance works	☐	_____	☐
1 1 2 ☐ Monitoring the condition of stations and other buildings and the quality of renewal/extention/maintenance works	☐	_____	☐
1 1 3 ☐ Monitoring the quality of large projects, undertaken by third parties (tunnels, large buildings, etc.)	☐	_____	☐
1 1 4 ☐ Monitoring the development of the annual programme of track and permanent installations renewal/maintenance.	☐	_____	☐
1 1 5 ☐ Monitoring the development of the annual programme of new constructions.	☐	_____	☐
1 1 6 ☐ Monitoring the availability of materials/tools in units.	☐	_____	☐
1 1 7 ☐ Monitoring the development of expenditure in track and permanent installations renewal/maintenance works.	☐	_____	☐
1 1 8 ☐ Monitoring the development of expenditure in track and permanent installations new constructions projects	☐	_____	☐
1 1 9 ☐ Monitoring the performance of the track and permanent installations renewal/maintenance works staff.	☐	_____	☐
1 2 0 ☐ Monitoring the performance of the track and permanent installations new works projects staff	☐	_____	☐

14.5. Activities Related to the 'Signalling/Telecoms' sub-system

activity	I am responsible	responsible is ... (fill in)	don't know who is responsible
	☐ 1	_____ 2	☐ 3
1. Research and Development			
1 2 1 ☐ Monitoring technological development in railway signalling issues	☐	_____	☐
1 2 2 ☐ Monitoring technological development in telecommunications networks issues (telephones, radiotelephones, etc.).	☐	_____	☐
1 2 3 ☐ Monitoring technological development in railway central traffic control issues	☐	_____	☐
1 2 4 ☐ Monitoring technological development in level crossings keeping issues	☐	_____	☐
1 2 5 ☐ Monitoring development in organizing and managing mechanical and electrical engineering projects.	☐	_____	☐
2. Planning-Organizing			
Definition of characteristics of Signalling system			
1 2 6 ☐ Selection of signalling system	☐	_____	☐
1 2 7 ☐ Definition of the way of installation of signalling system. . . .	☐	_____	☐
1 2 8 ☐ Definition of maintenance regime of signalling system.	☐	_____	☐
Definition of characteristics of Telecommunications system			
1 2 9 ☐ Selection of telecommunications system	☐	_____	☐
1 3 0 ☐ Definition of the way of installation of telecommunications system	☐	_____	☐
1 3 1 ☐ Definition of maintenance regime of telecommunications system . .	☐	_____	☐
Definition of characteristics of Central Traffic Control system			
1 3 2 ☐ Selection of central traffic control system.	☐	_____	☐
1 3 3 ☐ Definition of way of installation of central traffic control system	☐	_____	☐
1 3 4 ☐ Definition of maintenance regime of central traffic control system	☐	_____	☐
Definition of characteristics of level crossings keeping system			
1 3 5 ☐ Selection of level crossings keeping system.	☐	_____	☐
1 3 6 ☐ Definition of way of installation of level crossings keeping system	☐	_____	☐
1 3 7 ☐ Definition of maintenance regime of level crossings keeping system	☐	_____	☐
1 3 8 ☐ Identification of requirements in tools/materials/spare parts for the maintenance of signalling system	☐	_____	☐
1 3 9 ☐ Identification of requirements in tools/materials/spare parts for the maintenance of telecommunications system	☐	_____	☐
1 4 0 ☐ Identification of requirements in tools/materials/spare parts for the maintenance of central traffic control system.	☐	_____	☐

Activities Related to the 'Signalling/Telecoms' sub-system (continued)

activity	I am responsible	responsible is ... (fill in)	don't know who is responsible
	☐ 1	<input type="text"/> 2	☐ 3
1 4 1 ☐ Identification of requirements in tools/materials/spare parts for the maintenance of level crossings keeping system.	☐	<input type="text"/>	☐
3. Annual Programming			
1 4 2 ☐ Preparation of the annual programme of signalling system maintenance.	☐	<input type="text"/>	☐
1 4 3 ☐ Preparation of the annual programme of telecommunications system maintenance	☐	<input type="text"/>	☐
1 4 4 ☐ Preparation of the annual programme of central traffic control system maintenance	☐	<input type="text"/>	☐
1 4 5 ☐ Preparation of the annual programme of level crossings keeping system maintenance	☐	<input type="text"/>	☐
1 4 6 ☐ Preparation of the annual programme of new signalling systems installation	☐	<input type="text"/>	☐
1 4 7 ☐ Preparation of the annual programme of new telecommunication systems installation	☐	<input type="text"/>	☐
1 4 8 ☐ Preparation of the annual programme of new central traffic control systems installation	☐	<input type="text"/>	☐
1 4 9 ☐ Preparation of the annual programme of new level crossings keeping systems installation	☐	<input type="text"/>	☐
4. Performance Monitoring			
1 5 0 ☐ Monitoring the condition of signalling systems and the quality of maintenance works	☐	<input type="text"/>	☐
1 5 1 ☐ Monitoring the condition of telecommunications systems and the quality of maintenance works	☐	<input type="text"/>	☐
1 5 2 ☐ Monitoring the condition of central traffic control systems and the quality of maintenance works	☐	<input type="text"/>	☐
1 5 3 ☐ Monitoring the condition of level crossings keeping systems and the quality of maintenance works	☐	<input type="text"/>	☐
1 5 4 ☐ Monitoring the quality of large projects, undertaken by third parties (installation of new signalling, etc. systems) . .	☐	<input type="text"/>	☐
1 5 5 ☐ Monitoring the expenditure of the signalling system (maintenance, operation)	☐	<input type="text"/>	☐
1 5 6 ☐ Monitoring the expenditure of the telecommunications system (maintenance, operation).	☐	<input type="text"/>	☐
1 5 7 ☐ Monitoring the expenditure of the central traffic control system (maintenance, operation).	☐	<input type="text"/>	☐
1 5 8 ☐ Monitoring the expenditure of the level crossings keeping system (maintenance, operation).	☐	<input type="text"/>	☐
1 5 9 ☐ Monitoring the expenditure of large projects, undertaken by third parties (installation of new systems)	☐	<input type="text"/>	☐
1 6 0 ☐ Monitoring the availability of signalling maintenance materials/tools/spare parts.	☐	<input type="text"/>	☐
1 6 1 ☐ Monitoring the availability of telecommunications maintenance materials/tools/spare parts.	☐	<input type="text"/>	☐

Activities Related to the 'Signalling/Telecoms' sub-system (continued)

activity	I am responsible	responsible is ... (fill in)	don't know who is responsible
	☐ 1	_____ 2	☐ 3
1 6 2 ☐ Monitoring the availability of central traffic control system maintenance materials/tools/spare parts.	☐	_____	☐
1 6 3 ☐ Monitoring the performance of the signalling system maintenance staff.	☐	_____	☐
1 6 4 ☐ Monitoring the performance of the telecommunications system maintenance staff.	☐	_____	☐
1 6 5 ☐ Monitoring the performance of the level crossings keeping systems staff.	☐	_____	☐
1 6 6 ☐ Monitoring the performance of the signalling operating staff.	☐	_____	☐
1 6 7 ☐ Monitoring the performance of the central traffic control system operating staff	☐	_____	☐
1 6 8 ☐ Monitoring the performance of the level crossings keeping staff	☐	_____	☐

SECTION FOUR: INFORMATION FLOWS

15. For each activity of Section Three (Analysis of Activities), for which you noted that you are responsible, fill in this section.

(Fill one copy for each activity).

Title of Activity: _____

Code of Activity:

15.1. Where from you receive information when performing this activity ?

- (write down any kind of information, i.e.:
- directions. etc., receiving from superiors.
 - reports, etc., receiving from subordinates.
 - direct information, received through personal investigation of the environment, the company's operations, etc.)

Outside the Railways

☐ 1

Specify: _____

From Top Management

☐ 2

Specify: _____

From Functional Management

☐ 3

Specify: _____

From Regional Management

☐ 4

Specify: _____

From Regional Divisional Management

☐ 5

Specify: _____

From Area Management

☐ 6

Specify: _____

From Foremen, Stationmasters an other Operational

☐ 7

Specify: _____

15.2. For each origin of information you mentioned, fill the table below:

Origin of Information: _____

Information Type	Not Written (verbal, visit , etc.)						Written, not Processed (reports, directions, publications, etc.)						Written, Processed (data tables, graphs, etc)					
	yes		no				yes		no				yes		no			
	☐		☐		1	2	☐		☐		1	2	☐		☐		1	2
Specify:																		
Information Receipt Frequency	per day	per week	per month	per quarter	per 1/2year	per year	per day	per week	per month	per quarter	per 1/2year	per year	per day	per week	per month	per quarter	per 1/2year	per year
Tick a box:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
Information Quality	totally ade-quate	almost ade-quate	almost ade-quate	inade-quate	inade-quate	totally inade-quate	totally ade-quate	almost ade-quate	almost ade-quate	inade-quate	inade-quate	totally inade-quate	totally ade-quate	almost ade-quate	almost ade-quate	inade-quate	inade-quate	totally inade-quate
Tick a box:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	1	2	3	4	5		1	2	3	4	5		1	2	3	4	5	

Origin of Information: _____

Information Type	Not Written (verbal, visit , etc.)	yes ☐ 1	no ☐ 2	Written, not Processed (reports, directions, publications, etc.)	yes ☐ 1	no ☐ 2	Written, Processed (data tables, graphs, etc)	yes ☐ 1	no ☐ 2			
Specify:												
Information Receipt Frequency	per day	per week	per month	per quarter	per 1/2year	per year	per day	per week	per month	per quarter	per 1/2year	per year
Tick a box:	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
Information Quality	totally ade-quate	almost ade-quate	almost ade-quate	inade-quate	inade-quate	totally ade-quate	totally ade-quate	almost ade-quate	almost ade-quate	inade-quate	inade-quate	totally ade-quate
Tick a box:	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5		☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	

Origin of Information: _____

Information Type	Not Written (verbal, visit , etc.)	yes ☐ 1	no ☐ 2	Written, not Processed (reports, directions, publications, etc.)	yes ☐ 1	no ☐ 2	Written, Processed (data tables, graphs, etc)	yes ☐ 1	no ☐ 2			
Specify:												
Information Receipt Frequency	per day	per week	per month	per quarter	per 1/2year	per year	per day	per week	per month	per quarter	per 1/2year	per year
Tick a box:	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
Information Quality	totally ade-quate	almost ade-quate	almost ade-quate	inade-quate	inade-quate	totally ade-quate	totally ade-quate	almost ade-quate	almost ade-quate	inade-quate	inade-quate	totally ade-quate
Tick a box:	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5		☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	

15.3. What do you think about the total information you receive, concerning this activity ?

(Tick the appropriate box).

is absolutely adequate

is adequate

is almost adequate

is inadequate

is absolutely inadequate

☐

☐

☐

☐

☐

1

2

3

4

5

15.4. Where do you send information when performing this activity ?

(write down any kind of information, i.e.:
- directions. etc., to subordinates,
- reports, etc., to superiors, .
- direct information, received through personal investigation of the environment, the company's operations, etc.)

Outside the Railways

☐ 1

Specify: _____

To Top Management

☐ 2

Specify: _____

To Functional Management

☐ 3

Specify: _____

To Regional Management

☐ 4

Specify: _____

To Regional Divisional Management

☐ 5

Specify: _____

To Area Management

☐ 6

Specify: _____

To Foremen, Stationmasters an other Operational

☐ 7

Specify: _____

15.5. For each destination of information you mentioned, fill the table below:

Information Destination: _____

Information Type	Not Written (verbal, visit , etc.)						Written, not Processed (reports, directions, publications, etc.)						Written, Processed (data tables, graphs, etc)											
	yes ☐ 1		no ☐ 2				yes ☐ 1		no ☐ 2				yes ☐ 1		no ☐ 2									
Specify:																								
Information Sending Frequency	per day	per week	per month	per quarter	per 1/2year	per year	per day	per week	per month	per quarter	per 1/2year	per year	per day	per week	per month	per quarter	per 1/2year	per year						
Tick a box:	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6						
Information quality	totally ade-quate		almost ade-quate		totally inade-quate		totally ade-quate		almost ade-quate		totally inade-quate		totally ade-quate		almost ade-quate		totally inade-quate							
Tick a box:	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5		☐ 1	☐ 2	☐ 3	☐ 4	☐ 5		☐ 1	☐ 2	☐ 3	☐ 4	☐ 5							

Information
Destination: _____

Information Type	Not Written (verbal, visit , etc.) yes ☐ 1 no ☐ 2	Written, not Processed (reports, directions, publications, etc.) yes ☐ 1 no ☐ 2	Written, Processed (data tables, graphs, etc) yes ☐ 1 no ☐ 2
Specify:			
Information Sending Frequency	per day per week per month per quarter per 1/2year per year	per day per week per month per quarter per 1/2year per year	per day per week per month per quarter per 1/2year per year
Tick a box:	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6
Information Quality	totally ade-quate almost ade-quate totally inade-quate	totally ade-quate almost ade-quate totally inade-quate	totally ade-quate almost ade-quate totally inade-quate
Tick a box:	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Information
Destination: _____

Information Type	Not Written (verbal, visit , etc.) yes ☐ 1 no ☐ 2	Written, not Processed (reports, directions, publications, etc.) yes ☐ 1 no ☐ 2	Written, Processed (data tables, graphs, etc) yes ☐ 1 no ☐ 2
Specify:			
Information Sending Frequency	per day per week per month per quarter per 1/2year per year	per day per week per month per quarter per 1/2year per year	per day per week per month per quarter per 1/2year per year
Tick a box:	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6
Information Quality	totally ade-quate almost ade-quate totally inade-quate	totally ade-quate almost ade-quate totally inade-quate	totally ade-quate almost ade-quate totally inade-quate
Tick a box:	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

15.6. What do you think about the total information you send,
concerning this activity ?

(Tick the appropriate box).

is absolutely adequate	is adequate	is almost adequate	is inadequate	is absolutely inadequate
☐	☐	☐	☐	☐
1	2	3	4	5

APPENDIX D

SURVEY DATA

This appendix contains all data collected during the survey within the case study, that is:

- Managerial responses to Questions 3-12 (*Table D1*) and Question 13 (*Table D2*) of *Section Two* of the *Survey Questionnaire*. This material is discussed in *Chapter 11*.
- Managerial responses to the accountability allocation questions of the *Survey Questionnaire* (Question 14, *Section Three*), referring to managerial activities at Corporate Level (*Table D3*, Question 14.1), activities of the Operations system (*Table D4*, Question 14.2), the Rolling Stock system (*Table D5*, Question 14.3), the Permanent Way system (*Table D6*, Question 14.4.) and the Signalling & Telecommunications system (*Table D7*, Question 14.5). This material was used in *Chapter 10*, for the construction of the VSM of the enterprise.
- Managerial responses relating to information exchange associated with managerial activities and corresponding to the information flows questions of the *Survey Questionnaire* (Question 15, *Section Four*). This material is contained in *Table D8*, extending over 19 pages, and was partly utilised in the information network discussion of the last part of *Chapter 10*.

respondent	object							task							contrib							p b f l u r a d q n g b	view				opin									journ			reason											
	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7		1	2	3	4	1	2	3	4	5	6	7	8	9	1	2	3	1	2	3	4	5	6	7	8	9			
1	2	1	2	3	4	3	3	3	2	5	5	4	5	4	5	2	3	4	2	4	3	5	6	5	2	3	2	4	2	3	3	2	3	3	3	2	1	2	4	2	4	1	2	3	5	3	5	4		
2	2	2	4	4	5	5	4	3	3	5	4	3	5	4	2	3	3	3	4	4	3	3	6	1	2	4	4	5	3	4	2	2	2	3	3	3	3	4	5	2	2	3	3	3	3	3	3			
3	2	2	4	3	4	4	4	5	2	5	4	5	4	5	0	0	2	3	4	3	3	6	5	1	2	5	4	2	4	2	3	2	4	4	4	3	4	5	3	1	2	3	3	4	4	3	5	5		
6	2	2	4	4	5	5	4	3	3	5	4	3	5	4	2	3	3	3	4	4	3	3	3	1	2	4	4	5	3	4	2	2	2	3	3	3	3	4	5	2	2	3	3	3	3	3	3			
8	2	4	4	4	5	5	4	5	3	4	5	4	5	5	3	2	0	0	0	3	0	3	6	5	1	2	5	5	2	3	2	2	1	3	2	3	2	3	6	5	2	4	2	3	2	4	4	5		
9	1	1	4	2	4	5	4	3	4	5	5	5	5	5	4	3	5	3	4	3	5	2	4	4	1	2	3	4	2	2	2	2	2	2	2	3	3	2	2	2	1	2	5	5	5	4	1	1	4	
11	5	5	4	4	2	4	2	5	3	3	4	3	4	4	3	2	0	0	3	4	0	3	6	6	1	3	3	4	3	3	3	2	3	2	2	2	3	5	4	4	1	4	3	4	4	2	2	4		
12	3	2	2	1	3	4	1	4	5	5	5	5	5	5	4	4	4	0	4	4	2	2	6	3	2	3	3	3	2	3	3	3	2	2	2	2	3	3	3	2	4	4	3	2	3	2	3			
13								5	5	5	4	5	5	4	2	2	4	3	5	4	1	2	5	6	1	2	0	0			2	3	2	3	3	3	3	3	6	4	3	3				2				
15	2	2	4	2	4	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	2	6	6	1	1	1	2	2	3	2	2	2	2	2	1	1	5	6	5	1	1	4	4	4	4	2		4	
16	2	2	4	4	4	4	4	3	3	5	5	5	5	5	0	0	0	0	0	0	0	2	6	6	2	2	2	2	1	3	2	1	1	2	2	1	1	6	6	6	4	4	4	4	3	2	2	3	3	
17	2	2	4	2	4	4	4	5	5	5	5	5	5	5	5	5	0	0	0	0	0	2	6	6	1	1	1	2	2	3	2	2	2	2	2	1	1	5	6	5	1	1	4	4	4	4	2		4	
18	1	4	4	1	4	4	2	2	2	5	5	5	5	5	3	3	0	0	0	2	0	2	3	2	1	4	4	4	2	2	2	1	2	3	2	3	2	1	3	3	2	2	4	4	4	4	2	2	3	
19	2	2	4	2	4	4	4	5	3	5	5	5	5	5	5	4	1	1	1	2	2	2	6	1	2	2	2	2	3	5	3	2	2	2	3	3	2	6	6	6	2	2	4	4	4	3	2	3	4	
20	2	1	2	2	3	5	2	3	3	5	5	5	4	5	4	4	3	2	4	2	2	2	1	1	1	5	2	5	1	5	2				2	5	5	6	2	2	4	4	2	2	1	2	4			
21	2	2	2	3	3	4	2	5	4	5	5	5	5	5	2	2	5	1	5	2	3	3	3	3	3	5	5	5	3	5	5	5				2	5		2	4	4	4	2	2	3					
22	2	2	2	4	4	5	1	5	3	5	5	5	5	5	3	0	0	0	0	4	0	2	2	1	1	3	3	3			2	2	2				4	6	4	2	4	4	5			2		4		
23	2	2	2	3	2	2	2	4	5	5	5	5	5	5	0	0	0	0	0	0	0	2	2	4	1	2	4	4			2	1	1	2	2	3	3	6	6	3	4	2	4	1	4	4	2	3	4	
24	4	4	4	4	4	5	5	3	2	5	4	4	5	5	0	0	1	3	4	4	4	2	5	5	3	3	4	5			3	1	1	3	3	3	3	3	6	3	2	2	4	4	4	2	4	4		
25	3	2	2	4	4	3	2	4	4	5	5	5	5	5	3	1	4	3	5	2	4	3	6	2	4	3	4	5			3	2	1	2	3	3	3	2	2	6	6	2	2	2	4	4	2	4	4	
26	2	4	5	4	4	4	4	4	2	4	4	5	4	4	3	1	1	1	4	1	1	3	3	1	3	3	3	4			3	3	3	2	2	3	3	3	3	3	3	3	3	3	2	3	3			
27	3	3	4	3	3	4	2	2	2	5	4	3	4	4	2	0	5	4	4	4	4	2	5	5	3	4	4	5			4	4	4	3	3	3	3	3	3	4	4	4	3	3	3	3	3			
28	4	4	4	4	4	4	3	0	0	5	5	5	5	5	0	0	5	5	2	5	3	2	3	1	2	5	5	3			3	3	2	3	3	2	3	3	6	6	2	4	4	4	2	2	4	4		
29	1	5	5	5	5	5	5	2	5	5	5	1	5	3	2	1	3	3	3	3	1	2	2	5	3	5	5	5			2	4	3	3	2	3	3	3	3	1	3	6	1	4	4	4	3	3	1	4
30								4	3	5	4	4	5	4	3	3	3	3	3	3	3	2	5	2	2	3	4	5			1	3	2	2	2	2	3	3	6	6	6	2	2	4	3	4	2	2	3	3
31	2	2	4	2			4	3	3	5	5	5	5	5	2	1	0	4	0	3	3	2	6	4	1	3	3	3			2	3	3	2	2	2	2	3	2	4	6	4	2	2	4	4	3	4	4	
34	1	2	3	2	4	4	4	3	3	5	5	4	5	3	5	4	5	4	4	4	5	2	5	1	4	4	4	4			4	4	4	4				5	6	4	4	4	3	4	1	4	2	2	4	
35	4	4	4	3	4	4	3	5	5	5	4	4	4	4	3	3	2	2	2	2	0	3	2	1	2	4	2	4			3	4	3	3	3	3	4	4	3	2	6	6	3	2						

t a s k	improved quality of services	resources optimum utilization	improved systems cooperation	improved subsystem rolling stock	improved subsystem permanent way	improved subsystem signalling/tcm
method	ch im eff s work salary increases	ch im eff s work salary increases	ch im eff s work salary increases	ch im eff s work salary increases	ch im eff s work salary increases	ch im eff s work salary increases
respondent	ch im eff s work salary increases	ch im eff s work salary increases	ch im eff s work salary increases	ch im eff s work salary increases	ch im eff s work salary increases	ch im eff s work salary increases
1	4 7 1 2 5 3 6	2 7 3 6 1 4 5	1 4 2 5 3 6 7	2 4 1 6 3 5 7	3 2 1 5 4 6 7	3 6 2 5 1 4 7
2	2 3 4 7 1 5 6	2 3 4 7 1 5 6	2 3 4 7 1 5 6	2 3 4 7 1 5 6	2 3 4 7 1 5 6	2 3 4 7 1 5 6
3	2 5 3 1 4 7 6	1 4 2 6 7 3 5	3 4 1 2 5 7 6	5 7 1 2 6 3 4	5 6 2 1 7 4 3	6 7 4 2 1 5 3
6	2 3 4 7 1 5 6	2 3 4 7 1 5 6	2 3 4 7 1 5 6	2 3 4 7 1 5 6	2 3 4 7 1 5 6	2 3 4 7 1 5 6
8	2 5 1 4 3 6 7	2 6 1 4 3 5 7	1 4 2 5 3 6 7	1 3 2 4 5 6 7	6 7 3 4 1 2 5	1 2 3 4 5 6 7
9	3 2 1 4 5	1 7 4 3 2 6 5	1 7 2 3 4 6 5	2 7 3 4 1 5 6	1 2 3 4 5	1 3 2 4 5
11	2 5 3 4 1 7 6	4 6 1 2 5 3 7	1 3 2 4 5 6 7	4 6 5 3 2 1 7	3 5 4 1 2 6 7	6 4 3 1 2 5 7
12	5 6 1 3 4 2 7	5 7 4 1 2 3 6	3 4 2 5	5 2 1 3 4		
13	1 2	2 1 3	1 2	2 1 3 5 4		
15	5 7 6 4 2 3 1	5 7 6 4 3 2 1	2 6 1 4 3 5 7			
17	5 7 6 4 2 3 1	5 7 6 4 3 2 1	2 6 1 4 3 5 7			
18	1 7 2 6 5 3 4	2 6 4 3 1 5 7	1 5 2 6 3 4 7	2 6 3 1 4 5 7	2 6 3 1 4 5 7	2 6 3 1 4 5 7
19	1 5 3 4 2 7 6	1 5 4 3 2 7 6	1 4 5 3 2 7 6	1 4 5 3 2 7 6	1 4 5 3 2 7 6	1 5 3 4 2 7 6
20	6 7 3 1 2 5 4	6 7 3 2 1 4 5	3 7 1 2 6 5 4		5 7 3 2 1 6 4	
21	5 4 1 7 6 3 2	3 7 1 4 2 6 5	1 7 2 6 3 4 5		2 5 1 6 3 7 4	
22	7 6 5 3 1 4 2	7 6 4 3 1 5 2	7 6 2 1 3 5 4		7 6 4 3 1 5 2	
23	1 7 2 3 4 6 5	3 5 1 2 4 6 7	4 5 2 3 1 6 7	4 5 2 3 1 6 7	4 5 2 3 1 6 7	4 5 2 3 1 6 7
24	4 7 6 5 2 3 1	5 7 2 6 3 4 1	2 7 6 5 3 4 1	2 7 5 6 3 4 1	5 7 4 6 2 3 1	5 7 3 6 2 4 1
25	6 4 7 2 1 3 5	1 2 3 4 6 5 7	2 3 1 4 5 7 6	1 3 2 4 5 6 7	3 6 1 5 2 7 4	
26	1 7 2 3 4 6 5	1 7 2 3 4 6 5	1 7 2 3 4 6 5	1 7 2 3 4 6 5	1 7 2 3 4 6 5	1 7 2 3 4 6 5
27	1 6 2 7 3 5 4	1 7 2 6 3 5 4	1 7 2 6 3 5 4	1 7 2 6 3 5 4	1 7 2 6 3 5 4	1 7 2 6 3 5 4
28	1 7 2 5 6 4 3	5 7 1 2 6 3 4	1 4 3 2 5 7 6	7 6 1 2 3 4 5	2 7 1 3 6 5 4	7 6 1 2 3 4 5
29	2 7 3 4 1 5 6	3 7 5 2 1 4 6	5 7 3 2 1 4 6	4 7 3 2 1 5 6	4 7 3 2 1 5 6	4 7 3 2 1 5 6
30	6 7 5 2 1 4 3					
31	1 5 2 4 3 7 6	4 6 1 2 3 5 7	1 3 2 4 5 6 7			
34	2 1 4 7 3 6 5	3 1 4 7 2 6 5	2 1 4 7 3 6 5	3 2 4 7 1 6 5	3 2 4 7 1 6 5	3 2 4 7 1 6 5
35	6 5 4 3 2 7	6 5 4 3 2 7	2 6 5 4 3 7	4 6 5 3 2 7	6 5 4 3 2 7	2 3 4 5 6 7
36	5 6 1 3 4 7	7 2 1 3 5 6	2 7 3 1 4 6 5	7 2 1 3 6 5	4 1 2 3 6 7	7 2 1 3 6 5
37	1 3 4 5 2 6 7	3 6 2 1 7 5 4		1 5 2 3 4 6 7	1 5 2 3 4 6 7	1 7 4 3 2 5 6
38	6 7 1 2 3 4 5		6 7 1 2 3 4 5			
39	7 3 5 2 6 4	7 3 5 2 6 4	7 3 5 2 6 4	7 3 5 2 6 4	7 3 5 2 6 4	7 3 5 2 6 4
40	5 6 1 4 3 2 7	5 6 1 4 3 2 7	5 6 1 4 3 2 7	5 6 1 4 3 2 7	5 6 1 4 3 2 7	5 6 1 4 3 2 7
41	1 3 4 6 2 7 5	3 2 4 7 1 6 5	1 2 4 3 5 7 6		7 2 3 6 1 5 4	
42	7 5 6 1 2 3 4	7 4 5 2 1 3 6	1 2 4 3 5 6 7	7 6 5 3 1 2 4	6 5 4 2 1 3 7	6 5 4 2 1 3 7
43	1 2	1 2	1 2	1 2	1 2	1 2
44	1 2	1 2	1 2	1 2	1 2	1 2
46	6 7 1 4 5 2 3	6 7 1 2 3 4 5	3 4 1 2 5 7 6			
47	1 3 2 4 5 6 7	1 3 2 4 5 6 7	1 3 2 4 5 6 7	1 3 2 4 5 6 7	1 3 2 4 5 6 7	1 3 2 4 5 6 7
48	2 1 7 6 4 5 3	2 1 5 6 7 3 4	2 4 7 6 1 3 5	2 1 7 6 4 5 3	2 1 7 6 4 5 3	2 1 7 5 4 6 3
49	1 7 2 3 4 6 5	1 7 2 3 4 6 5	1 6 2 3 4 7 5	1 7 2 3 5 4 6	1 7 2 3 4 5 6	1 6 2 3 4 7 5
50	4 7 6 2 1 3 5	6 7 3 2 1 5 4	6 7 3 2 1 4 5		6 7 3 2 1 5 4	
51	6 5 2 1 4 7 3	7 5 2 1 3 6 4	6 4 3 1 2 7 5	4 3 2 1 5 7 6	7 5 2 1 3 4 6	7 4 1 2 3 6 5
52	7 5 2 1 3 6 4	7 5 2 1 3 6 4	3 4 1 2 5 6 7	7 5 2 1 3 6 4	7 5 2 1 3 6 4	7 5 2 1 3 6 4
53	1 4 3 5 2 6 7	1 4 5 2 3 6 7	1 4 3 2 5 6 7	1 5 4 3 2 6 7	1 4 3 2 5 6 7	
54	2 7 1 4 6 3 5	2 7 1 5 6 3 4	2 7 1 5 6 3 4	2 7 1 5 6 3 4	2 7 1 5 6 3 4	2 7 1 5 6 3 4
57	7 6 5 3 1 2 4	6 7 1 3 2 4 5	1 7 2 5 3 4 6	6 7 3 4 2 1 5		
58	2 1 7 6	1 2 7 6	1 2 7	1 3 2 5 6		
59	4 7 3 2 1 6 5	5 7 4 3 1 2 6		6 7 4 5 1 2 3		
60	6 7 5 1 2 4 3	2 3 1 4 6 5 7	1 3 2 4 5 7 6	1 2 3 5 4 6 7	2 1 3 4 5 6 7	1 5 2 3 4 6 7

Table D2: Survey Questionnaire, Section Two: Question 13: Managers' Responses

ASKE = Representative Assembly for Social Control
DS = Board
GM = General Manager
AGM = Assistant General Manager (EK: Operations, GR: Track & Signalling, EL: Rolling Stock, PR: Personnel & Finance)
DOMP = Department of Organization and Planning
DET = Department of Operations (Technical)
DEM = Department of Operations (Commercial)
DEL = Department of Traction
DG = Department of Permanent Way
DNE = Department of New Projects
DOY = Department of Financial Affairs
DOE = Department of Financial Control
DEE = Department of Receipts Control
DIP = Department of Tenders and Purchases
DAP = Department of Stores
DP = Department of Personnel
DD = Department of Clerical Affairs
ALLD = All Heads of Departments
MK = Computer Department (reports to DOMP)
DPER = Regional Managers (DPA: Athens Region, DPTh: Thessaloniki Region, DPP: Peloponnese Region)
YEK = Regional Functional Managers, Operations
EPITH = Area Managers, Operations
KGPA = Train Crew Controllers, Operations
DISTY = Department of Mechanical Engineering
ERSIA = Workshop Managers
MXSIA = Depot Managers
YGR = Regional Functional Managers, Permanent Way
TMGR = Area Managers, Permanent Way
YSTHE = Manager, Signalling, Telecommunications and Electrical Installations
TTHE = Regional Managers, Signalling, Telecommunications and Electrical Installations

Table D3: Survey Questionnaire, Section Three: Activities nos.1-23: Managers' Responses

ACTIVITY	NUMBER OF MANAGERS INTERVIEWED	Frequencies of Managers' Answers to the Question "Who Is Responsible for This Activity ?"																															
		I am	r e s p o n s i b l e i s :																										n o n e	k n o w n			
			A S K E S M	A G M K	A G M R	A G M L	A G M R	D O P T	D D M	D D L	D D G	D D N	D D O	D D Y	D D E	D D I	D D A	D D D	A L M	D P E	P Y E	E I T	K G P	D E S	I R S	M X S	T Y G	S M R			T H E	T H E	
024	8	4		1				3	4	4											1												
025	8	3					1	4		3				2						1													1
026	8	3		1					1	4										1													1
027	8	4		1				2	3	4										1													2
028	21	8		1					12	1		1	1							5	3	1											2
029	25	6		1		2			15	2	14													7									2
030	21	5							9	1		14	1							2	1												2
031	23	6						1	16	1		2	2							2	2	1											4
032	15	6		1					9	7										4	3	1											1
033	15	6		1					9	10										4	2	1											1
034	15	2	1	1						13												1											1
035	15	4		1						13										1	1	1											
036	25	7				2			17		5									3	7	1			1								
037	24	7			2				12		10									3	3				5								1
038	24	9			1				7		5									11	7	1			1								1
039	27	5			1			1	12			10								3	3	1					1						3
040	27	5		1				1	12	1		15								3	1	1					2						1
041	27	9		1				1	16	1		5	2							5	6	1					1						1
042	15	3		1					11				2								1	1							2	1			1
043	15	4		1					8				1									1							8	1			1
044	25	3		1					6		19	1										1							4	4	1		1
045	15	5		1					7		1	2								2	4	1							1	1			1
046	12	7						4	2	7										1	4	1											1
047	12	7						4	2	7										1	5	1											1
048	12	4						2		8			3		2					1	1	1											1
049	12	4						2		8			3		2					1	1	1											1
050	12												3							1	1	1											4
051	12	1							1				6							2	2												4
052	12	1							1				6							2	2	1											4
053	12	8							9	1										4	5	1											
054	18	7							9		2									6	6	1											1
055	22	5							11			1								3	5	1											1
056	11	6							4			1								3	4	1						4					1
057	18	8							4	2	2									9	7	1			1								1
058	17	6							3			1								5	10	1											1
059	11	7		1					2											5	5			3									
060	11	6		1					2											5	5	1											

Table D4: Survey Questionnaire, Section Three: Activities nos.24-60: Managers' Responses

ACTIVITY	NUMBER OF MANAGERS INTERVIEWED	Frequencies of Managers' Answers to the Question "Who Is Responsible for This Activity ?"																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
		I am	r e s p o n s i b l e i s :																										n o n e	k n o w n																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
			A S E K D G M S K R	A A G G G E M M L	A G M P P R	A D O M E T	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M			D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M	D D E E E M

Table D5: Survey Questionnaire, Section Three: Activities nos.61-87: Managers' Responses

ACTIVITY	NUMBER OF MANAGERS INTERVIEWED	Frequencies of Managers' Answers to the Question "Who Is Responsible for This Activity ?"																										
		I am	r e s p o n s i b l e i s :																									
			A S K E S M K	A G D G E R	A G M G R	A A M P L	D O M P T M L	D D D D G	D N G	D D O O Y	D D E E P	D D I A P	A L D L M K	D P E R	E Y I G T P K	D I S S Y	E R S S I A	M X I I A	T Y G R	Y T T H E	n o n e	k n o w n						
088	9	3							9	5																		
089	8	4							3	8																		
090	12	4					10		7	10																		
091	9	3							6	5									1									
092	12	1							12										1									
093	11	1							11										1									
094	12	2							12										2									
095	11								8										3									
096	15	2							4	14																		
097	16	2					1		11	9									1									
098	17	5							7	13									2		2							
099	16	3							15	8									1									
100	12	7							10										8		4							
101	14	8							11	1									8		5							
102	11	7							7										9		5							
103	12	8							10										9		5							
104	13	8							10					1					11		7							
105	11	7							7					1					8		5							
106	14	9							9										13		7							
107	17	13					1		8	10									9		6							
108	14	10							12										11		7							
109	14	10							13										11		7							
110	11	8							8										9		6							
111	12	8							6										9		8							
112	13	10							5										9		8			1				
113	14	7							4	9									9		4							
114	15	10							10										9		7							
115	16	7								12									5									
116	13	6					1		9										7		2							
117	15	6							7										5		4							
118	16	4					1		4	8									1									
119	15	10							7										9		7							
120	15	6							4	9									6		1							

Table D6: Survey Questionnaire, Section Three: Activities nos.88-120: Managers' Responses

ACTIVITY	NUMBER OF MANAGERS INTER- VIEWED	Frequencies of Managers' Answers to the Question "Who Is Responsible for This Activity ?"																												
		I am	r e s p o n s i b l e i s :																											
			A S K E S M	A G D G E K	A G M G R	A G M E L	A G M P R	D O M P	D E T	D E M	D E L	D N G	D N E	D O Y	D D E	D D I	D D A	D D P	A L D L M	D P E	D Y E	E P T	K I G	D E M I R S S T I I A A	T Y M G R	Y S T H E	T S T H E	n o n e	k n o w n	
121	7	4						3				4															4			
122	7	4						1	3				4														4			
123	7	4							4				3														5			
124	14	6							3			8	6														8			
125	7	3							1				3										1				2			
126	7	4							4				4														2			
127	8	2							2				5														2			
128	8	2							1			1	3														4			
129	8	3						1	3				4														4			
130	8	2						1	1			1	4														4			
131	8	2										1	2														5			
132	8	3							5				2														4			
133	8	2							1				3														4			
134	8	2							1				2														5			
135	17	6							4			9	2														6			
136	17	4										6	4													4	2	6		
137	17	5										4	1													3	3	8	1	
138	6	2																								4	3	10	1	
139	6	2																									5			
140	6	2																									5			
141	14	8										3															5			
142	5	2																								4	4	9	2	
143	5	2																									5			
144	5	2																									5			
145	14	4																									5			
146	5	1						1	2			1	2													2	2	10	1	
147	5	1						1	2				3															2		
148	5	1						1	3				2																	
149	18	5						1				11	6														1			
150	5	3							1																	5	2	4	1	
151	5	3							1												2						4	2		
152	5	3							1												1						4	1		
153	15	4							1			1									2						4	1		
154	5	1																			1					1	2	9	4	
155	8	1										4															1			
156	8	1																									4			
157	7	1																									4			
158	17	5										2								1						3	5	7	3	
159	6	2											2														1			
160	4	2																									4	2		
161	4	2																									4	2		
162	13	6										1															4	2		
163	6	2																								2	4	11	5	
164	6	2																									3	1		
165	15	4										1															3	1		
166	7	2																		1						2	1	8	3	
167	6	2																									3	1		
168	16	8																			1						6	8	3	

Table D7: Survey Questionnaire, Section Three: Activities nos.121-168: Managers' Responses

ACTIVITY	RES- PON- DENT	information from						information to					
		c o d e	UNIT	f f q o r u r e a m q l	f f q o r u r e a m q l	f f q o r u r e a m q l	c o d e	UNIT	f f q o r u r e a m q l	f f q o r u r e a m q l	f f q o r u r e a m q l		
1	2	2	05	1 7 3		3 7 2	2	05		2 7 3			
3	2	2	05			3 6 2	2	05		2 6 3			
4	3	3	15	1 3 3		3 4 3	1	82	1 3 2			3 5 2	
	3	8	81	1 2 2	2 4 3		2	03	1 3 2			3 4 2	
5	3	3	61	1 2 3	2 3 2	3 4 2	1	82	1 3 2			3 5 2	
	3	8	81	1 3 2	2 3 2		2	03				3 4 2	
	8	1	85	1 6 1			1	85	1 6 1				
	8	3	61			3 5 1	3	61				3 5 1	
6	15						3	10		2 5 2			
	15						3	20		2 5 2			
	15						3	24		2 5 2			
	15						3	29		2 5 2			
	15						3	31		2 5 2			
	15	1	86		2 4 1	3 5 2	2	04		2 4 1			
	15	1	87		2 4 1	3 5 2	2	05		2 4 1			
7	15						1	84		2 3 2			
	15	1	85		2 3 2		1	85		2 3 2			
	15	1	87		2 3 2		2	32		2 3 2			
	15	2	04		2 3 2								
8	15						1	84		2 3 2			
	15	1	85		2 3 2		1	85		2 3 2			
	15	1	87		2 3 2		2	32		2 3 2			
	15	2	04		2 3 2								
9	15						2	04		2 3 2			
	15						3	32		2 3 2			
	15	1	85		2 4 2		1	85		2 3 2			
	15	2	04		2 3 2		1	84		2 3 2			
10	2	2	05			3 7 3	2	05		2 7 3			
	15						2	04		2 3 2			
	15						3	32		2 3 2			
	15	1	85		2 4 2		1	85		2 3 2			
	15	2	04		2 3 2		1	84		2 3 2			
11	16						2	05				3 3 2	
	16	1	85		2 6 2		1	85	1 4 2	2 4 2		3 4 2	
	16	3	32	1 4 2	2 5 2	3 5 2	3	32		2 3 2			
	16	4	33		2 5 2		4	33		2 3 2			
12	19	1	85		2 6 3		1	85		2 6 1			
	19	2	04	1 5 3	2 4 2		2	04		2 4 1		3 4 1	
	19	3	33		2 4 1	3 4 1							
	19	3	32		2 4 3		3	32		2 4 1		3 4 1	
13	16						2	05				3 3 2	
	16	1	85		2 6 2		1	85	1 4 2	2 4 2		3 4 2	
	16	3	32	1 4 2	2 5 2	3 5 2	3	32		2 3 2			
	16	4	33		2 5 2		4	33		2 3 2			
14	8	2	04	1 6 2			2	04	1 6 2				
	8	3	61			3 5 1	3	61				3 5 1	
15	3						2	03	1 4 3				
	3	3	18		2 4 3	3 4 2	1	82	1 4 2				
	17						2	04		2 4 3			
	17	3	31		2 4 2		1	85		2 4 3			
16	17	1	85		2 4 2		1	85		2 4 3			
	17	1	94		2 4 2		2	04		2 4 3			
17	16						4	33		2 3 2			
	16	1	85		2 6 2		1	85	1 4 2	2 4 2		3 4 3	
	16	3	32	1 4 2	2 5 2	3 5 2							
	16	3	32		2 5 2	3 5 2	2	05				3 3 2	
	16	4	33		2 5 2		3	32		2 3 2			
18	16						2	05				3 3 2	
	16	1	85		2 6 2		1	85	1 4 2	2 4 2		3 4 2	
	16	3	32	1 4 2	2 5 2	3 5 2	3	32		2 3 2			
	16	4	33		2 5 2		4	33		2 3 2			
19	3	3	61	1 3 3		3 4 2	1	82	1 4 3			3 5 2	
	8	3	61			3 3 2	2	05				3 3 2	
20	3	3	61	1 3 3		3 4 2	1	82	1 4 3			3 5 2	
	8	3	61			3 3 2	2	05				3 3 2	
21	8	3	61				2	05					
22	1	1	82		2 3 3		2	05		2 3 3			
					2 4 2		1	82		2 4 2			

Table D8: Survey Questionnaire, Section Four: Information Flows: Managers' Responses

ACTIVITY	RES- PONDENT	information from						information to					
		c o d e	UNIT	f o r e a m q l	f f q o r u r e a m q l	f f q o r u r e a m q l	f f q o r u r e a m q l	c o d e	UNIT	f f q o r u r e a m q l	f f q o r u r e a m q l	f f q o r u r e a m q l	f f q o r u r e a m q l
22	1	2	04			2 5 3		2	04	1 4 2			
	3	1	82	1 2 3				1	82	1 3 2			
	3	2	03	1 3 2			3 5 2						
	3	3	66				3 5 2						
23	8	1	82	1 2 4	2 2 4			1	82	1 2 4	2 2 4		
	8	3	67		2 3 2			2	05		2 3 2		
24	15							3	10		2 5 2		
	15							3	20		2 5 2		
	15							3	24		2 5 2		
	15							3	29		2 5 2		
	15							3	31		2 5 2		
	15	1	86		2 4 1	3 5 2		2	04		2 4 1		
	15	1	87		2 4 1	3 5 2		2	05		2 4 1		
	30							4	52		2 7 2		
	30							5	34		2 7 2		
	30	1	83	1 7 3	2 7 3			3	20		2 7 2		
	30	1	87	1 7 3	2 7 3			3	10		2 7 2		
	30	4	52	1 7 3	2 7 3			3	24		2 7 2		
25	8	1	84		2 3 3								
	8	1	85		2 3 3								
	15				2 3 2			1	84		2 3 2		
	15	1	85		2 3 2			1	85		2 3 2		
	15	1	87		2 3 2			2	32		2 3 2		
	15	2	04		2 3 2								
26	15				2 3 2			1	84		2 3 2		
	15	1	85		2 3 2			1	85		2 3 2		
	15	1	87		2 3 2			2	32		2 3 2		
	15	2	04		2 3 2								
27	15	1			2 3 2			1	84		2 3 2		
	15	1	85		2 3 2			1	85		2 3 2		
	15	1	87		2 3 2			2	32		2 3 2		
	15	2	04		2 3 2								
28	30							3	10		2 7 2		
	30	4	35			2 7 3		3	31		2 7 2		
	30	1	83	1 7 3	2 7 3			3	15		2 7 3		
	30	1	87	1 7 3	2 7 3			3	24		2 7 3		
	30	3	24	1 7 3	2 7 3			3	20		2 7 3		
	35	5	36	1 3 2	2 3 3			3	29		2 5 2		
	35	6	42	1 4 3	2 4 3								
	35	6	37	1 4 3	2 4 3			3	20		2 5 2		
	35	6	58	1 4 3	2 4 3			5	39		2 3 3		
	36							3	35		2 6 1		
	36							3	39		2 4 1		
	36							3	52		2 6 1		
	36	6	37		2 4 3			3	29		2 6 1		
	26	6	38		2 4 3			3	31		2 6 1		
	43	5	36					3	29				
29	44	6	37		2 5 3			3	29		2 4 3	3 6 3	
	44	8	81		2 3 2			5	39		2 4 3	3 6 3	
	30	1	83	1 7 3	2 7 3			3	10		2 7 3		
	30	1	87	1 7 3	2 7 3			3	15		2 7 3		
	30	3	10	1 7 3	2 7 3								
	53	3	29		2 5 3			3	29		2 4 3		
	53	6	57	1 3 4	2 4 3								
	53	6	58	1 3 4	2 4 3								
30	53	8	81	1 3 2									
	26	1	83		2 6 3								
	26	3	29	1 6 3	2 6 3								
	30	1	83	1 7 3	2 7 3			3	15		2 7 3		
	30	1	87	1 7 3	2 7 3			3	24		2 7 3		
	30	3	24	1 7 3	2 7 3								
	30	3	20	1 7 3	2 7 3			3	20		2 7 3		
	30	1	83	1 7 3	2 7 3			3	15		2 7 3		
31	30	1	87	1 7 3	2 7 3			3	24		2 7 3		
	30	3	20	1 7 3	2 7 3								
	30	3	24	1 7 3	2 7 3								
	43	5	36					3	29				
	44	6	37		2 5 3			3	29		2 4 3	3 6 3	

Table D8: (continued)

ACTIVITY	RES- PON- DENT	information from						information to					
		c o d e	UNIT	f o r e a m q l	f f q o r u r e a m q l	f f q o r u r e a m q l	f f q o r u r e a m q l	c o d e	UNIT	f f q o r u r e a m q l	f f q o r u r e a m q l	f f q o r u r e a m q l	
31	44	8	81			2 3 2		5	39		2 4 3	3 6 3	
32	30	1	83	1 7 3	2 7 3			3	15		2 7 3		
	30	1	87	1 7 3	2 7 3			3	31		2 7 3		
	30	3	31	1 7 3	2 7 3								
	43							3	31				
	43	5	36					3	29				
	44							3	31		2 6 3		
	44	6	37		2 6 3			3	29		2 6 3		
33	30	1	83	1 7 3	2 7 3			3	15		2 7 3		
	30	1	87	1 7 3	2 7 3			3	31		2 7 3		
	30	3	31	1 7 3	2 7 3								
	43							3	31				
	43	5	36					3	29				
	44							3	31		2 6 3		
	44	6	37		2 6 3			3	29		2 6 3		
35	30	1	99		2 7 3			4	35		2 7 2		
	30	4	35		2 7 3								
36	30	4	35		2 7 3			4	35		2 7 2		
	30	4	52		2 7 3			4	52		2 7 2		
	36							4	52	1 2 2	2 4 2		
	36	6	37	1 1 2	2 2 1			3	29		2 3 1		
	36	6	38	1 1 2	2 2 1			4	35	1 2 2	2 3 2		
37	30	4	35		2 7 3			4	35		2 7 2		
	30	4	52		2 7 3			4	52		2 7 2		
	36				2 2 1			4	52	1 2 2	2 4 2		
	36	6	37	1 1 2	2 2 2			3	29		2 3 1		
	36	6	38	1 1 2	2 2 2			4	35	1 2 2	2 3 2		
38	30	4	35		2 7 3			4	35		2 7 2		
	30	4	52		2 7 3			4	52		2 7 2		
	35							5	36	1 6 2			
	36							4	52	1 2 2	2 4 2		
	36	6	37	1 1 2	2 2 1			3	29		2 3 1		
	36	6	38	1 1 2	2 2 1			4	35	1 2 2	2 3 2		
39	30	3	20		2 7 3			3	20		2 7 2		
	30	4	35		2 7 3			4	35		2 7 2		
	36							4	35		2 4 1		
	36	6	37		2 3 2			3	29		2 6 1		
	36	6	38		2 3 2			5	39		2 3 1		
40	30	3	20		2 7 3			3	20		2 7 2		
	30	4	35		2 7 3			4	35		2 7 2		
	36							4	35		2 4 1		
	36	6	37		2 3 2			3	29		2 6 1		
	36	6	38		2 3 2			5	39		2 3 1		
41	28	1	87			3 4 2							
	28	3	20			3 6 1							
	28	3	29	1 4 3	2 5 3			3	29			3 3 1	
	30	3	20		2 7 3			3	20		2 7 2		
	30	4	35		2 7 3			4	35		2 7 2		
	35	5	36	1 3 3	2 3 3			5	36		2 4 2		
	35	5	39	1 3 3	2 3 3			5	39		2 4 2		
	35	6	37	1 3 3	2 3 3								
	35	6	42	1 3 3	2 3 3								
	35	6	58	1 3 3	2 3 3			3	29		2 4 2		
	36							4	35		2 4 1		
	36	6	37		2 3 2			3	29		2 6 1		
	36	6	38		2 3 2			5	39		2 3 1		
42	30	3	24		2 7 3			3	24		2 7 2		
	30	5	34		2 7 3			5	34		2 7 2		
43	30	3	24		2 7 3			3	24		2 7 2		
	30	5	34		2 7 3			5	34		2 7 2		
45	30	3	24		2 7 3			3	24		2 7 2		
	30	5	34		2 7 3			5	34		2 7 2		
46	17							1	04		2 4 2		
	17	3	31		2 4 2			1	85		2 4 2		
	30							2	04		2 7 2	3 7 2	
	30	4	35	1 7 3	2 7 3			1	85		2 7 2	3 7 2	
	36	3	31			3 6 2							
	43							3	18				

Table D8: (continued)

ACTIVITY	RES- PONDENT	information from						information to					
		c o d e	UNIT	f f q o r u r e a m q l	f f q o r u r e a m q l	f f q o r u r e a m q l	c o d e	UNIT	f f q o r u r e a m q l	f f q o r u r e a m q l	f f q o r u r e a m q l		
46	43						3	29					
	43	5	36				3	31					
	44						3	18				3	3
	44						3	29				3	3
47	44	7	96			3 3 3	3	31				3	3
	17						1	04		2 4 2			
	17	3	31		2 4 2		1	85		2 4 2			
	30	4	35	1 7 3	2 7 3		2	04		2 7 2		3	7
48	36	3	29			3 6 2	1	85		2 7 2		3	7
	36	3	31			3 6 2							
	43						3	18					
	43						3	29					
49	43	5	36				3	31					
	44						3	18				3	3
	44						3	29				3	3
	44	7	96			3 3 3	3	31				3	3
50	43						3	18					
	43						3	29					
	43	5	36				3	31					
	44						3	18				3	3
51	44						3	29				3	3
	44	7	96			3 3 3	3	31				3	3
	43						3	18					
	43						3	29					
52	43	5	36				3	31					
	44						3	18				3	3
	44						3	29				3	3
	44	7	96			3 3 3	3	31				3	3
53	30	4	35	1 7 3	2 7 3		2	04		2 7 2		3	7
	30	5	36	1 1 2	2 1 1		1	85		2 7 2		3	7
	35	5	39	1 1 2	2 1 1		5	36	1 1 2	2 1 2			
	35	5	37	1 1 2	2 1 1		5	39	1 1 2	2 1 2			
54	35	6	37	1 1 2	2 1 1								
	35	6	42	1 1 2	2 1 1								
	35	6	58	1 1 2	2 1 1								
	35	8	81	1 1 2	2 1 1								
55	36						4	52	1 3 2	2 4 2			
	36						5	39	1 3 2	2 3 2			
	36						5	55	1 3 2	2 3 2			
	36						6	37	1 2 2	2 3 2			
56	36						6	38	1 2 2	2 3 2			
	36	3	29		2 4 1		3	29		2 4 1			
	36	6	38		2 3 2		3	10	1 3 2	2 4 2			
	36	6	37		2 3 2		4	35	1 3 2	2 4 2			
57	43						3	18					
	43						3	29					
	43	5	36				3	31					
	44						3	18				3	3
58	44						3	29				3	3
	44	7	96			3 3 3	3	31				3	3
	35	5	36	1 1 2	2 1 1		5	36	1 1 2	2 1 2			
	35	5	39	1 1 2	2 1 1		5	39	1 1 2	2 1 2			
59	35	6	37	1 1 2	2 1 1								
	35	6	42	1 1 2	2 1 1								
	35	6	58	1 1 2	2 1 1								
	35	8	81	1 1 2	2 1 1								
60	36						4	52	1 3 2	2 4 2			
	36						5	39	1 3 2	2 3 2			
	36						6	37	1 2 2	2 3 2			
	36						6	38	1 2 2	2 3 2			
61	36						6	55	1 3 2	2 3 2			
	36	3	29		2 4 1		3	29		2 4 1			
	36	6	38		2 3 2		3	10	1 3 2	2 4 2			
	36	6	37		2 3 2		4	35	1 3 2	2 4 2			
62	35	5	36	1 1 2	2 1 1		5	36	1 1 2	2 1 2			
	35	5	39	1 1 2	2 1 1		5	39	1 1 2	2 1 2			
	35	6	37	1 1 2	2 1 1								
	35	6	37	1 1 2	2 1 1								

Table D8: (continued)

RES-		information from						information to					
ACTIVITY	PON-	c	UNIT	f f q	f f q	f f q	c	UNIT	f f q	f f q	f f q		
DENT		o		o r u	o r u	o r u	o		o r u	o r u	o r u		
		d		r e a	r e a	r e a	d		r e a	r e a	r e a		
		e		m q l	m q l	m q l	e		m q l	m q l	m q l		
56	35	6	42	1 1 2	2 1 1								
	35	6	58	1 1 2	2 1 1								
	35	8	81	1 1 2	2 1 1								
	36	3	29		2 5 1		3	29		2 5 1			
	36	3	20		2 6 1		4	35	1 4 1	2 4 1			
	36	6	37	1 3 2	2 4 2		5	39	1 4 1	2 4 1			
	36	6	38	1 3 2	2 4 2		6	37	1 4 1	2 4 1			
	35	5	36	1 1 2	2 1 1		5	36	1 1 2	2 1 2			
	35	5	39	1 1 2	2 1 1		5	39	1 1 2	2 1 2			
	35	6	37	1 1 2	2 1 1								
	35	6	42	1 1 2	2 1 1								
	35	6	58	1 1 2	2 1 1								
	35	8	81	1 1 2	2 1 1								
	36						6	37	1 4 1	2 4 1			
57	36	3	34		2 7 1		3	29		2 5 1			
	36	6	37	1 7 2	2 7 2		4	35	1 4 1	2 4 1			
	36	6	38	1 7 2	2 7 2		5	39	1 4 1	2 4 1			
	35	5	36	1 1 2	2 1 2		5	36	1 1 2				
	35	5	39	1 1 2	2 1 2		5	39	1 1 2				
	35	6	37	1 1 2	2 1 2								
	35	6	42	1 1 2	2 1 2								
	35	6	58	1 1 2	2 1 2								
	35	8	81	1 1 2	2 1 2								
	36	1	84		2 2 2		1	84		2 2 1	3 2 1		
	36	2	04	1 2 1	2 2 1		2	04	1 2 1	2 2 1			
	36	3	29	1 5 1			3	29		2 3 1			
	36	3	31	1 5 1			3	31		2 3 1			
	36	4	35	1 2 1	2 3 1		4	35	1 2 1	2 2 1			
58	36	6	37	1 1 2	2 1 1		6	37	1 2 1	2 2 1			
	36	6	38	1 1 1	2 1 1		6	38	1 2 1	2 2 1			
	43						3	18					
	43						3	29					
	43	5	36				3	31					
	44						3	18			3 3 3		
	44						3	29			3 3 3		
	44	7	96			3 3 3	3	31			3 3 3		
	35	5	36	1 1 2	2 1 2		5	36	1 1 2				
	35	5	39	1 1 2	2 1 2		5	39	1 1 2				
	35	6	37	1 1 2	2 1 2								
	35	6	42	1 1 2	2 1 2								
	35	6	58	1 1 2	2 1 2								
	35	8	81	1 1 2	2 1 2								
59	36	1	84		2 2 2		1	84		2 2 1	3 2 1		
	36	2	04	1 2 1	2 2 1		2	04	1 2 1	2 2 1			
	36	3	29	1 5 1			3	29		2 3 1			
	36	3	31	1 5 1			3	31		2 3 1			
	36	4	35	1 2 1	2 3 1		4	35	1 2 1	2 2 1			
	36	6	37	1 1 2	2 1 2		6	37	1 2 1	2 2 1			
	36	6	38	1 1 2	2 1 2		6	38	1 2 1	2 2 1			
	43						3	18					
	43						3	29					
	43	5	36				3	31					
	44						3	18			3 3 3		
	44						3	29			3 3 3		
	35	5	36	1 1 2	2 1 2		5	36	1 1 2				
	35	5	39	1 1 2	2 1 2		5	39	1 1 2				
35	6	37	1 1 2	2 1 2									
35	6	42	1 1 2	2 1 2									
35	6	58	1 1 2	2 1 2									
35	8	81	1 1 2	2 1 2									
36	1	84		2 2 2		1	84		2 2 1	3 2 1			
36	2	04	1 2 1	2 2 1		2	04	1 2 1	2 2 1				
36	3	29	1 5 1			3	29		2 3 1				
36	3	31	1 5 1			3	31		2 3 1				
36	4	35	1 2 1	2 3 1		4	35	1 2 1	2 2 1				
36	6	37	1 1 2	2 1 2		6	37	1 2 1	2 2 1				
36	6	38	1 1 2	2 1 2		6	38	1 2 1	2 2 1				
38	5	36	1 1 2	2 1 2	3 1 1	5	36	1 1 2	2 1 2	3 3 2			

Table D8: (continued)

ACTIVITY	RES- PON- DENT	information from						information to												
		c o d e	UNIT	f f q		f f q		f f q		c o d e	UNIT	f f q		f f q		f f q				
				o r e a m q l	u r e a m q l	o r e a m q l	u r e a m q l	o r e a m q l	u r e a m q l			o r e a m q l	u r e a m q l	o r e a m q l	u r e a m q l					
59	38	7	96	1	1	2	2	1	2	3	3	2								
	43									3	18									
	43									3	29									
	43	5	36							3	31									
	44									3	18					3	3	3		
	44									3	29					3	3	3		
	44	7	96							3	31					3	3	3		
	46	5	36	1	3	3	2	4	3	5	36			2	4	3	3	3	1	
	46	6	37	1	3	2	2	4	2											
	46	6	58	1	3	2	2	4	2											
	46	6	96	1	3	2	2	4	2											
60	35	5	36	1	1	2	2	1	2	5	36	1	1	2						
	35	5	39	1	1	2	2	1	2	5	39	1	1	2						
	35	6	37	1	1	2	2	1	2											
	35	6	42	1	1	2	2	1	2											
	35	6	58	1	1	2	2	1	2											
	35	8	81	1	1	2	2	1	2											
	36	1	84				2	2	2	1	84			2	2	1	3	2	1	
	36	2	04	1	2	1	2	2	1	2	04	1	2	1	2	2	1			
	36	3	29	1	5	1				3	29			2	3	1				
	36	3	31	1	5	1				3	31			2	3	1				
	36	4	35	1	2	1	2	3	1	4	35	1	2	1	2	2	1			
	36	6	37	1	1	2	2	1	2	6	37	1	2	1	2	2	1			
	36	6	38	1	1	2	2	1	2	6	38	1	2	1	2	2	1			
	43									3	18									
	43									3	29									
	43	5	36							3	31									
	44									3	18						3	3	3	
	44									3	29						3	3	3	
61	44	7	96							3	31						3	3	3	
	9									3	29	1	1	2	2	2	3	3	1	
	9									4	52	1	1	2	2	2	3	3	1	
	9	1	83			2	3	2	3	2	04	1	1	2	2	2	3	3	1	
	9	1	87			2	3	2	3	2	10	1	1	2	2	2	3	3	1	
	11	1	83	1	2	3	2	4	3	1	93			2	4	2				
	11	1	93	1	2	3	2	4	3	2	04	1	2	3	2	3	5	1		
	11	3	29			2	3	3	3	5	2	1	1	3	2	3	5	1		
	11	3	52	1	1	2	2	3	3	4	52	1	1	3	2	3	5	1		
	12	3	83			2	4	2	3	3	10	1	4	2	2	3	4	2		
	12	3	29			2	4	2	3	3	29	1	4	2	2	4	2	3	4	3
	12	4	52			2	4	2	3	4	52	1	4	2	2	4	2	3	4	2
	13	1	83	1	3	2	2	3	3											
	13	1	87	1	3	2	2	3	3											
	13	3	10	1	2	2	2	3	2											
	13	3	29	1	2	2	2	3	2											
62	9									3	29	1	1	2	2	2	3	3	1	
	9									4	52	1	1	2	2	2	3	3	1	
	9	1	83			2	3	2	3	2	04	1	1	2	2	2	3	3	1	
	9	1	87			2	3	2	3	2	10	1	1	2	2	2	3	3	1	
	11	1	83	1	2	3	2	4	3	1	93			2	4	2				
	11	1	93	1	2	3	2	4	3	2	04	1	2	3	2	3	5	1		
	11	3	29			2	3	3	3	3	29	1	1	3	2	3	5	1		
	11	4	52	1	1	2	2	3	3	4	52	1	1	3	2	3	5	1		
	12	1	83			2	4	2	3	3	10	1	4	2	2	4	2	3	4	2
	12	3	29			2	4	2	3	3	29	1	4	2	2	4	2	3	4	2
	12	4	52			2	4	2	3	4	52	1	4	2	2	4	2	3	4	2
	13	1	83	1	3	2	2	3	3											
	13	1	87	1	3	2	2	3	3											
	13	3	10	1	2	2	2	3	2											
	13	3	29	1	2	2	2	3	2											
63	9									3	29	1	1	2	2	2	3	3	1	
	9									4	52	1	1	2	2	2	3	3	1	
	9	1	83			2	3	2	3	2	04	1	1	2	2	2	3	3	1	
	9	1	87			2	3	2	3	2	10	1	1	2	2	2	3	3	1	
	13	1	83	1	3	2	2	3	3											
	13	1	87	1	3	2	2	3	3											
	13	3	10	1	2	2	2	3	2											
	13	3	29	1	2	2	2	3	2											

Table D8: (continued)

ACTIVITY	RES- PON- DENT	information from						information to					
		c o d e	UNIT	f o r e a m q l	f f q r e a m q l	f f q r e a m q l	f f q r e a m q l	c o d e	UNIT	f f q r e a m q l	f f q r e a m q l	f f q r e a m q l	f f q r e a m q l
63	53	1	86	1 6 3	2 6 3								
	53	1	83		2 2 4			6	58	1 3 3	2 4 3		
	53	1	87	1 6 3				6	57	1 3 3	2 4 3		
	53	6	57	1 6 3	2 2 2								
	53	6	58	1 6 3	2 2 4								
	54	1	93		2 1 4	3 2 2		1	93	1 1 2	2 1 2		
	54	1	83		2 1 4	3 2 2		3	10	1 1 2	2 1 2	3 1 2	
	54	1	87		2 1 4	3 2 2		3	29	1 1 2	2 1 2	3 1 2	
	54	3	10	1 1 2	2 1 2	3 1 2		4	52	1 1 2	2 1 2	3 1 2	
	54	3	29	1 1 2	2 1 2	3 1 2		5	53	1 1 2	2 1 2	3 1 2	
	54	4	52	1 1 2	2 1 2	3 1 2		6	57	1 1 2	2 1 2	3 1 2	
	54	5	53	1 1 2	2 1 2	3 1 2		6	58	1 1 2	2 1 2	3 1 2	
	54	6	57	1 1 2	2 1 2	3 1 2							
	54	6	58	1 1 2	2 1 2	3 1 2							
64	9							3	29	1 1 2	2 2 2	3 3 1	
	9							4	52	1 1 2	2 2 2	3 3 1	
	9	1	83		2 3 2	3 3 2		2	04	1 1 2	2 2 2	3 3 1	
	9	1	87		2 3 2	3 3 2		3	10	1 1 2	2 2 2	3 3 1	
	53	1	87	1 6 3									
	53	1	83		2 2 4			6	58	1 3 3	2 4 3		
	53	1	86	1 6 3	2 6 3			6	57	1 3 3	2 4 3		
	53	6	57	1 6 3	2 2 4								
	53	6	58	1 6 3	2 2 4								
	54	1	93		2 1 4	3 2 2		1	93	1 1 2	2 1 2	3 1 2	
	54	1	83		2 1 4	3 2 2		3	10	1 1 2	2 1 2	3 1 2	
	54	1	87		2 1 4	3 2 2		3	29	1 1 2	2 1 2	3 1 2	
	54	3	10	1 1 2	2 1 2	3 1 2		4	52	1 1 2	2 1 2	3 1 2	
	54	3	29	1 1 2	2 1 2	3 1 2		5	53	1 1 2	2 1 2	3 1 2	
	54	4	52	1 1 2	2 1 2	3 1 2		6	58	1 1 2	2 1 2	3 1 2	
	54	5	53	1 1 2	2 1 2	3 1 2		6	57	1 1 2	2 1 2	3 1 2	
	54	6	57	1 1 2	2 1 2	3 1 2							
	54	6	58	1 1 2	2 1 2	3 1 2							
	58	1	93	1 4 4	2 4 3			1	93	1 5 4			
	58	5	53	1 5 3		3 6 2		5	53		2 3 3		
	58	7	92	1 3 4									
65	9							3	29	1 1 2	2 2 2	3 3 1	
	9							4	52	1 1 2	2 2 2	3 3 1	
	9	1	83		2 3 2	3 3 2		2	04	1 1 2	2 2 2	3 3 1	
	9	1	87		2 3 2	3 3 2		3	10	1 1 2	2 2 2	3 3 1	
	11	1	83	1 2 3	2 4 3	3 6 3		1	93		2 4 2		
	11	1	93	1 2 3	2 4 3	3 6 3		2	04	1 2 3	2 3 2	3 5 1	
	11	3	29		2 3 3	3 5 3		3	29	1 1 3	2 3 2	3 5 1	
	11	4	52	1 1 2	2 3 3	3 5 1		4	52	1 1 3	2 3 2	3 5 1	
66	9	3	10		2 6 2	3 6 2		2	05			3 4 2	
	9	4	52		2 6 2	3 6 2		4	52			3 4 2	
	53	1						6	57		2 4 3	3 3 3	
	53	1	93	1 5 3	2 3 3	3 1 3		6	58		2 4 3	3 3 2	
	53	6	57	1 1 3									
	53	6	58	1 1 3									
	57	1	83		2 3 2			4	52	1 1 3	2 2 2	3 6 2	
	57	4	52	1 1 3	2 3 3	3 5 3		7	92	1 1 2	2 3 2		
	57	6	58	1 2 4	2 3 3								
	57	7	92	1 1 4	2 4 4								
67	9							4	52			3 4 2	
	9	3	10		2 6 2	3 6 2		2	05			3 4 2	
	9	4	52		2 6 2	3 6 2		3	10			3 4 2	
	53	1	93	1 5 3	2 3 3	3 1 3		6	58		2 4 3	3 3 2	
	53	6	58	1 1 3									
	53	6	57	1 1 3				6	57		2 4 3	3 3 2	
	58	1	93	1 4 4	2 6 2			1	93	1 6 3			
	58	5						5	55	1 1 3	2 1 2		
	58	5	53	1 2 3	2 2 4	3 6 2		5	53	1 1 2	2 2 2		
	58	8	81	1 1 3	2 1 4	3 6 2		5	56	1 1 3	2 1 2		
68	9							4	52			3 4 2	
	9	3	10		2 6 2	3 6 2		2	05			3 4 2	
	9	4	52		2 6 2	3 6 2		3	10			3 4 2	
	53	1	83		2 3 4	3 6 2		1	85			3 6 2	
	53	1	87	1 4 3	2 3 4	3 6 2		3	15			3 6 2	

Table D8: (continued)

		information from						information to									
RES-																	
ACTIVITY	PON-	c	UNIT	f f q	f f q	f f q		c	UNIT	f f q	f f q	f f q					
DENT		o		o r u	o r u	o r u		o		o r u	o r u	o r u					
		d		r e a	r e a	r e a		d		r e a	r e a	r e a					
		e		m q l	m q l	m q l		e		m q l	m q l	m q l					
68	53	6	57			3 6 3		3	64							3 6 2	
	53	6	58			3 6 3		3	10							3 6 2	
	53	8	81	1 5 3	2 3 3	3 6 2											
	57	1	93	1 5 3	2 5 3			4	52		2 6 2						
	57	4	52	1 5 3	2 6 3												
	57	7	92	1 5 4	2 6 3												
69	9							4	52							3 4 2	
	9	3	10		2 6 2	3 6 2		2	05							3 4 2	
	9	4	52		2 6 2	3 6 2		3	10							3 4 2	
	53	1	83		2 3 4	3 6 2		1	85							3 6 2	
	53	1	87	1 4 3	2 3 4	3 6 2		3	15							3 6 2	
	53	6	57			3 6 3		3	64							3 6 2	
	53	6	58			3 6 3		3	20							3 6 2	
	53	8	81	1 5 3	2 3 3	3 6 2											
	58	1	93	1 4 4	2 4 3			1	93	1 5 4							
	58	5	53	1 5 3		3 6 2		5	53		2 3 3						
	58	7	92	1 3 4													
	70	9							4	52							3 4 2
9		3	10		2 6 2	3 6 2		2	05							3 4 2	
9		3	64		2 6 2	3 6 2		3	64							3 4 2	
9		4	52		2 6 2	3 6 2		3	10							3 4 2	
53		3	65			3 2 2		3	64							3 1 2	
53		6	57			3 1 2											
53		6	58			3 1 2											
57		1	93	1 1 3	2 6 2			1	93	1 1 3	2 6 2						
57		3	64	1 1 3	2 1 3			3	64	1 1 3	2 1 3						
57		3	65	1 1 3	2 1 3			3	65	1 1 3	2 1 3						
57		4	52	1 1 3	2 1 3			4	52	1 1 3	2 1 3						
57		6	58	1 2 4	2 5 3												
71	57	7	92	1 2 4	2 5 3												
	9							4	52							3 4 2	
	9	3	10		2 6 2	3 6 2		2	05							3 4 2	
	9	3	64		2 6 2	3 6 2		3	64							3 4 2	
	9	4	52		2 6 2	3 6 2		3	10							3 4 2	
	53	3	65			3 2 2											
	53	6	57			3 1 2											
	53	6	58			3 1 2		3	64							3 1 2	
	57	1	93	1 1 3	2 6 2			1	93	1 1 3	2 6 2						
	57	3	64	1 1 3	2 1 3			3	64	1 1 3	2 1 3						
	57	3	65	1 1 3	2 1 3			3	65	1 1 3	2 1 3						
	57	4	52	1 1 3	2 1 3			4	52	1 1 3	2 1 3						
72	57	6	58	1 2 4	2 5 3												
	57	7	92	1 2 4	2 5 3												
	58							5	53	1 3 5	2 4 3						
	58	7	92	1 1 3	2 2 3			1	93	1 1 4	2 1 4						
	59							4	52							3 3 3	
	59	7	92			3 1 3		3	64							3 3 3	
	9							3	10							3 6 2	
	9							3	15							3 6 2	
	9							3	61							3 6 2	
	9							3	64							3 6 2	
	9	4	52			3 6 2		2	05							3 6 2	
	53	6	57		2 4 2	3 6 2		6	57							3 6 2	
73	53	6	58		2 4 2	3 6 2		6	58							3 6 2	
	53	8	81		2 2 2	3 2 2											
	57	4	52	1 6 3	2 5 3			4	52	1 6 3	2 6 3						
	57	6	58	1 6 4	2 6 3												
	57	7	92	1 5 4	2 5 3												
	9							3	10							3 6 2	
	9							3	15							3 6 2	
	9							3	61							3 6 2	
	9							3	64							3 6 2	
	9	4	52			3 6 2		2	05							3 6 2	
	53	6	57		2 4 2	3 6 2		6	57							3 6 2	
	53	6	58		2 4 2	3 6 2		6	58							3 6 2	
53	8	81		2 2 2	3 2 2												
59							7	92							3 3 2		
59	5	52			3 3 2		5	52							3 3 2		

Table D8: (continued)

ACTIVITY	RES- PONDENT	information from						information to													
		c o d e	UNIT	f f q		f f q		f f q		c o d e	UNIT	f f q		f f q		f f q					
				o r e a m q l	u r e a m q l	o r e a m q l	u r e a m q l	o r e a m q l	u r e a m q l			o r e a m q l	u r e a m q l	o r e a m q l	u r e a m q l						
74	9									3	10					3	6	2			
	9									3	15					3	6	2			
	9									3	61					3	6	2			
	9									3	64					3	6	2			
	9	4	52					3	6	2	2	05				3	6	2			
	53	3	65					3	2	2	3	64				3	1	2			
	53	6	57					3	1	2											
	53	6	58					3	1	2											
75	9									3	10					3	6	2			
	9									3	15					3	6	2			
	9									3	61					3	6	2			
	9									3	64					3	6	2			
	9	4	52					3	6	2	2	05				3	6	2			
	53	3	65					3	2	2	3	64				3	1	2			
	53	6	57					3	1	2											
	53	6	58					3	1	2											
76	59									4	52					3	3	3			
	59	7	92					3	1	3	3	64				3	3	3			
	9	3	29	1	1	2	2	1	2	2	05			2	1	2	3	1	2		
	9	4	35	1	1	2	2	1	2												
	9	4	52	1	1	2	2	1	2												
	53	6	57					3	3	2											
	53	6	58					3	3	2	2	04	1	1	2	3	3	2			
	54									6	57	1	1	2	2	1	2	3	1	2	
77	54									6	58	1	1	2	2	1	2	3	1	2	
	54	4	52	1	1	2	2	1	2	3	1	2	1	1	2	2	1	2	3	1	2
	54	6	58	1	1	2	2	1	2	3	1	2	1	1	2	2	1	2	3	1	2
	54	6	57	1	1	2	2	1	2	3	1	2	1	1	2	2	1	2	3	1	2
	57									5	53	1	1	2	2	1	2	3	1	2	
	57	2	04	1	2	4				7	92	1	1	3	2	4	3				
	57	4	52	1	3	3	2	3	3	2	4	52	1	3	3	2	3	3			
	57	6	58	1	1	3	2	3	3	6	58	1	1	3	2	4	3				
78	9	3	29	1	1	2	2	1	2	3	1	2			2	1	2	3	1	2	
	9	4	35	1	1	2	2	1	2												
	9	4	52	1	1	2	2	1	2												
	53	6	57					3	3	2											
	53	6	58					3	3	2	2	04	1	1	2		3	3	2		
	57	4	52	1	6	3	2	5	3	4	52	1	6	3	2	6	3				
	57	6	58	1	6	4	2	6	3												
	57	7	92	1	5	4	2	5	3												
79	9	3	29	1	1	2	2	1	2	3	1	2			2	1	2	3	1	2	
	9	4	35	1	1	2	2	1	2												
	9	4	52	1	1	2	2	1	2												
	53	6	57					3	3	2											
	53	6	58					3	3	2	2	04	1	1	2		3	3	2		
	58	5	55	1	2	5	2	3	5	3	3	3	1	3	4	2	2	4	3	3	3
	58	5	36	1	2	5	2	3	5	3	3	3	1	3	4	2	2	4	3	3	3
	58	7	92	1	1	2				5	53										
80	59									7	92						3	3	2		
	59	5	52					3	3	2	5	52					3	3	2		
	9	3	29	1	1	2	2	1	2	3	1	2			2	1	2	3	1	2	
	9	4	35	1	1	2	2	1	2												

Table D8: (continued)

ACTIVITY	RES- PONDENT	information from						information to					
		c o d e	UNIT	f f q o r u r e a m q l	f f q o r u r e a m q l	f f q o r u r e a m q l		c o d e	UNIT	f f q o r u r e a m q l	f f q o r u r e a m q l	f f q o r u r e a m q l	
80	53	6	57				3 3 2						
	53	6	58				3 3 2	2	04	1 1 2			3 3 2
	57							7	92	1 1 3	2 3 3		
	57	3	64	1 1 3	2 1 3			2	04	1 3 3	2 5 2		
	57	3	65	1 1 3	2 1 3			3	64	1 1 3	2 1 3		
	57	4	52	1 1 3	2 1 3			3	65	1 1 3	2 1 3		
	57	6	58	1 1 3	2 3 3			4	52	1 1 3	2 1 3		
	57	7	92	1 1 3	2 3 3			6	58	1 1 3	2 3 3		
	9	3	29	1 1 2	2 1 2	3 1 2		2	05		2 1 2	3 1 2	
	9	4	35	1 1 2	2 1 2	3 1 2							
81	9	4	52	1 1 2	2 1 2	3 1 2							
	53	6	57				3 3 2						
	53	6	58				3 3 2	2	04	1 1 2			3 3 2
	57							7	92	1 1 3	2 3 3		
	57	3	64	1 1 3	2 1 3			2	04	1 3 3	2 5 2		
	57	3	65	1 1 3	2 1 3			3	64	1 1 3	2 1 3		
	57	4	52	1 1 3	2 1 3			3	65	1 1 3	2 1 3		
	57	6	58	1 1 3	2 3 3			4	52	1 1 3	2 1 3		
	57	7	92	1 1 3	2 3 3			6	58	1 1 3	2 3 3		
	58							5	53	1 1 2	2 3 3	3 3 3	
82	58	7	92	1 1 2		3 2 3		3	35	1 1 2	2 3 3	3 3 3	
	59							4	52			3 3 3	
	59	7	92				3 1 3	3	64			3 3 3	
	9	3	29	1 1 2	2 1 2	3 1 2		2	05		2 1 2	3 1 2	
	9	4	35	1 1 2	2 1 2	3 1 2							
	9	4	52	1 1 2	2 1 2	3 1 2							
	13	1	93	1 1 2	2 2 1	3 2 1		1	93	1 1 2	2 2 1	3 2 1	
	13	2	04	1 2 2	2 2 2			2	04	1 1 2	2 2 1	3 3 1	
	13	3	10	1 2 2	2 2 2			3	10	1 2 2	2 3 2		
	13	3	29	1 2 2	2 2 2			3	29	1 2 2	2 3 2		
83	13	4	52	1 2 2	2 2 2			4	52	1 2 2	2 3 2		
	13	6	57	1 2 2	2 2 2			6	57	1 2 2	2 3 2		
	13	6	58	1 2 2	2 2 2			6	58	1 2 2	2 3 2		
	53	6	57				3 3 2						
	53	6	58				3 3 2	2	04	1 1 2			3 3 2
	57							4	52	1 2 3	2 2 3		
	57							6	58	1 3 3	2 3 3		
	57							7	92	1 3 3	2 3 3		
	57	4	52	1 4 2	2 4 2			1	93	1 3 3	2 3 3		
	57	6	58	1 3 3	2 3 2			3	64	1 2 3	2 2 3		
84	57	7	92	1 3 3	2 3 2			3	65	1 2 3	2 2 3		
	58	5	36		2 2 3								
	58	7	92	1 2 3									
	9	3	29	1 1 2	2 1 2	3 1 2		2	05		2 1 2	3 1 2	
	9	4	35	1 1 2	2 1 2	3 1 2							
	9	4	52	1 1 2	2 1 2	3 1 2							
	53	6	57				3 3 2						
	53	6	58				3 3 2	2	04	1 1 2			3 3 2
	58	3	15				3 3 5						
	58	3	61				3 3 5						
85	58	7	92	1 2 3									
	9	3	29	1 1 2	2 1 2	3 1 2		2	05		2 1 2	3 1 2	
	9	4	35	1 1 2	2 1 2	3 1 2							
	9	4	52	1 1 2	2 1 2	3 1 2							
	12	3	18				3 4 3	3	61			3 6 2	
	53	6	57				3 3 2						
	53	6	58				3 3 2	2	04	1 1 2			3 3 2
	9	3	29	1 1 2	2 1 2	3 1 2		2	05		2 1 2	3 1 2	
	9	4	35	1 1 2	2 1 2	3 1 2							
	9	4	52	1 1 2	2 1 2	3 1 2							
86	53	6	57				3 3 2						
	53	6	58				3 3 2	2	04	1 1 2			3 3 2
	57	2	04	1 5 3				2	04	1 5 3			

Table D8: (continued)

ACTIVITY	RES- PON- DENT	information from						information to					
		c o d e	UNIT	f f q o r u r e a m q l	f f q o r u r e a m q l	f f q o r u r e a m q l	c o d e	UNIT	f f q o r u r e a m q l	f f q o r u r e a m q l	f f q o r u r e a m q l		
87	57	4	52	1 2 3	2 6 2		4	52	1 2 3	2 6 2			
	9	3	29	1 1 2	2 1 2	3 1 2	2	05		2 1 2	3 1 2		
	9	4	35	1 1 2	2 1 2	3 1 2							
	9	4	52	1 1 2	2 1 2	3 1 2							
	53	6	57			3 3 2							
	53	6	58			3 3 2	2	04	1 1 2		3 3 2		
	58	5	36		2 2 5		4	52	1 2 3				
	58	5	55		2 2 5		4	52			3 6 3		
	58	7	92	1 1 4									
	59	5	36			3 1 5	5	52			3 1 2		
	59	5	55			3 1 5	7	92			3 1 2		
	21	1	83	1 2 3	2 2 3	3 2 3							
	21	1	87	1 2 3	2 2 3	3 2 3							
88	21	1	86	1 2 3	2 2 3	3 2 3	5	39		2 3 3	3 3 3		
	26	1	83		2 4 4	3 5 4							
	26	1	86	1 4 4	2 4 4	3 5 4							
	23	1	87			3 6 2	5	39	1 3 2	2 5 2			
	25	1	85	1 5 3	2 5 2		5	39	1 4 3				
	25	1	86	1 6 2		3 6 2	5	26	1 4 3				
	25	4	95	1 3 3	2 4 3								
	26	1	83		2 4 4	3 5 4							
	26	1	86	1 4 4	2 4 4	3 5 4							
	28	1	87			3 4 2	3	29			3 3 1		
	28	3	20			3 6 1							
	28	3	29	1 4 3	2 5 3								
	30						5	34		2 7 2			
89	30	1	83	1 7 3	2 7 3		3	20		2 7 2			
	30	1	87	1 7 3	2 7 3		3	10		2 7 2			
	30	1	83		2 7 3		4	52		2 7 2			
	30	4	35	1 7 3	2 7 3		3	24		2 7 2			
	21	1	83	1 2 3	2 2 3	3 2 3							
	21	1	87	1 2 3	2 2 3	3 2 3							
	21	1	86	1 2 3	2 2 3	3 2 3	5	39		2 3 3	3 3 3		
	25	1	86	1 6 2	2 6 2								
	21	1	83	1 2 3	2 2 3	3 2 3							
	21	1	87	1 2 3	2 2 3	3 2 3							
	21	1	86	1 2 3	2 2 3	3 2 3	5	39		2 3 3	3 3 3		
	23	1	83	1 1 2			5	39		2 4 2			
	23	1	83	1 1 2			5	39		2 4 2			
	51	1	83		2 6 3	3 6 3	7	92	1 2 2	2 4 2			
90	51	3	20	1 4 4	2 6 3		3	20		2 4 2			
	51	5	39	1 3 2	2 4 2		5	39		2 4 2			
	26	1	83	1 3 4	2 3 4	3 4 4	5	25			3 3 3		
	21	3	29	1 3 3	2 3 3								
	21	3	24	1 3 3	2 3 3		5	39			3 3 2		
	21	5	39	1 3 3	2 3 3								
	26	1	83	1 3 4	2 3 4	3 4 4	5	25			3 3 3		
	23	1	83	1 1 2			5	39		2 4 2			
	26	1	83	1 3 4	2 3 4	3 4 4	5	25			3 3 3		
	42	3	20	1 3 3	2 4 3	3 5 3	5	39	1 3 3	2 4 3			
	42	5	39	1 2 3	2 2 3	3 6 3	7	92	1 4 3	2 4 3			
	42	7	92	1 3 4	2 4 4								
	51	1	83		2 6 3	3 6 3	7	92	1 2 2				
	51	3	20	1 4 4	2 6 3		3	20		2 4 2			
91	51	5	39	1 3 2	2 4 2		5	39		2 4 2			
	22	3	10		2 6 5								
	22	3	29		2 6 5		5	39			3 4 1		
	22	4	35		2 6 5								
	22	4	52		2 6 5								
	26	1	83	1 3 4	2 3 4	3 4 4	5	25			3 3 3		
	21	3	24		2 6 3		3	15			3 6 2		
	21	5	39		2 6 3		3	64			3 6 2		
	39	6	42	1 2 2	2 2 2		3	20		2 3 2			
	40	6	42	1 2 2	2 2 2		3	20		2 3 2			
	41	7	91	1 3 3	2 3 3		5	39	1 1 2	2 3 2	3 6 2		
	41	8	81	1 2 2									
	47	2	06	1 2 3									
	47	3	20	1 3 3	2 3 2		3	20	1 3 2	2 3 2	3 3 2		

Table D8: (continued)

ACTIVITY	RES- PON- DENT	information from						information to													
		c o d e	UNIT	f f q		f f q		f f q		c o d e	UNIT	f f q		f f q		f f q					
				o r e a m q l	u r e a m q l	o r e a m q l	u r e a m q l	o r e a m q l	u r e a m q l			o r e a m q l	u r e a m q l	o r e a m q l	u r e a m q l						
100	47	6	42	1	2	2	2	3	4	2	6	42	1	2	2	2	3	2			
	48	3	20	1	2	3					3	20	1	2	3						
	48	5	39	1	1	1					5	39	1	1	3						
101	48	6	42	1	2	3					6	42	1	2	3						
	21	3	24				2	6	3		3	15						3	6	2	
	21	5	39				2	6	3		3	64						3	6	2	
	39	6	42	1	2	2	2	2	2		3	20		2	3	2					
	40	6	42	1	2	2	2	2	2		3	20		2	3	2					
	42	7	92	1	6	3	2	6	3		5	39		2	6	2					
	47	2	06	1	2	3															
	47	3	20	1	3	3	2	3	2		3	20	1	3	2	2	3	2	3	3	2
	47	6	42	1	2	2	2	3	2	3	4	2	6	42	1	2	2	2	3	2	
	48	3	20	1	2	3					3	20	1	2	3						
	48	5	39	1	1	1					5	39	1	1	3						
	48	6	42	1	2	3					6	42	1	2	3						
	50	7	91	1	3	3	2	3	3		5	39		2	2	3	3	3	3	3	
	50	8	81	1	3	2	2	3	2												
	51	5	39	1	2	2					3	20		2	3	2					
	51	5	39						3	6	2	5	39		2	3	2				
	51	5	39				2	3	2		5	39	1	3	2						
	51	7	92				2	1	2		7	92		2	2	2					
102	51	7	92	1	2	2					7	92	1	2	2						
	39	6	42	1	2	2	2	2	2		3	20		2	3	2					
	40	6	42	1	2	2	2	2	2		3	20		2	3	2					
	41	7	91	1	3	3	2	3	3		5	39	1	1	2	2	3	2	3	6	2
	41	8	81	1	2	2															
	47	2	06	1	2	3															
	47	3	20	1	3	3	2	3	2		3	20	1	3	2	2	3	2	3	3	2
	47	6	42	1	2	2	2	3	2	3	4	2	6	42	1	2	2	2	3	2	
	48	3	20	1	2	3					3	20	1	2	3						
	48	5	39	1	1	1					5	39	1	1	3						
	48	6	42	1	2	3					6	42	1	2	3						
	50	7	91	1	3	3	2	3	3		5	39		2	2	3	3	3	2		
103	50	8	81	1	3	2	2	3	2												
	21	3	24				2	6	3		3	15						3	6	2	
	21	5	39				2	6	3		3	64						3	6	2	
	39	6	42	1	2	2	2	2	2		3	20		2	3	2					
	40	6	42	1	2	2	2	2	2		3	20		2	3	2					
	41	7	91	1	3	3	2	3	3		5	39	1	1	2	2	3	2	3	6	2
	41	8	81	1	2	2															
	47	2	06	1	2	3															
	47	3	20	1	3	3	2	3	2		3	20	1	3	2	2	3	2	3	3	2
	47	6	42	1	2	2	2	3	2	3	4	2	6	42	1	2	2	2	3	2	
	48	3	20	1	2	3					3	20	1	2	3						
	48	5	39	1	1	1					5	39	1	1	3						
	48	6	42	1	2	3					6	42	1	2	3						
	50	7	91	1	3	3	2	3	3		5	39		2	2	3	3	3	2		
	50	8	81	1	3	2	2	3	2												
104	39	6	42	1	2	2	2	2	2		3	20		2	3	2					
	40	6	42	1	2	2	2	2	2		3	20		2	3	2					
	42	7	92	1	6	3	2	6	3		5	39		2	6	2					
	47	2	06	1	2	3															
	47	3	20	1	3	3	2	3	2		3	20	1	3	2	2	3	2	3	3	2
	47	6	42	1	2	2	2	3	2	3	4	2	6	42	1	2	2	2	3	2	
	48	3	20	1	2	3					3	20	1	2	3						
	48	5	39	1	1	1					5	39	1	1	3						
	48	6	42	1	2	3					6	42	1	2	3						
	50	7	91	1	3	3	2	3	3		5	39		2	2	3	3	3	2		
	50	8	81	1	3	2	2	3	2												
	51	5	39	1	2	2	2	3	2	3	6	2	5	39	1	3	2	2	3	2	
105	51	7	92	1	2	2	2	1	2		7	92	1	2	2	2	2	2			
	39	6	42	1	2	2	2	2	2		3	20		2	3	2					
	40	6	42	1	2	2	2	2	2		3	20		2	3	2					
	41	7	91	1	3	3	2	3	3		5	39	1	1	2	2	3	2	3	6	2
	41	8	81	1	2	2															
	47	2	06	1	2	3															
	47	3	20	1	3	3	2	3	2		3	20	1	3	2	2	3	2	3	3	2

Table D8: (continued)

		information from						information to					
ACTIVITY	RES- PONDENT												
		c o d e	UNIT	f o r e m	f r e a m q l	f r e a m q l	c o d e	UNIT	f o r e m	f r e a m q l	f r e a m q l	f o r e m	f r e a m q l
105	47	6	42	1 2 2	2 3 2	3 4 2	6	42	1 2 2	2 3 2			
	48	3	20	1 2 3			3	20	1 2 3				
	48	5	39	1 1 1			5	39	1 1 3				
	48	6	42	1 2 3			6	42	1 2 3				
	50	7	91	1 3 3	2 3 3		5	39		2 2 3	3 3 2		
106	50	8	81	1 3 2	2 3 2								
	39	6	42	1 4 2	2 4 2		3	20		2 6 2			
	40	6	42		2 6 2		3	20		2 6 2			
	41	7	91	1 3 3	2 3 3		5	39	1 4 3			3 6 1	
	41	8	81	1 2 2									
	42	7	92	1 2 3	2 3 3		5	39	1 2 3	2 3 3	3 6 3		
	47	3	20	1 5 3	2 5 3	3 6 3	3	20	1 3 2	2 3 2	3 6 2		
	47	3	42	1 4 2	2 4 2	3 6 2	6	42	1 3 2	2 3 2	3 6 2		
	48	3	20	1 5 3	2 5 3	3 6 3	3	20	1 3 2	2 3 2	3 6 2		
	48	6	42	1 4 2	2 4 2	3 6 2	6	42	1 3 2	2 3 2	3 6 2		
	50	5	39		2 3 2	3 3 2	5	39	1 4 2	2 4 2	3 6 3		
	50	6	37	1 4 3	2 4 3								
	50	6	58	1 4 3	2 4 3								
	50	7	91	1 5 3	2 5 3								
107	51						3	20		2 3 2			
	51	5	39	1 2 2	2 3 2	3 6 2	5	39	1 3 2	2 3 2			
	51	7	92	1 2 2	2 1 2		7	92	1 2 2	2 2 2			
	16						2	05			3 3 2		
	16	1	85		2 6 2		1	85	1 4 2	2 4 2	3 4 2		
	16	3	32	1 4 2	2 5 2	3 5 2	1	85		2 4 2			
	16	4	33		2 5 2		4	33		2 3 2			
	21	3	24		2 6 2		3	15			3 6 2		
	21	5	39		2 6 2		3	64			3 6 2		
	25	3	20	1 6 1									
	25	3	24	1 6 1			5	39	1 5 2				
	28	2	06	1 6 2			2	06	1 6 2				
	39	3	24	1 5 3	2 5 3		3	24	1 6 2				
	40	5	39	1 6 2			5	39	1 6 2				
	41	7	91	1 3 3	2 3 3		5	39	1 4 3		3 6 1		
	41	8	81	1 2 2									
	47	3	20	1 6 2	2 6 2	3 6 2	3	20	1 3 2	2 4 2	3 6 2		
	47	3	24		2 6 2		3	24	1 5 2	2 6 2	3 6 2		
	47	6	42	1 3 2	2 3 2	3 6 2	6	42	1 3 2	2 4 2	3 6 2		
	48	3	20	1 6 2	2 6 2		3	20	1 3 2	2 4 2	3 6 2		
	48	3	24		2 6 2	3 6 2	3	24	1 5 2	2 6 2	3 6 2		
	48	6	42	1 3 2	2 3 2	3 6 2	6	42	1 3 2	2 4 2	3 6 2		
	50	5	39		2 3 2	3 3 2	5	39	1 4 2	2 4 2	3 6 3		
	50	6	37	1 4 3	2 4 3								
	50	6	58	1 4 3	2 4 3								
	50	7	91	1 5 3	2 5 3								
108	51						3	20		2 3 2			
	51	5	39	1 2 2	2 3 2	3 6 2	5	39	1 3 2	2 3 2			
	51	7	92	1 2 2	2 1 2		7	92	1 2 2	2 2 2			
	21	3	24		2 6 2		3	14			3 6 2		
	21	5	39		2 6 2		3	64			3 6 2		
	39	6	42	1 4 2	2 4 2		3	20		2 6 2			
	40	6	42		2 6 2		3	20		2 6 2			
	41	7	91	1 3 3	2 4 3		5	39	1 4 3	2 5 2			
	41	8	81	1 2 2									
	42	7	92	1 6 3	2 6 3		5	39		2 6 2			
	47	3	20	1 3 3	2 4 3	3 6 3	3	20	1 3 2	2 3 2	3 6 2		
	47	3	64	1 3 3	2 5 3	3 6 3	3	64	1 3 2	2 3 2	3 6 2		
	47	3	65	1 3 3	2 3 3	3 6 3	3	65	1 3 2	2 3 2	3 6 2		
	47	6	42	1 2 2	2 3 2	3 6 2	6	42	1 2 2	2 3 2	3 6 2		
	48	3	20	1 3 3	2 4 3	3 6 3	3	20	1 3 2	2 3 2	3 6 2		
	48	3	64	1 3 3	2 5 3	3 6 3	3	64	1 3 2	2 2 2	3 6 2		
	48	3	65	1 3 3	2 3 3	3 6 3	3	65	1 3 2	2 3 2	3 6 2		
	48	6	42	1 3 2	2 4 2	3 6 2	6	42	1 3 2	2 4 2	3 6 2		
	50	5	39		2 3 2	3 3 2	5	39	1 4 2	2 4 2	3 6 3		
	50	6	37	1 4 3	2 4 3								
	50	6	58	1 4 3	2 4 3								
	50	7	91	1 5 3	2 5 3								
	51						3	20		2 3 2			

Table D8: (continued)

ACTIVITY	RES-PON-DENT	information from						information to					
		c o d e	UNIT	f f q	f f q	f f q	c o d e	UNIT	f f q	f f q	f f q	c o d e	UNIT
				o r u r e a m q l	o r u r e a m q l	o r u r e a m q l			o r u r e a m q l	o r u r e a m q l	o r u r e a m q l		
108	51	5	39	1 2 2	2 3 2	3 6 2	5	39	1 3 2	2 3 2			
	51	7	92	1 2 2	2 1 2		7	92	1 2 2	2 2 2			
109	39	6	42	1 4 2	2 4 2		3	20		2 6 2			
	40	6	42		2 6 2		3	20		2 6 2			
	41	7	91	1 3 3	2 4 3		5	39	1 4 3	2 5 2			
	41	8	81	1 2 2									
	42	7	92	1 6 3	2 6 3		5	39		2 6 2			
	47	3	20	1 3 3	2 4 3	3 6 3	3	20	1 3 2	2 3 2	3 6 2		
	47	3	64	1 3 3	2 5 3	3 6 3	3	64	1 3 2	2 3 2	3 6 2		
	47	3	65	1 3 3	2 3 3	3 6 3	3	65	1 3 2	2 3 2	3 6 2		
	47	6	42	1 2 2	2 3 2	3 6 2	6	42	1 2 2	2 3 2	3 6 2		
	48	3	20	1 3 3	2 4 3	3 6 3	3	20	1 3 2	2 3 2	3 6 2		
	48	3	64	1 3 3	2 5 3	3 6 3	3	64	1 3 2	2 2 2	3 6 2		
	48	3	65	1 3 3	2 3 3	3 6 3	3	65	1 3 2	2 3 2	3 6 2		
	48	6	42	1 3 2	2 3 2	3 6 2	6	42	1 3 2	2 3 2	3 6 2		
	50	5	39		2 3 2		5	39	1 4 2	2 4 2	3 6 3		
	50	6	37	1 4 3	2 4 3								
	50	6	58	1 4 3	2 4 3								
	50	7	91	1 5 3	2 5 3								
	51												
	51	5	39	1 2 2	2 3 2	3 6 2	3	20		2 3 2			
110	51	7	92	1 2 2	2 1 2		7	92	1 2 2	2 2 2			
	21	5	39			3 5 3	2	06	1 4 2		3 4 2		
	39	6	42	1 2 2	2 3 2								
	39	8	81		2 1 1								
	40	6	42	1 3 2	2 3 2		5	39	1 3 2				
	40	8	81	1 3 2									
	41	7	91	1 1 2	2 3 2		5	39	1 2 2		3 5 2		
	41	8	81	1 2 2									
	47	3	20	1 4 3	2 5 3	3 6 3	3	20	1 3 2	2 4 2	3 6 2		
	47	6	42	1 2 2	2 3 2	3 6 2	6	42	1 2 2	2 3 2	3 6 2		
	48	3	20	1 4 3	2 5 3	3 6 3	3	20	1 3 2	2 4 2	3 6 2		
	48	6	42	1 2 2	2 3 2	3 6 2	6	42	1 2 2	2 3 2	3 6 2		
	50	6	37	1 3 4	2 3 4								
	50	6	58	1 3 4	2 3 4		5	39		2 3 2	3 6 2		
	50	7	91	1 2 3	2 2 3								
	50	8	81	1 3 2									
111	39	6	42	1 2 2	2 3 2								
	39	8	81		2 1 1								
	40	6	42	1 3 2	2 3 2		5	39	1 3 2				
	40	8	81	1 3 2									
	42	7	92	1 2 3	2 3 3	3 6 3	5	39	1 2 3	2 3 3	3 6 3		
	47	3	20	1 4 3	2 5 3	3 6 3	3	20	1 3 2	2 4 2	3 6 2		
	47	6	42	1 2 2	2 3 2	3 6 2	6	42	1 2 2	2 3 2	3 6 2		
	48	3	20	1 4 3	2 5 3	3 6 3	3	20	1 3 2	2 4 2	3 6 2		
	48	6	42	1 2 2	2 3 2	3 6 2	6	42	1 2 2	2 3 2	3 6 2		
	50	6	37	1 3 4	2 3 4								
	50	6	58	1 3 4	2 3 4		5	39		2 3 2	3 6 2		
	50	7	91	1 2 3	2 2 3								
	50	8	81	1 3 2									
	51												
	51	7	92	1 1 2	2 2 2		7	92	1 2 2				
	51	8	81	1 2 2			3	20	1 3 2	2 6 2			
112	22	3	29		2 6 3		5	39	1 2 2	2 3 2			
	22	5	36		2 6 3						3 4 2		
	22	5	39		2 6 3								
	39	6	42	1 2 2	2 3 2								
	39	8	81	1 2 1									
	40	6	42	1 3 2	2 3 2		5	39	1 3 2				
	40	8	81	1 3 2									
	41	7	91	1 1 2	2 3 2		5	39	1 2 2		3 5 2		
	41	8	81	1 2 2									
	42	7	92	1 2 3	2 3 3	3 6 3	5	39	1 2 3	2 3 3	3 6 3		
	47	3	20	1 4 3	2 5 3	3 6 3	3	20	1 3 2	2 4 2	3 6 2		
	47	6	42	1 2 2	2 3 2	3 6 2	6	42	1 2 2	2 3 2	3 6 2		
	48	3	20	1 4 3	2 5 3	3 6 3	3	20	1 3 2	2 4 2	3 6 2		
	48	6	42	1 2 2	2 3 2	3 6 2	6	42	1 2 2	2 3 2	3 6 2		
	50	6	37	1 3 4	2 3 4								

Table D8: (continued)

ACTIVITY	RES- PONDENT	information from						information to									
		code	UNIT	ffq		ffq		ffq		code	UNIT	ffq		ffq		ffq	
				oreamql	urql	oreamql	urql	oreamql	urql			oreamql	urql	oreamql	urql	oreamql	urql
112	50	6	58	134	234				5	39			232	362			
	50	7	91	123	223												
	50	8	81	132													
113	51								7	92	122						
	51	7	92	112	222				3	20	132	262					
	51	8	81	122					5	39	122	232					
	25	1	85		252	352			2	06	142	252					
	25	8	81	132					3	24	122	232					
	39	6	42	111	211				4	35	121						
	40	6	42	112	212				5	39		212					
	47	3	20			363			3	20				362			
	47	3	20		253				3	20		232					
	47	3	20	143					3	20	132						
	47	6	42		232				6	42		232					
	47	6	42			362			6	42				362			
	47	6	42	122					6	42	122						
	48	3	20	143	253	363			3	20	132	232	362				
	48	6	42	122	232	362			6	42	122	232	362				
	114	21	5	39			353			2	06	142			342		
		39	6	42	122	222											
		40	6	42	112					5	39	112					
41		7	91	112	232				5	39	122			352			
41		8	81	122													
42		7	92		233	363			5	39		233	363				
43		5	39						3	20							
47		3	20	143	253	363			3	20	142	242	362				
47		6	42	122	232	362			6	42	122	232	362				
48		3	20	143	253	363			3	20	142	242	362				
48		6	42	122	232	362			6	42	122	232	362				
50		7	91	123	233				5	39	133	242	342				
50		8	81	132													
115		6	3	15	174												
		6	3	24	142	272	362										
		6	3	20	142	272	362			2	05	173	273				
		6	8	81	172		362										
		28								2	06				332		
	28								3	15				332			
	28	3	24		233				2	05				332			
	39	6	42	122	222												
	40	6	42	112					5	39	112						
	116	21								3	64		232				
		21	5	39			353			2	06	142			342		
		39	6	42	142	232				3	20		242				
		40	6	42	132					5	39	132					
		47	3	20	163	253	363			3	20	132	232	362			
		47	6	42	122	232	362			6	42	122	232	362			
		48	3	20	163	253	363			3	20	132	232	362			
		48	6	42	122	232	362			6	42	122	232	362			
		117	42	7	91			312			5	39				332	
42			7	92	113		333			5	39				333		
47			5	39						3	20						
47			3	20	153	263	363			3	20	142	252	362			
47			6	42	122	232	362			6	42	122	232	362			
48			3	20	153	263	363			3	20	142	252	362			
48			6	42	122	232	362			6	42	122	232	362			
51										3	18		232				
51										5	39	132	232				
118			51	7	92	112	232				3	61		232			
	6		3	24	174	274	344										
	6		3	61	174	274	344										
	6		3	15		274	344			2	05	173					
	28									2	06				332		
	28									3	15				332		
	28		3	24		233				2	05				334		
	39		6	42	122	222											
	40		6	42	122					5	39	122					
	41	7	91			332			5	39				352			
	42	7	92	113		333			5	39				333			

ACTIVITY	RES- PON- DENT	information from						information to					
		c o d e	UNIT	f f q	f f q	f f q	c o d e	UNIT	f f q	f f q	f f q	c o d e	UNIT
				o r u r e a m q l	o r u r e a m q l	o r u r e a m q l			o r u r e a m q l	o r u r e a m q l	o r u r e a m q l		
119	43	5	39				3	20					
	47	3	20	1 5 3	2 6 3	3 6 3	3	20	1 4 2	2 3 2	3 6 2		
	47	6	42	1 2 2	2 3 2	3 6 2	6	42	1 2 2	2 3 2	3 6 2		
	48	3	20	1 5 3	2 6 3	3 6 3	3	20	1 4 2	2 3 2	3 6 2		
	48	6	42	1 2 2	2 3 2	3 6 2	6	42	1 2 2	2 3 2	3 6 2		
	50	7	91	1 2 3	2 3 3		5	39		2 3 3	3 4 2		
	50	8	81	1 3 2									
	51	7	92	1 1 2	2 2 2		5	39	1 3 2	2 3 2			
	51	8	81	1 1 2									
120	25	8	81	1 3 2			3	24	1 3 2	2 6 2			
	39	6	42	1 2 2	2 2 2								
	40	6	42	1 2 2			5	39	1 2 2				
121	27	1	83		2 4 4		3	24		2 5 4			
	30						5	34		2 7 2			
	30	1	83	1 7 3	2 7 3		3	20		2 7 2			
	30	1	87	1 7 3	2 7 3		3	10		2 7 2			
	30	1	83		2 7 3		4	52		2 7 2			
	30	4	35	1 7 3	2 7 3		3	24		2 7 2			
122	27	1	83		2 4 4		3	24		2 5 4			
	30						4	52		2 7 2			
	30						5	34		2 7 2			
	30	1	83	1 7 3	2 7 3		3	20		2 7 2			
	30	1	87	1 7 3	2 7 3		3	10		2 7 2			
	30	4	35	1 7 3	2 7 3		3	24		2 7 2			
123	27	1	83		2 4 4		3	24		2 5 4			
	30						4	52		2 7 2			
	30						5	34		2 7 2			
	30	1	83	1 7 3	2 7 3		3	20		2 7 2			
	30	1	87	1 7 3	2 7 3		3	10		2 7 2			
	30	4	35	1 7 3	2 7 3		3	24		2 7 2			
124	21	1	83	1 2 3	2 2 3	3 2 3							
	21	1	87	1 2 3	2 2 3	3 2 3							
	21	1	86	1 2 3	2 2 3	3 2 3	5	39		2 3 3	3 3 3		
	27	1	83		2 4 4		3	24		2 5 4			
	30						4	52		2 7 2			
	30						5	34		2 7 2			
	30	1	83	1 7 3	2 7 3		3	20		2 7 2			
	30	1	87	1 7 3	2 7 3		3	10		2 7 2			
	30	4	35	1 7 3	2 7 3		3	24		2 7 2			
125	27	1	83		2 4 4		3	24		2 5 4			
	30						4	52		2 7 2			
	30						5	34		2 7 2			
	30	1	83	1 7 3	2 7 3		3	20		2 7 2			
	30	1	87	1 7 3	2 7 3		3	10		2 7 2			
	30	4	35	1 7 3	2 7 3		3	24		2 7 2			
126	27	1	83		2 4 4		3	24		2 5 4			
	30						5	34	1 7 3	2 7 3			
	30	1	87	1 7 3	2 7 3		2	04	1 7 3	2 7 3			
	30	1	83	1 7 3	2 7 3		3	24	1 7 3	2 7 3			
127	27	1	83		2 4 4		3	24		2 5 4			
128	27	1	83		2 4 4		3	24		2 5 4			
129	27	1	83		2 4 4		3	24		2 5 4			
	30						5	34	1 7 3	2 7 3			
	30	1	87	1 7 3	2 7 3		2	04	1 7 3	2 7 3			
	30	1	83	1 7 3	2 7 3		3	24	1 7 3	2 7 3			
130	27	1	83		2 4 4		3	24		2 5 4			
131	27	1	83		2 4 4		3	24		2 5 4			
132	30						5	34	1 7 3	2 7 3			
	30	1	87	1 7 3	2 7 3		2	04	1 7 3	2 7 3			
	30	1	83	1 7 3	2 7 3		3	24	1 7 3	2 7 3			
133	27	1	83		2 4 4		3	24		2 5 4			
134	27	1	83		2 4 4		3	24		2 5 4			
135	30						5	34	1 7 3	2 7 3			
	30	1	87	1 7 3	2 7 3		2	04	1 7 3	2 7 3			
	30	1	83	1 7 3	2 7 3		3	24	1 7 3	2 7 3			
	47	3	20	1 3 3	2 6 3	3 6 3	3	20	1 3 2	2 3 2	3 6 2		
	47	4	34	1 3 3	2 6 3	3 6 3	4	34	1 3 2	2 3 2	3 6 2		
	47	6	42	1 2 2	2 3 2	3 6 2	6	42	1 2 2	2 3 2	3 6 2		

Table D8: (continued)

ACTIVITY	RES- PON- DENT	information from						information to									
		c o d e	UNIT	f f q		f f q		f f q		c o d e	UNIT	f f q		f f q		f f q	
				o r e a m q l	u r e a m q l	o r e a m q l	u r e a m q l	o r e a m q l	u r e a m q l			o r e a m q l	u r e a m q l	o r e a m q l	u r e a m q l		
136	47	3	20	1 3 3	2 6 3	3 6 3		3	20	1 2 2	2 3 2	3 6 2					
	47	4	34	1 3 3	2 6 3	3 6 3		4	34	1 2 2	2 3 2	3 6 2					
	47	6	42	1 2 2	2 3 2	3 6 2		6	42	1 2 2	2 3 2	3 6 2					
137	39	6	42	1 3 2	2 3 2			3	20		2 6 2						
	40	6	42	1 3 2	2 3 2			5	39	1 3 2	2 3 2						
	47	3	20	1 3 3	2 6 3	3 6 3		3	20	1 2 2	2 3 2	3 6 2					
	47	4	34	1 3 3	2 6 3	3 6 3		4	34	1 2 2	2 3 2	3 6 2					
138	47	6	42	1 2 2	2 3 2	3 6 2		6	42	1 2 2	2 3 2	3 6 2					
	60							3	65		2 1 1						
	60							5	34		2 1 1						
	60	7	92		2 1 1			1	93		2 1 1						
139	60							3	65		2 1 1						
	60							5	34		2 1 1						
140	60	7	92		2 1 1			1	93		2 1 1						
	60							3	65		2 1 1						
	60							5	34		2 1 1						
141	60	7	92		2 1 1			1	93		2 1 1						
	39	6	42	1 3 2	2 3 2			3	20		2 6 2						
	40	6	42	1 3 2	2 3 2			5	39	1 3 2							
	42	7	92	1 6 3	2 6 3			5	39		2 6 2						
	47	3	20	1 3 3	2 6 3	3 6 3		3	20	1 2 2	2 3 2	3 6 2					
	47	4	34	1 3 3	2 6 3	3 6 3		4	34	1 2 2	2 3 2	3 6 2					
	47	6	42	1 2 2	2 3 2	3 6 2		6	42	1 2 2	2 3 2	3 6 2					
142	60							3	65		2 1 1						
	60							5	34		2 1 1						
	60	7	92		2 1 1			1	93		2 1 1						
	60	7	92	1 3 1	2 2 1			5	34		2 6 1						
	60	8	81	1 3 1	2 2 1												
	60	7	92	1 3 1	2 2 1			5	34		2 6 1						
	60	8	81	1 3 1	2 2 1												
143	60	7	92	1 3 1	2 2 1			5	34		2 6 1						
	60	8	81	1 3 1	2 2 1												
	60	7	92	1 3 1	2 2 1			5	34		2 6 1						
	60	8	81	1 3 1	2 2 1												
144	60	7	92	1 3 1	2 2 1			5	34		2 6 1						
	60	8	81	1 3 1	2 2 1												
	60	7	92	1 3 1	2 2 1			5	34		2 6 1						
	60	8	81	1 3 1	2 2 1												
145	47	3	20	1 3 3	2 6 3	3 6 3		3	20	1 2 2	2 3 2	3 6 2					
	47	4	34	1 3 3	2 6 3	3 6 3		4	34	1 2 2	2 3 2	3 6 2					
	47	6	42	1 2 2	2 3 2	3 6 2		6	42	1 2 2	2 3 2	3 6 2					
	60	7	92	1 3 1	2 2 1			5	34		2 6 1						
146	60	8	81	1 3 1	2 2 1												
	27	3	20			3 6 2											
	27	3	29			3 6 2											
	27	3	15			3 6 2		3	25					3 6 2			
147	27	3	20			3 6 2											
	27	3	29			3 6 2											
	27	3	15			3 6 2		3	25					3 6 2			
148	27	3	20			3 6 2											
	27	3	29			3 6 2											
	27	3	15			3 6 2		3	25					3 6 2			
149	21							2	04								
	21							5	34		2 5 2						
	21							5	39		2 5 2						
	21	5	34		2 5 2			1	84		2 5 2						
	21	5	39		2 5 2			1	85		2 5 2						
	27	3	20			3 6 2											
	27	3	29			3 6 2											
	27	3	15			3 6 2		3	25					3 6 2			
	47	3	20	1 3 3	2 6 3	3 6 3		3	20	1 2 2	2 3 2	3 6 2					
	47	4	34	1 3 3	2 6 3	3 6 3		4	34	1 2 2	2 3 2	3 6 2					
150	47	6	42	1 2 2	2 3 2	3 6 2		6	42	1 2 2	2 3 2	3 6 2					
	50	7	91	1 4 3	2 4 3			5	39		2 6 3						
	50	8	81	1 4 3													
	36							3	20			2 5 1					
	36							5	34			2 5 1					
	36	6	37		2 4 2			3	29			2 5 1					
	60	7	92	1 1 1	2 1 1												
	60	8	81	1 1 1	2 1 1												
	36							3	20			2 5 1					
	36							5	34			2 5 1					
151	36	6	37		2 4 2			3	29			2 5 1					
	60	7	92	1 1 1	2 1 1												

Table D8: (continued)

ACTIVITY	RES- PON- DENT	information from						information to					
		c o d e	UNIT	f f q	f f q	f f q	c o d e	UNIT	f f q	f f q	f f q		
				o r u r e a m q l	o r u r e a m q l	o r u r e a m q l			o r u r e a m q l	o r u r e a m q l	o r u r e a m q l		
152	60	8	81	1 1 1	2 1 1								
	36						3	20		2 5 1			
	36						5	34		2 5 1			
	36	6	37		2 4 2		3	29		2 5 1			
	60	7	92	1 1 1	2 1 1								
153	60	8	81	1 1 1	2 1 1								
	36						3	20		2 5 1			
	36						5	34		2 5 1			
	36	6	37		2 4 2		3	29		2 5 1			
	42	7	92	1 2 3	2 3 3	3 6 3	5	39	1 2 3	2 3 3	3 6 3		
	47	3	20	1 3 3	2 3 3	3 6 3	3	20	1 3 2	2 4 2	3 6 2		
	47	4	34	1 3 3	2 3 3	3 6 3	4	34	1 3 2	2 4 2	3 6 2		
	47	6	42	1 2 2	2 3 2	3 6 2	6	42	1 2 2	2 3 2	3 6 2		
	60	7	92	1 1 1	2 1 1								
	60	8	81	1 1 1	2 1 1								
154	27						3	24		2 5 2			
	27	3	25	1 3 2			2	04		2 5 2			
158	41	7	91			3 1 2	5	39			3 3 2		
	43	5	39				3	20					
	47	3	20	1 3 3	2 3 3	3 6 3	3	20	1 3 2	2 4 2	3 6 2		
	47	4	34	1 3 3	2 3 3	3 6 3	4	34	1 3 2	2 4 2	3 6 2		
	47	6	42	1 2 2	2 3 2	3 6 2	6	42	1 2 2	2 3 2	3 6 2		
	50	7	91		2 2 2		5	39		2 3 2			
	50	8	81	1 3 3	2 3 2								
	27						3	24		2 5 2			
159	27	3	25	1 3 2			2	04		2 5 2			
	60	7	92		2 1 1								
160	60	7	92		2 1 1								
162	39	6	42	1 3 2	2 3 2		3	20		2 6 2			
	40	6	42	1 3 2	2 3 2		5	39	1 3 2	2 3 2			
	47	3	20	1 3 3	2 3 3	3 6 3	3	20	1 3 2	2 4 2	3 6 2		
	47	4	34	1 3 3	2 3 3	3 6 3	4	34	1 3 2	2 4 2	3 6 2		
	47	6	42	1 2 2	2 3 2	3 6 2	6	42	1 2 2	2 3 2	3 6 2		
	60	7	92		2 1 1								
	60	7	92	1 1 1	2 3 2		5	34		2 6 2			
	60	8	81	1 1 1	2 3 2								
164	60	7	92	1 1 1	2 3 2		5	34		2 6 2			
	60	8	81	1 1 1	2 3 2								
165	43	5	39				3	20					
	47	3	20	1 3 3	2 3 3	3 6 3	3	20	1 3 2	2 4 2	3 6 2		
	47	4	34	1 3 3	2 3 3	3 6 3	4	34	1 3 2	2 4 2	3 6 2		
	47	6	42	1 2 2	2 3 2	3 6 2	6	42	1 2 2	2 3 2	3 6 2		
	60	7	92	1 1 1	2 3 2		5	34		2 6 2			
166	60	8	81	1 1 1	2 3 2								
	60	7	92	1 1 1	2 3 2		5	34		2 6 2			
	60	8	81	1 1 1	2 3 2								
167	60	7	92	1 1 1	2 3 2		5	34		2 6 2			
	60	8	81	1 1 1	2 3 2								
168	39	6	42		2 3 2		4	35		2 3 2			
	40	6	42		2 3 2		5	39		2 3 2			
	41	7	91			3 1 2	5	39			3 3 2		
	43	5	39				3	20					
	47	3	20	1 3 3	2 3 3	3 6 3	3	20	1 3 2	2 4 2	3 6 2		
	47	4	34	1 3 3	2 3 3	3 6 3	4	34	1 3 2	2 4 2	3 6 2		
	47	6	42	1 2 2	2 3 2	3 6 2	6	42	1 2 2	2 3 2	3 6 2		
	50	7	91		2 2 2		5	39		2 3 2			
	50	8	81	1 3 3	2 2 2								

Table D8: (continued)

Index:

1. Activities numbers:

as Survey Questionnaire

2. Code:

1: Outside the Railways	2: Top Management
3: Headquarters Departments	4: Production Departments
5: Production Division Managers	6: Production Area Managers
7: Elementary managerial units	8: Personal information

3. Unit:

3: Board	4: GM & AGM	5: GM	6: AGM GR
7: AGM EK	8: AGM PR	9: AGMEL	10: DEL
11: DEL/TY	12: DEL/TK	13: DEL/YM 294	14: DOMP
15: DOMP/YM	16: DOMP/YP	17: DOMP/YSK	18: DOMP/MK
19: DOMP/YO/TO	20: DG	21: DG/YG	22: DG/YKTE
23: DG/GEME	24: DNE	25: DNE/YK	26: DNE/YM
27: DNE/YMESTH	28: DNE/YMEEKE	29: DET	30: DET/TY
31: DEM	32: ALL HDQS DEPTS	33: ALL PRODUCTION DEPTS	34: YSTHE
35: DPER	36: YEK	37: EPITH	38: KGPA
39: YGR	42: TMGR/TMK	52: DISTY	53: DISTY/YOSTY
54: DISTY/TY	55: YEL	57: ERSIA	58: MHXSIA
60: TTHE	61: DOY	62: DOE	63: DEE
64: DIP	65: DAP	66: DP	67: DD
81: Personal Information	82: Trade Unions	83: Literature	84: Press
85: State/Public Sector	86: Seminars/Education	87: UIC/Railways/Cnfrncs	91: ERGODHGOI
92: SYNERGEIA	93: Trade/Manufacturers	94: Carriers	95: DNE supervisors
96: GPA/STATIONMASTERS	99: Public		

4. Information form:

1: not printed	2: printed, not processed	3: printed, processed
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5. Information frequency:

1: Every day	2: Every 15 days	3: Once a month
4: Once every 3 months	5: Once every 6 months	6: Once a year
7: Whenever happens		

6. Information quality:

1: Absolutely adequate	2: Adequate	3: Almost adequate
4: Inadequate	5: Absolutely inadequate	

Table D8: Survey Questionnaire, Section Four: Information Flows: Managers' Responses

APPENDIX E

VSM CONSTRUCTION

The appendix contains information utilised in *Chapter 10* of the thesis. Thus::

- *Table E1* (four pages) provides a functional analysis of managers interviewed for each of the 168 managerial activities, listed in *Section Three* of the *Survey Questionnaire*. This table illustrates the functional relation of the interviewed managers to any activity for which they were requested to allocate accountability, as discussed in *Chapter 9*.
- *Tables E2 to E6* provide the results of accountability allocation, under the methodology discussed in *Chapter 9*, concerning:
 - activities at Corporate Level (*Table E2*),
 - activities of the Operations sub-system (*Table E3*),
 - activities of the Rolling Stock sub-system (*Table E4*),
 - activities of the Permanent Way sub-system (*Table E5*), and
 - activities of the Signalling/Telecommunications sub-system (*Table E6*).
- *Table E7* provides a summary of accountability allocation by allocation criterion and content of managerial activity.
- *Figures E1 to E13* provide graphical interpretation of accountability allocation,
 - either in terms of Type of activity, Content of activity and Specific Content (as regards Production, Materials and Finance content) in respect to the allocation criteria (a to e),
 - or in terms of the accountable managerial units in respect to Type, Content and Specific Content of groups of activities.
- *Figures E14 to E33* contain information flows diagrams corresponding to the four Types of managerial activities (Research and Development, Planning/Organizing, Annual Programming, Performance Monitoring) for each of the five components of the Railway Enterprise (Corporate, Operations, Rolling Stock, Permanent Way, Signalling/Telecommunications).

A C T I V I T Y	HEADQUARTERS					REGIONAL STRUCTURE						SIGNAL. AND TELECOM		ROLLING STOCK			T O T A L
	CORPORATE MANAGEMENT			R. S.	O P.	P. W.	H E A D	OPERA- TIONS		PERMAN. WAY				H D Q S	WORK SHOP	DE- POTS	
	B O A R D	A G M	D O M P	D E L	D E T / D E M	D G / D N E	D P E R	Y E K	E P K I G H A	Y G R	Y G T / T M G R	Y S T H E	T T H E	D I S T Y	E R S I A	M X S I A	
	3	3	5	3	3	9	2	2	3	2	7	1	1	3	1	2	50
1	3	3															6
2	3	3															6
3	3	3															6
4	3	3															6
5	3	3															6
6	3	3	3														9
7	3	3	3														9
8	3	3	3														9
9	3	3	3														9
10	3	3	3														9
11	3	3	3														9
12	3	3	3														10
13	3	3	3														9
14	3	3	3														9
15	3	3	3		2												12
16	3	3	3		2												12
17	3	3	3														9
18	3	3	3														9
19	3	3	3														10
20	3	3	3														10
21	3	3	3														10
22	3	3					2										8
23	3	3					2										8
24		2	3		3												8
25		2	3		3												8
26		2	3		3												8
27		2	3		3												8
28		2	3		3	6	2	2	3								21
29		3	3	3	3		2	2	3					3	1	2	25
30		2	3		3	6	2	2	3								21
31		2	3		3	7	2	2	3			1					23
32		2	3		3		2	2	3								15
33		2	3		3		2	2	3								15
34		2	3		3		2	2	3								15
35		2	3		3		2	2	3								15
36		3	3	3	3		2	2	3					3	1	2	25
37		3	3		3		2	2	3					3	1	2	24
38		3	3		3		2	2	3					3	1	2	24
39		2	3		3	5	2	2	3	2	5						27
40		2	3		3	5	2	2	3	2	5						27
41		2	3		3	5	2	2	3	2	5						27
42		2	1		3	1	2	2	3			1					15

Table E1: Accountability Allocation: Functional Analysis of Managers Interviewed per Activity

A C T I V I T Y	HEADQUARTERS					REGIONAL STRUCTURE					SIGNAL.		ROLLING STOCK			T O T A L	
	CORPORATE MANAGEMENT			R. S.	O P.	P. W.	H E A D	OPERA- TIONS		PERMAN. WAY	AND TELECOM		H D Q S	WORK SHOP	DE- POTS		
	B O A R D	A G M	D O M P	D E L	D E T / D E M	D G / D N E	D P E R	Y E K	E P K I G T P H A	Y G R	Y G T / T M G R	Y S T H E	T T H E	D I S T Y	E R S I A		M X S I A
	3	3	5	3	3	9	2	2	3	2	7	1	1	3	1	2	50
43		2	1		3	1	2	2	3	2	5	1					15
44		2	1		3	4	2	2	3			1					25
45		2	1		3	1	2	2	3			1					15
46			2		3		2	2	3								12
47			2		3		2	2	3								12
48			2		3		2	2	3								12
49			2		3		2	2	3								12
50			2		3		2	2	3								12
51			2		3		2	2	3								12
52			2		3		2	2	3								12
53			2		3		2	2	3								12
54		1		2	3		2	2	3					2	1	2	18
55					3	5	2	2	3	2	5						22
56					3	1	2	2	3			1					11
57		1		2	3		2	2	3					2	1	2	18
58					3		2	2	3	2	5						17
59		1			3		2	2	3								11
60		1			3		2	2	3								11
61		1	1	3										3	1	2	11
62		1	1	3										3	1	2	11
63		1	1	3										3	1	2	11
64		1	1	3										3	1	2	11
65		1	1	3										3	1	2	11
66		1	1	3										3	1	2	11
67		1	1	3										3	1	2	11
68		1	1	3										3	1	2	11
69		1	1	3										3	1	2	11
70		1	1	3										3	1	2	11
71		1	1	3										3	1	2	11
72		1	1	3										3	1	2	11
73		1	1	3										3	1	2	11
74		1	1	3										3	1	2	11
75		1	1	3										3	1	2	11
76		1	1	3										3	1	2	10
77		1	1	3										3	1	2	10
78		1	1	3										3	1	2	10
79		1	1	3										3	1	2	10
80		1	1	3										3	1	2	10
81		1	1	3										3	1	2	10
82		1	1	3										3	1	2	10
83		2	1	3										3	1	2	12
84		2	1	3										3	1	2	12
85		1	1	3										3	1	2	10
86		1	1	3										3	1	2	11
87		1	1	3										3	1	2	11

Table E1: (continued)

A C T I V I T Y	HEADQUARTERS					REGIONAL STRUCTURE						SIGNAL. AND TELECOM		ROLLING STOCK			T O T A L
	CORPORATE MANAGEMENT			R. S.	O P.	P. W.	H E A D	OPERA- TIONS		PERMAN. WAY				H D Q S	WORK SHOP	DE- POTS	
	B O A R D	A G M	D O M P	D E L	D E T / D E M	D G / D N E	D P E R	Y E K	E P K I G T P H A	Y G R	Y G T T M G R	Y S T H E	T T H E	D I S T Y	E R S I A	M X S I A	
	3	3	5	3	3	9	2	2	3	2	7	1	1	3	1	2	50
88		1	1			7											9
89		1	1			6											8
90		1	1		3	7											12
91		1	1			7											9
92		1	1			3				2	5						12
93		1	1			2				2	5						11
94		1	1			2				2	6						12
95		1	1			2				2	5						11
96		1	1			6				2	5						15
97		1	1			7				2	5						16
98		1	1			6				2	7						17
99		1	1			7				2	5						16
100		1	1			3				2	5						12
101		1	1			3				2	7						14
102		1	1			2				2	5						11
103		1	1			3				2	5						12
104		1	1			2				2	7						13
105		1	1			2				2	5						11
106		1	1			3				2	7						14
107		1	1			7				2	6						17
108		1	1			3				2	7						14
109		1	1			3				2	7						14
110		1				3				2	5						11
111		1				2				2	7						12
112		1				3				2	7						13
113		1				6				2	5						14
114		1	2			3				2	7						15
115		1	2			6				2	5						16
116		1	1			3				2	6						13
117		1	2			2	1			2	7						15
118		1	2			6				2	5						16
119		2				3	1			2	7						15
120		2				6				2	5						15
121		1	1		2	1						1	1				7
122		1	1		2	1						1	1				7
123		1	1		2	1						1	1				7
124		1	1		2	8						1	1				14
125		1	1		2	1						1	1				7
126		1	1		2	1						1	1				7
127		1	1		2	1		1				1	1				8
128		1	1		2	1		1				1	1				8
129		1	1		2	1		1				1	1				8
130		1	1		2	1		1				1	1				8

Table E1: (continued)

A C T I V I T Y	HEADQUARTERS						REGIONAL STRUCTURE						SIGNAL. AND TELECOM		ROLLING STOCK			T O T A L
	CORPORATE MANAGEMENT			R. S.	O P.	P. W.	H E A D	OPERA- TIONS		PERMAN. WAY		H D Q S			WORK SHOP	DE- POTS		
	B O A R D	A G M	D O M P	D E L	D E T / D E M	D G / D N E	D P E R	Y E K	E P K I G H T P H A	Y G R	Y G T / T M G R	Y S T H E	T T H E	D I S T Y	E R S I A	M X S I A		
3	3	5	3	3	9	2	2	3	2	7	1	1	3	1	2			
131		1	1		2	1		1			1	1				8		
132		1	1		2	1		1			1	1				8		
133		1	1		2	1		1			1	1				8		
134		1	1		2	1		1			1	1				8		
135		1	1		2	3		1		2	5	1	1			17		
136		1	1		2	3		1		2	5	1	1			17		
137		1	1		2	3		1		2	5	1	1			17		
138		1	1			1		1				1	1			6		
139		1	1			1		1				1	1			6		
140		1	1			1		1				1	1			6		
141		1	1			1	1	1		2	5	1	1			14		
142		1	1			1						1	1			5		
143		1	1			1						1	1			5		
144		1	1			1						1	1			5		
145		1	1			3				2	5	1	1			14		
146		1	1			1						1	1			5		
147		1	1			1						1	1			5		
148		1	1			1						1	1			5		
149		1	1			7				2	5	1	1			18		
150		1				1		1				1	1			5		
151		1				1		1				1	1			5		
152		1				1		1				1	1			5		
153		1				3	1	1		2	5	1	1			15		
154		1				1		1				1	1			5		
155		1	2			1	1	1				1	1			8		
156		1	2			1	1	1				1	1			8		
157		1	2			1		1				1	1			7		
158		1	2			3	1	1		2	5	1	1			17		
159		1	2			1						1	1			6		
160		1				1						1	1			4		
161		1				1						1	1			4		
162		1				3				2	5	1	1			13		
163		2				1	1					1	1			6		
164		2				1	1					1	1			6		
165		2				3	1			2	5	1	1			15		
166		2				1	1	1				1	1			7		
167		2				1		1				1	1			6		
168		2				3	1	1		2	5	1	1			16		

Table E1: (continued)

ACTIVITY	accountability allocation (%) [survey data]															accountable manager						
	A S K E	D S	G M	A G M E K	A G M P R	D O M P	D E T	D E M	D N E	D O Y	D P	D D	A L L D	n o n e	k n o w n	name	p (%)	inter- viewed	accepted respon- sibility	% noone + not known	crite- rion	
001	50	33	83													GM	83	N	-	0	a	
002		17	83			33				33						GM	83	N	-	0	a	
003		33	67														GM	67	N	-	0	b
004		17	100			33											GM	100	N	-	0	a
005		17	83			33											GM	83	N	-	0	a
006				22	11	17	67	22									DOMP	67	Y	Y	0	b
007							22				22					67				67	e	
008							67									33	DOMP	67	Y	Y	33	d
009					33		33	22	22							22				22	e	
010			22	22	33		33	22	22							11				11	e	
011				11	22		78										DOMP	78	Y	Y	0	a
012					30		90										DOMP	90	Y	Y	0	a
013				11			89										DOMP	89	Y	Y	0	a
014						11					89						DOY	89	N	-	0	a
015			8	25			58	8	17								DOMP	58	Y	Y	0	c
016				17	17		50	8	25								DOMP	50	Y	Y	0	c
017				33			67										DOMP	67	Y	Y	0	b
018				22			56			11						10	DOMP	56	Y	Y	11	c
019			10	30		10					70						DOY	70	N	-	0	b
020			10	30		10					70						DOY	70	N	-	0	b
021				20		10					70						DOY	70	N	-	0	b
022			25	38		88						13	25				AGMPR	88	Y	Y	0	a
023						13							25	50			ALLD	50	Y	Y	0	c

Table E2: Activities at Corporate Level: Accountability Allocation

ACTIVITY	accountability allocation (%) [survey data]																	accountable manager					
	A G M E K	A G M E L	A G M P R	D O M P	D E T	D E M	D E L	D G	D N E	D O Y	D P E R	Y E K	D I S T Y	Y G R	o t h e r	n o n e	k n o w n	name	p (%)	inter- viewed	accepted respon- sibility	% noone + not known	crite- rion
024	13			38	50	50						13						DET	50	Y	Y	0	c
025			13	50		38				25	13					13	13	DEM	50	Y	Y	0	c
026	13				13	50					13						13	DOMP	50	Y	Y	26	d
027	13			25	38	50					13						25	DEM	50	Y	Y	13	c
028	5				57	5		5	5		24	14			5		10	DET	57	Y	Y	25	d
029	4	8			60	8	56						28				8	DET	60	Y	Y	10	c
030					36	5		67	5		10	5					10					8	c
031				4	70	4			10		10	10			4		17	DET	70	Y	Y	10	e
032	7				60	47					27	20			7		7	DET	60	Y	Y	17	c
033	7				60	67					27	13			7		7	DET	67	Y	Y	7	c
034	7					87									7		7	DEM	67	Y	Y	7	b
035	7														7			DEM	87	Y	Y	7	a
036		8			87						7	7			7			DET	87	Y	Y	0	a
037		8			68		20	20			12	28	4		4		4	DET	68	Y	Y	0	b
038		4			50		42	42			13	13	21					DET	50	Y	Y	4	c
039			4	4	29		21	21			46	29	4		4	4	11					4	e
040				4	44	4					11	11		4	7	4	4					15	e
041				4	44	4					11	4		8	7	4	4	DET				8	e
042					59				8		11	22		4	7		4	DET	59	Y	Y	4	c
043					73				13			6			20		6	DET	73	Y	Y	6	b
044					53				6						20		6	DET	53	Y	Y	6	c
045					24				4		4			16	12			DG	76	Y	Y	0	a
046					47				13		13	27			20		7					7	e
047				33	17	54					8	33			8		8	DEM	54	Y	Y	8	c
048				33	17	54					8	42			8		8	DEM	54	Y	Y	0	c
049				17		67				25	8	8			25		8	DEM	67	Y	Y	8	b
050						67				25	8	8			25		8	DEM	67	Y	Y	8	b
051					8					50	17	17					33	DOY	50	N	-	33	d
052					8					50	17	17			8		33	DOY	50	N	-	33	d
053					8					50	17	17			8		33	DOY	50	N	-	33	d
054					75	8					25	42			8		6	DET	75	Y	Y	0	a
055					50		11	11			33	33			5	6	6	DET	50	Y	Y	12	c
056					50						14	23			4	5	18	DET	50	Y	Y	23	d
057					36						27	36			9		9					9	e
058					22	11	11	11			50	39	6		6	6	6	DPER	50	Y	Y	6	c
059					18						29	59			6		6	YEK	59	Y	Y	6	c
060	9				18						45	45			27							0	e
060	9				18						45	45			9							0	e

Table E3: Activities of the Operations system: Accountability Allocation

ACTIVITY	accountability allocation (%) [survey data]														accountable manager					
	A G M E L	D O M P	D E T	D E L	D O Y	D I P	D A P	D P E R	Y E K	D I S T Y	E R S I A	M X S I A	n o n e	k n o w n	name	p (%)	inter- viewed	accepted respon- sibility	% noone + not known	crite- rion
061	9		9	100						27					DEL	100	Y	Y	0	a
062	9		18	82						36			9		DEL	82	Y	Y	9	a
063	9									91			9		DISTY	91	Y	Y	9	a
064	9									100					DISTY	100	Y	Y	0	a
065	9			73						36			9		DEL	73	Y	Y	9	b
066	9									100					DISTY	100	Y	Y	0	a
067	9									100					DISTY	100	Y	Y	0	a
068	9									100					DISTY	100	Y	Y	0	a
069	9									91		9			DISTY	91	Y	Y	0	a
070	9	9					27			91	18				DISTY	91	Y	Y	0	a
071	9	9					36			82	9	9			DISTY	82	Y	Y	0	a
072	9									100	9				DISTY	100	Y	Y	0	a
073	9									100		9			DISTY	100	Y	Y	0	a
074	9					18	45			91					DISTY	91	Y	Y	0	a
075	9					18	45			91		9			DISTY	91	Y	Y	0	a
076	10									90	20				DISTY	90	Y	Y	0	a
077	10									80		20			DISTY	80	Y	Y	0	a
078	10	10								100	10				DISTY	100	Y	Y	0	a
079	10									100		20			DISTY	100	Y	Y	0	a
080	10	10				30	20			90	10		10		DISTY	90	Y	Y	10	a
081	10	10				30	20			90	10	20			DISTY	90	Y	Y	0	a
082				10				30	20	60	10	20			DISTY	60	Y	Y	0	c
083	8	8			25					67				8	DISTY	67	Y	Y	8	b
084	8	8			25					67		8			DISTY	67	Y	Y	0	b
085	10			50	10		20			30				10	DEL	50	Y	Y	10	c
086	18									73	27				DISTY	73	Y	Y	0	b
087	18									64		27			DISTY	64	Y	Y	0	c

Table E4: Activities of the Rolling Stock system: Accountability Allocation

ACTIVITY	accountability allocation (%) [survey data]														accountable manager					
	A G M E K	A G M G R	D O M P	D E T	D G	D N E	D O Y	D A P	D P E R	Y G R	T M G R	T H E	n o n e	k n o w n	name	p (%)	inter- viewed	accepted respon- sibility	% noone + not known	crite- rion
088					100	55									DG	100	Y	Y	0	a
089					38	100									DNE	55	Y	Y	0	c
090				83	58	83									DNE	100	Y	Y	0	a
091					67	56				11					DET	83	Y	Y	0	a
092															DNE	83	Y	Y	0	a
093					100					8					DG	67	Y	Y	0	b
094					100					9					DNE	56	Y	Y	0	c
095					100					17					DG	100	Y	Y	0	a
096					73					27					DG	100	Y	Y	0	a
097				6	27	93				6					DNE	93	Y	Y	0	e
098					69	56									DG	69	Y	Y	0	a
099					41	76				12	12				DNE	56	Y	Y	0	b
100					94	50				6					DNE	76	Y	Y	0	b
101					83										DG	94	Y	Y	0	a
102															DNE	50	Y	Y	0	c
103					79	7				67	33				DG	83	Y	Y	0	a
104															YGR	67	Y	Y	0	b
105					64					57	36				DG	79	Y	Y	0	a
106					83										YGR	57	Y	Y	0	c
107										82	45				YGR	82	Y	Y	0	a
108					77				8	75	42				DG	83	Y	Y	0	a
109															YGR	75	Y	Y	0	a
110										85	54				YGR	85	Y	Y	0	a
111					64				9	77	45				DG	77	Y	N	0	a
112					64					73	50				YGR	73	Y	Y	0	b
113					64					93	50				YGR	93	Y	Y	0	a
114					47	59				53	35				DNE	59	Y	Y	0	c
115															YGR	53	Y	Y	0	c
116					86					79	50				DG	86	Y	Y	0	a
117															YGR	79	Y	Y	0	a
118					93					79	50				DG	93	Y	Y	0	a
119					73					82	55				YGR	79	Y	Y	0	a
120					50					75	67				DG	82	Y	Y	0	b
121															YGR	75	Y	Y	0	a
122					38					69	62	8			TMGR	67	Y	Y	0	b
123					29	64				64	29				YGR	69	Y	Y	8	b
124					67										TMGR	62	Y	Y	8	c
125															DNE	64	Y	Y	0	c
126															YGR	64	Y	Y	0	c
127										7	60	47			DG	67	Y	Y	0	b
128	6	6	6			75				60					YGR	60	Y	Y	0	c
129					69					31	15		8	6	DNE	75	Y	Y	6	a
130										54					DG	69	Y	Y	8	b
131					47		13			33	27		7		YGR	54	Y	Y	8	c
132					25	50	13			6					DNE	50	Y	Y	0	c
133					47					60	47				YGR	60	Y	Y	7	c
134					27	60				40	7				DNE	60	Y	Y	14	c

Table E5: Activities of the Permanent Way system: Accountability Allocation

ACTIVITY	accountability allocation (%) [survey data]														accountable manager						
	A G M G R	D O M P	D E T	D G	D N E	D O Y	D P E R	Y E K	D I S T Y	Y G R	T M G R	Y S T H E	T H E	n o n e	k n o w n	name	p (%)	inter- viewed	accepted respon- sibility	% noone + not known	crite- rion
121			43		57							57				DNE	57	Y	Y	0	c
122		14	43		57							57				YSTHE	57	Y	Y	0	c
123			57		43							71				DNE	57	Y	Y	0	c
124			21	57	43							57			7	YSTHE	71	Y	Y	0	b
125			14		43							29				DET	57	Y	Y	0	c
126			57		57				14			29			29	DG	57	Y	Y	7	c
127			25		63							25				YSTHE	57	Y	Y	0	c
128			13	13	38							50				DNE	57	Y	Y	0	c
129		13	38		50							50				YSTHE	63	Y	Y	0	c
130		13	13	13	50							50				DNE	50	Y	Y	0	c
131				13	25							63			13	YSTHE	50	Y	Y	0	c
132			63		25							50			13	DET	50	Y	Y	13	c
133			13		38							50			13	YSTHE	63	Y	Y	13	c
134			13		25							63			13	YSTHE	63	Y	Y	13	c
135			24	53	12					24	12	35				YSTHE	50	Y	Y	13	c
136				35	24					18	18	47	6		6	YSTHE	50	Y	Y	0	e
137				24	6					24	18	59	6		6	YSTHE	63	Y	Y	6	e
138												83	17		17	YSTHE	59	Y	Y	6	c
139												83	17		17	YSTHE	83	Y	Y	17	a
140												83	17		17	YSTHE	83	Y	Y	17	a
141				21						29	29	64	14		17	YSTHE	83	Y	Y	17	a
142												100	20			YSTHE	64	Y	Y	17	c
143												100	20			YSTHE	100	Y	Y	0	a
144												100	20			YSTHE	100	Y	Y	0	a
145										14	14	71	7		21	YSTHE	100	Y	Y	0	a
146		20	40	20	40							40			20	YSTHE	71	Y	Y	21	b
147		20	40		60									20	20	DNE	60	Y	Y	20	e
148		20	60		40							20		20	20		60		Y	40	d
149		6		61	33					28	11	22	6	6	11	DG	61	Y	Y	40	e
150			20					40				80	40			YSTHE	61	Y	Y	17	b
151			20					20				80	20			YSTHE	80	Y	Y	0	a
152			20					40				80	20			YSTHE	80	Y	Y	0	a
153			7	7				7		7	13	60	27		6	YSTHE	80	Y	Y	0	a
154					80							20			20	DNE	60	Y	Y	6	c
155												50		13	37	YSTHE	80	Y	Y	20	a
156												50		13	37	YSTHE	50	Y	Y	50	d
157												43		14	43	YSTHE	50	Y	Y	50	d
158				12		6	6			18	29	41	18	6	29				57	35	e
159					33							17		7	33				40		e
160												100	50			YSTHE	100	Y	Y	0	a
161												100	50			YSTHE	100	Y	Y	0	a
162			8							15	30	85	38			YSTHE	85	Y	Y	0	a
163	17											50	17	17		YSTHE	50	Y	Y	17	c
164	17											50	17	17		YSTHE	50	Y	Y	17	c
165	7			7			7			13	7	53	20	7		YSTHE	53	Y	Y	7	c
166	14											43	14	14	14	YSTHE				28	e
167	17							17				33	17	17	17				34		e
168	6						6			38	50	19			19	TMGR	50	Y	Y	19	c

Table E6: Activities of the Signalling/Telecommunications system: Accountability Allocation

c r i t e r i a	activities per criterion	A C T I V I T I E S											
		Corporate Level		Rail Operations		Rolling Stock		Permanent Way		Signalling/ Telecomms		T o t a l	
		9	9	4	4	20	20	19	19	12	12	64	64
criterion a	activities	9	9	4	4	20	20	19	19	12	12	64	64
	%	39	39	11	11	74	74	58	58	25	25	38	38
criterion b	activities	6		5		4		7		3		25	
	%	26		13		15		21		6		15	
criteria a+b	activities		15		9		24		26		15		89
	%		65		24		89		79		31		53
criterion c	activities	4		15		3		5		19		46	
	%	18		41		11		15		40		27	
criteria a+b+c	activities		19		24		27		31		34		135
	%		83		65		100		94		71		80
criterion d	activities	1		6		0		0		3		10	
	%	4		16		0		0		6		6	
criteria a+b+c+d	activities		20		30		27		31		37		145
	%		87		81		100		94		77		86
total	activities		23		37		27		33		48		168
	%		100		100		100		100		100		
non-accountable (criterion e)	activities		3		7		0		2		11		23
	%		13		19		0		6		23		14

Table E7: Accountability Allocation by Allocation Criterion and Content of Activity

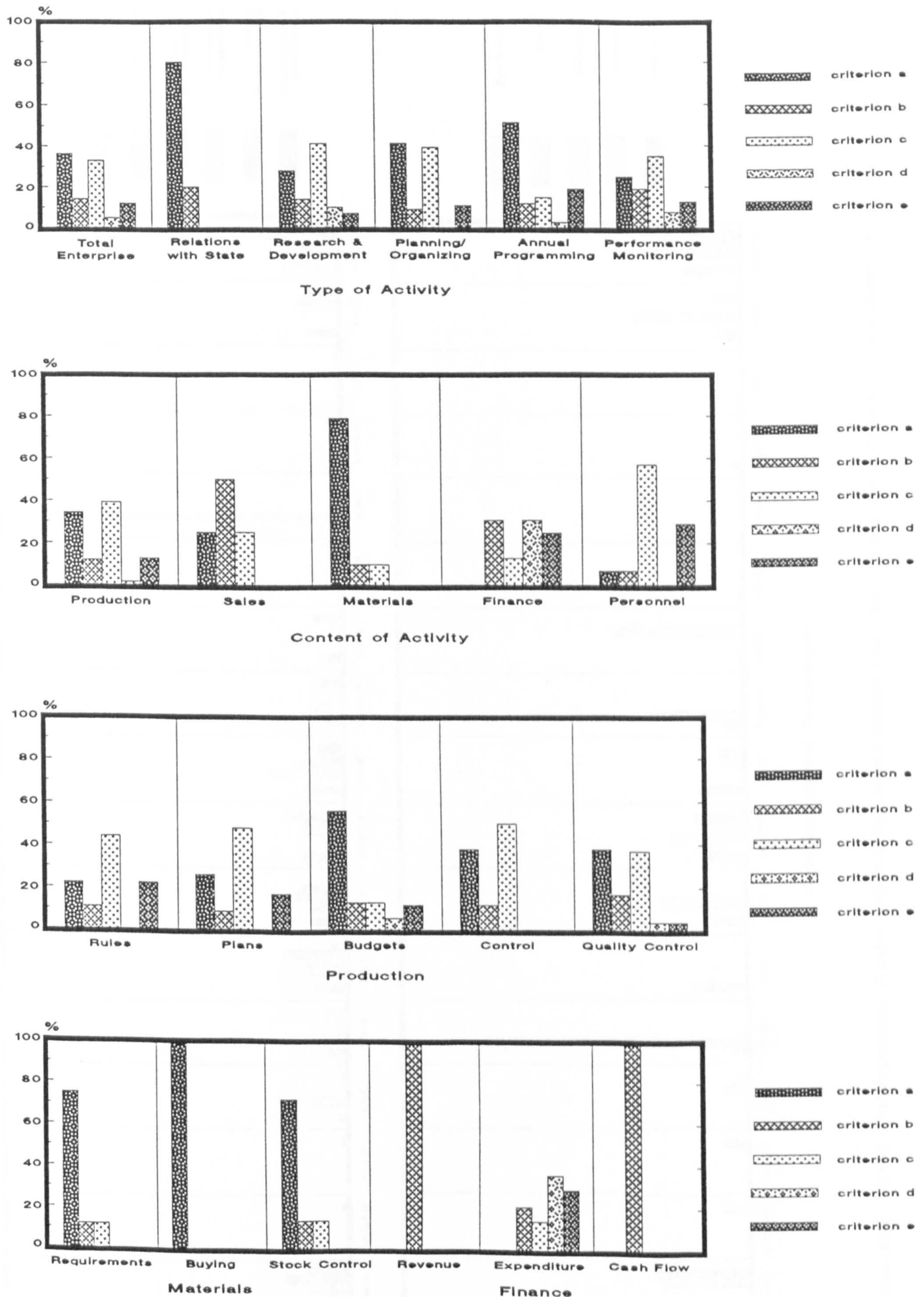


Figure E1: Total Enterprise: Rate of Precision of Accountability Allocation by Type and Content of Activity

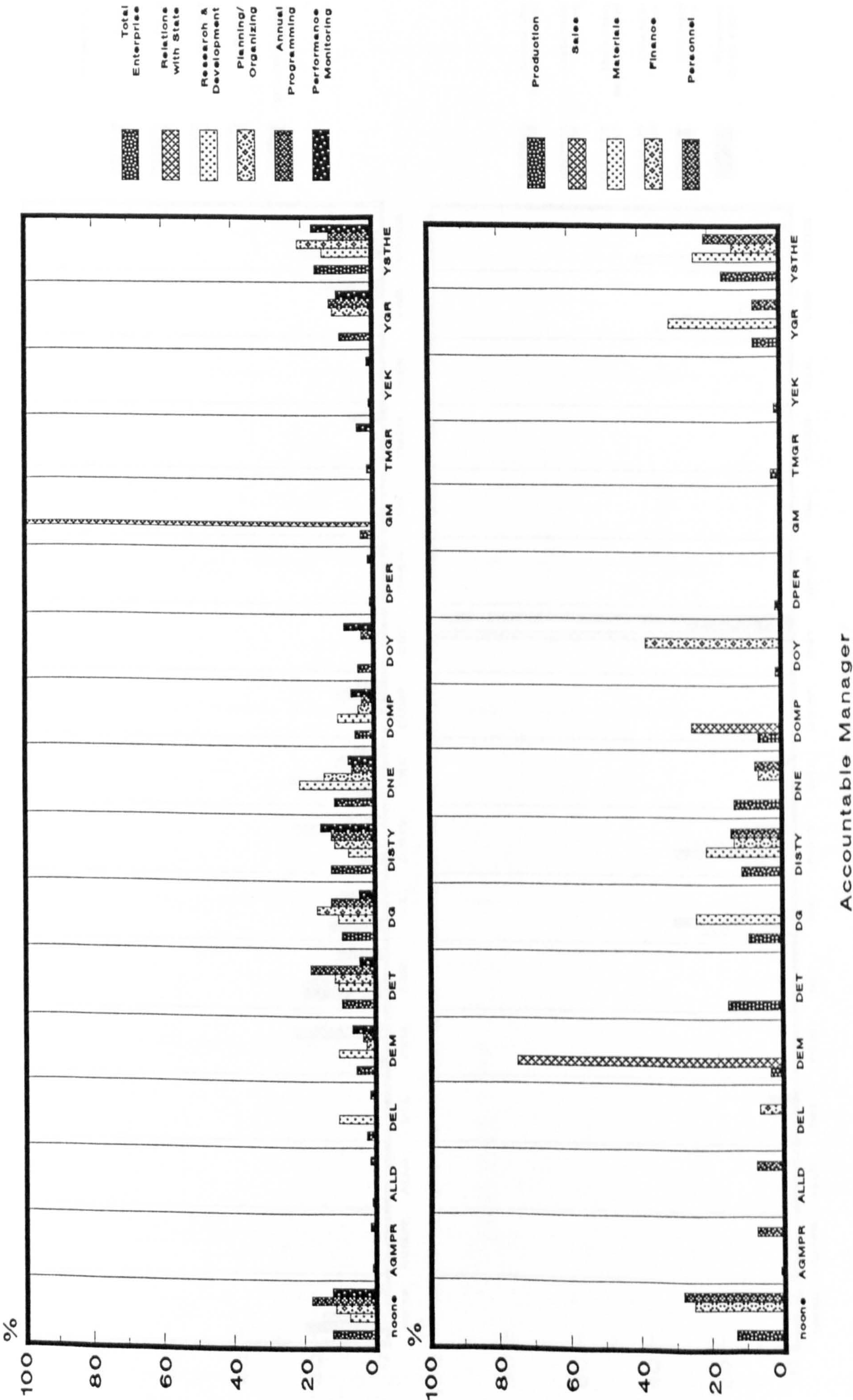
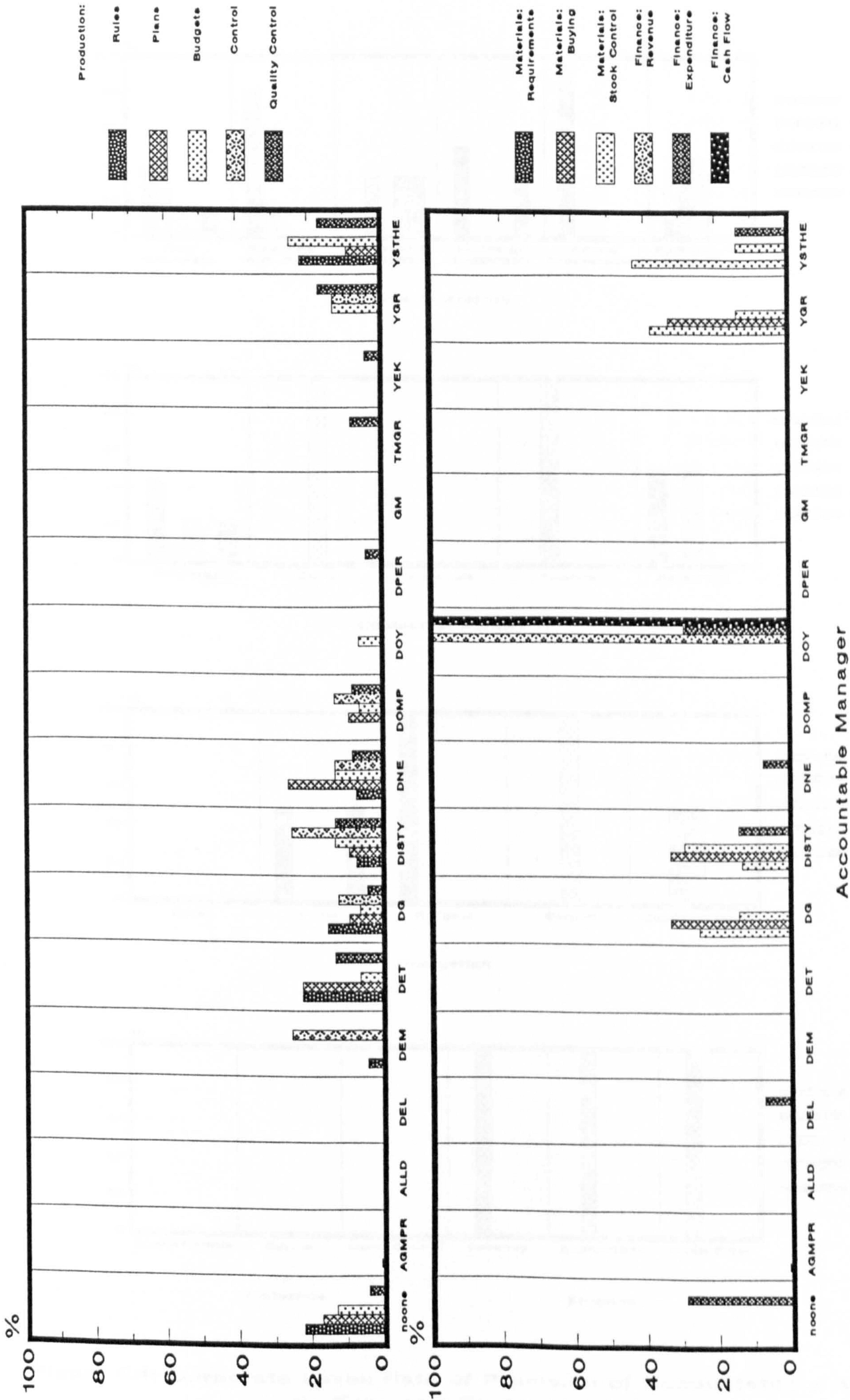


Figure E2: Total Enterprise: Accountability Allocation (%) by Type and Content of Activity



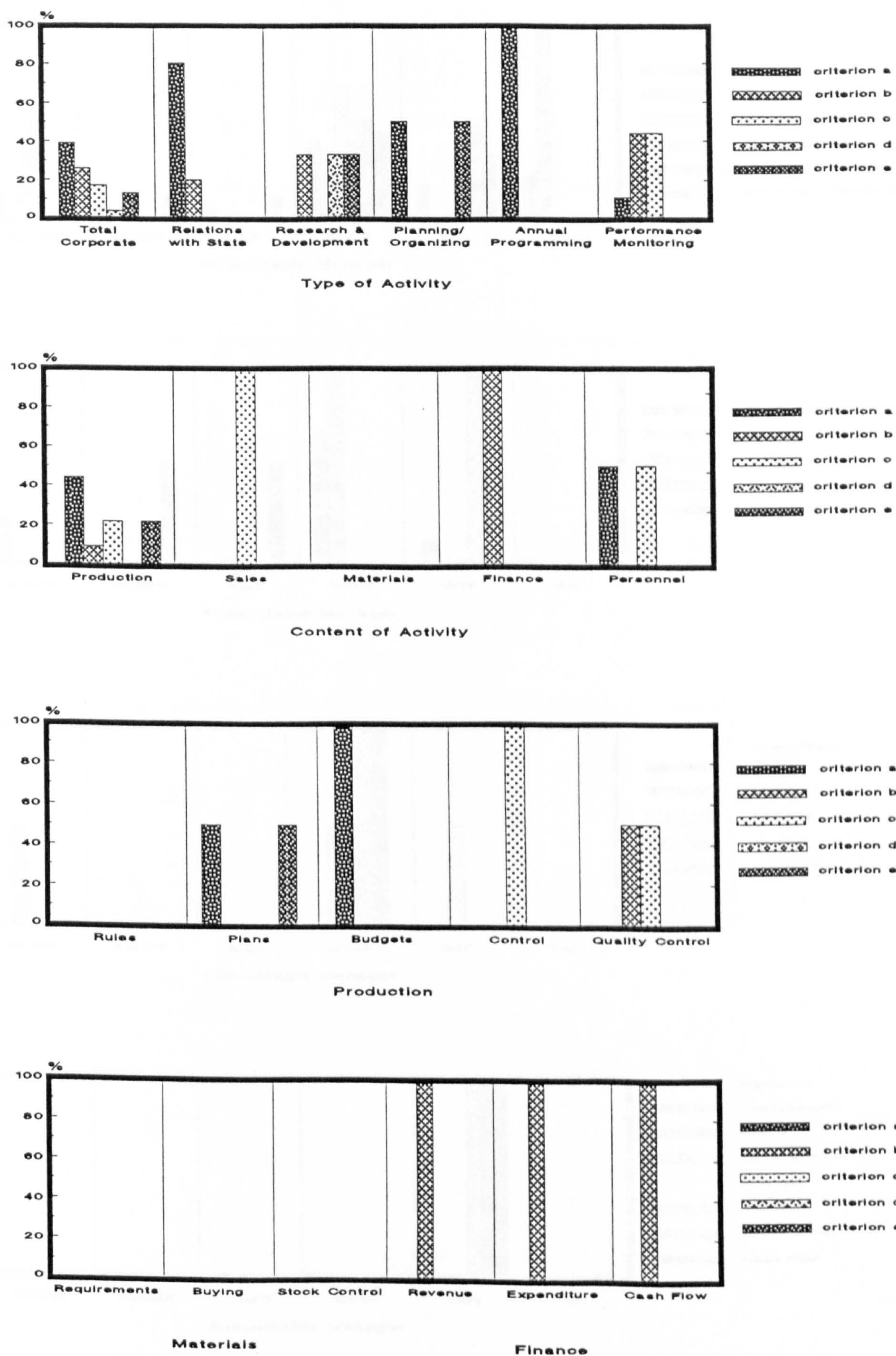


Figure E4: Corporate Level: Rate of Precision of Accountability Allocation by Type and Content of Activity

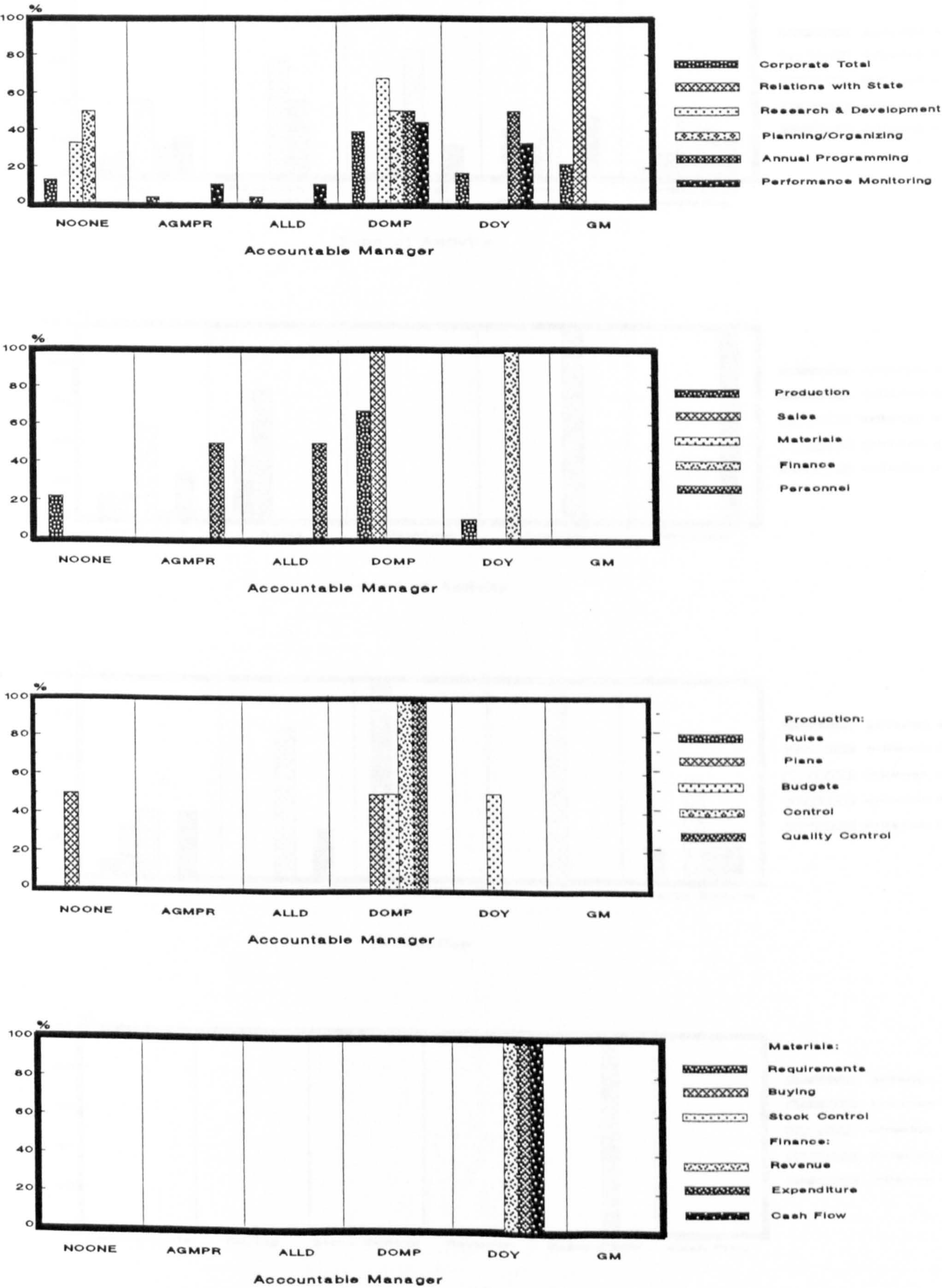


Figure E5: Corporate Level: Accountability Allocation by Type and Content of Activity

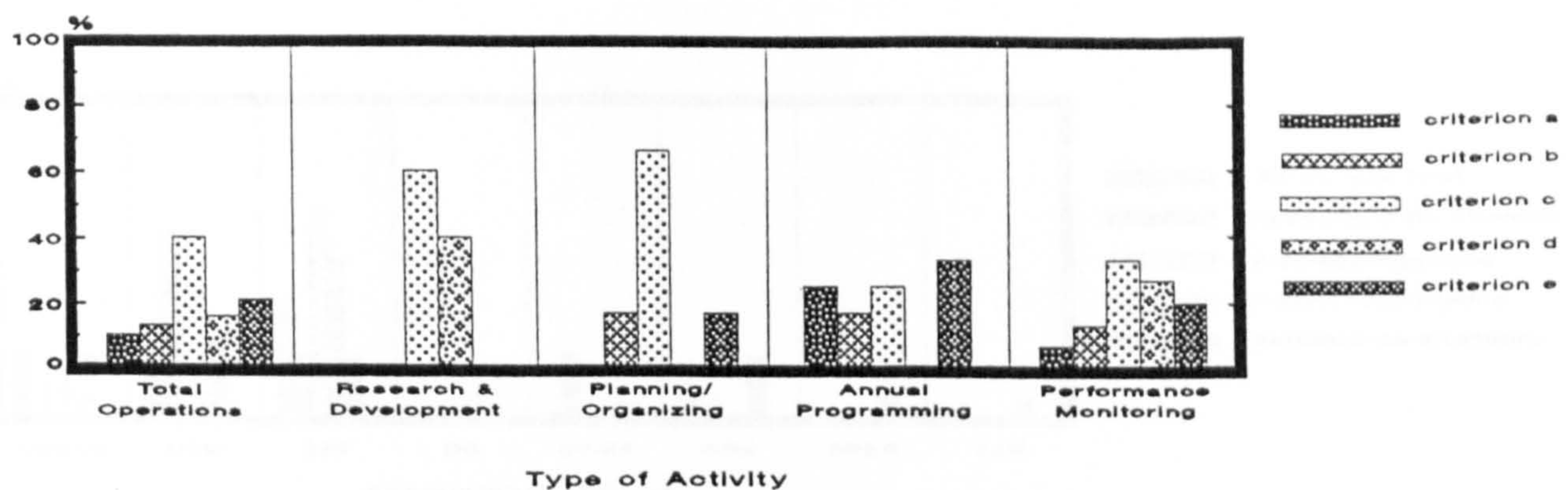
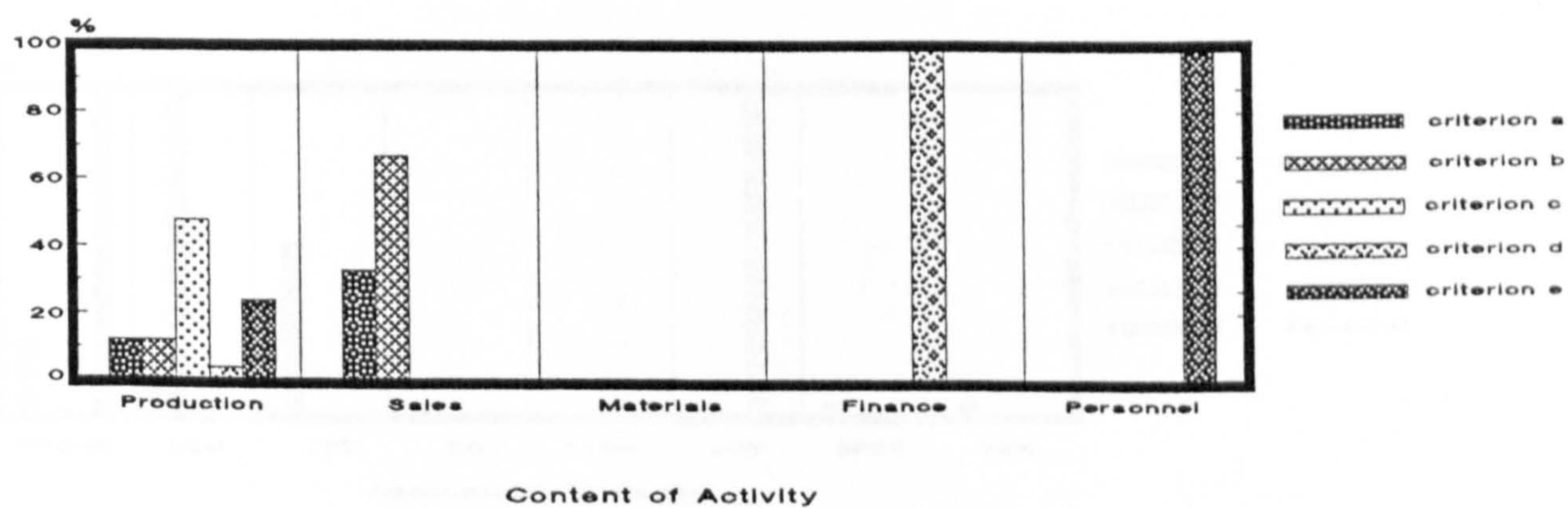
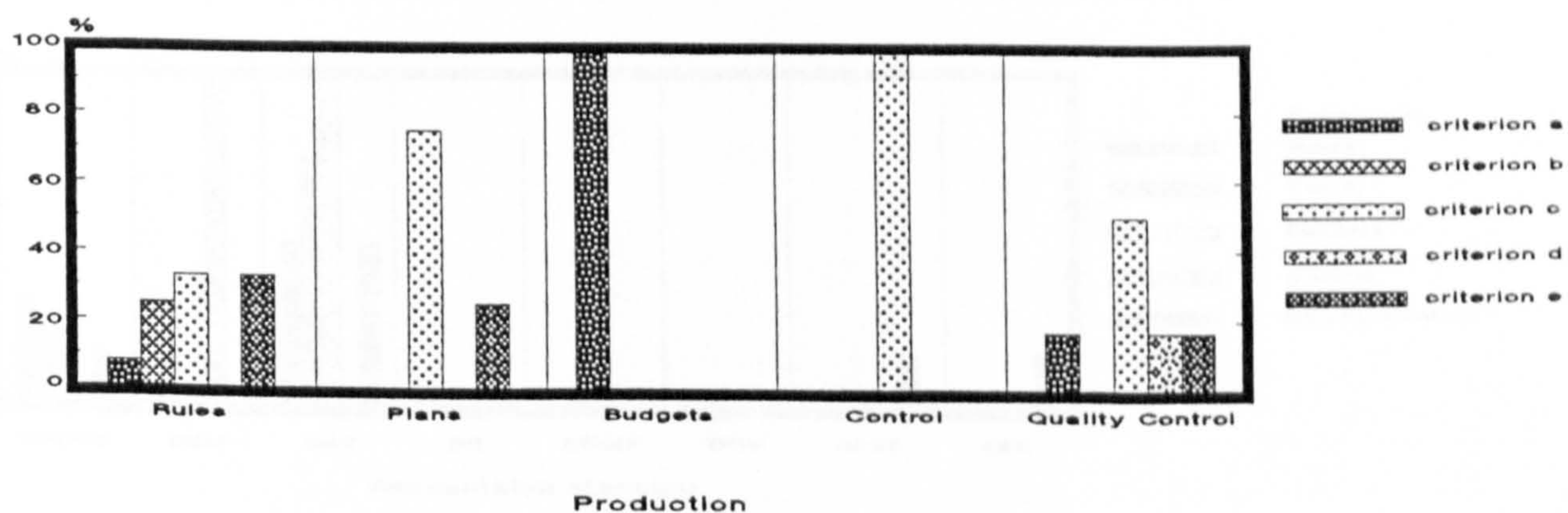
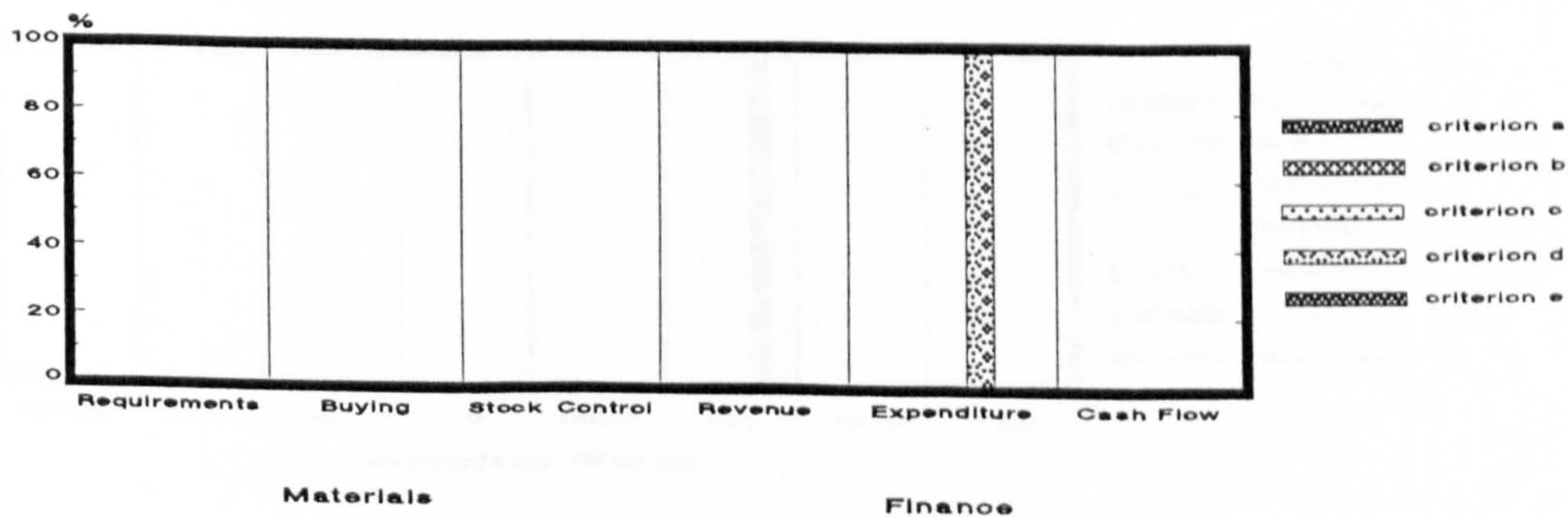


Figure E6: Operations: Rate of Precision of Accountability Allocation by Type and Content of Activity

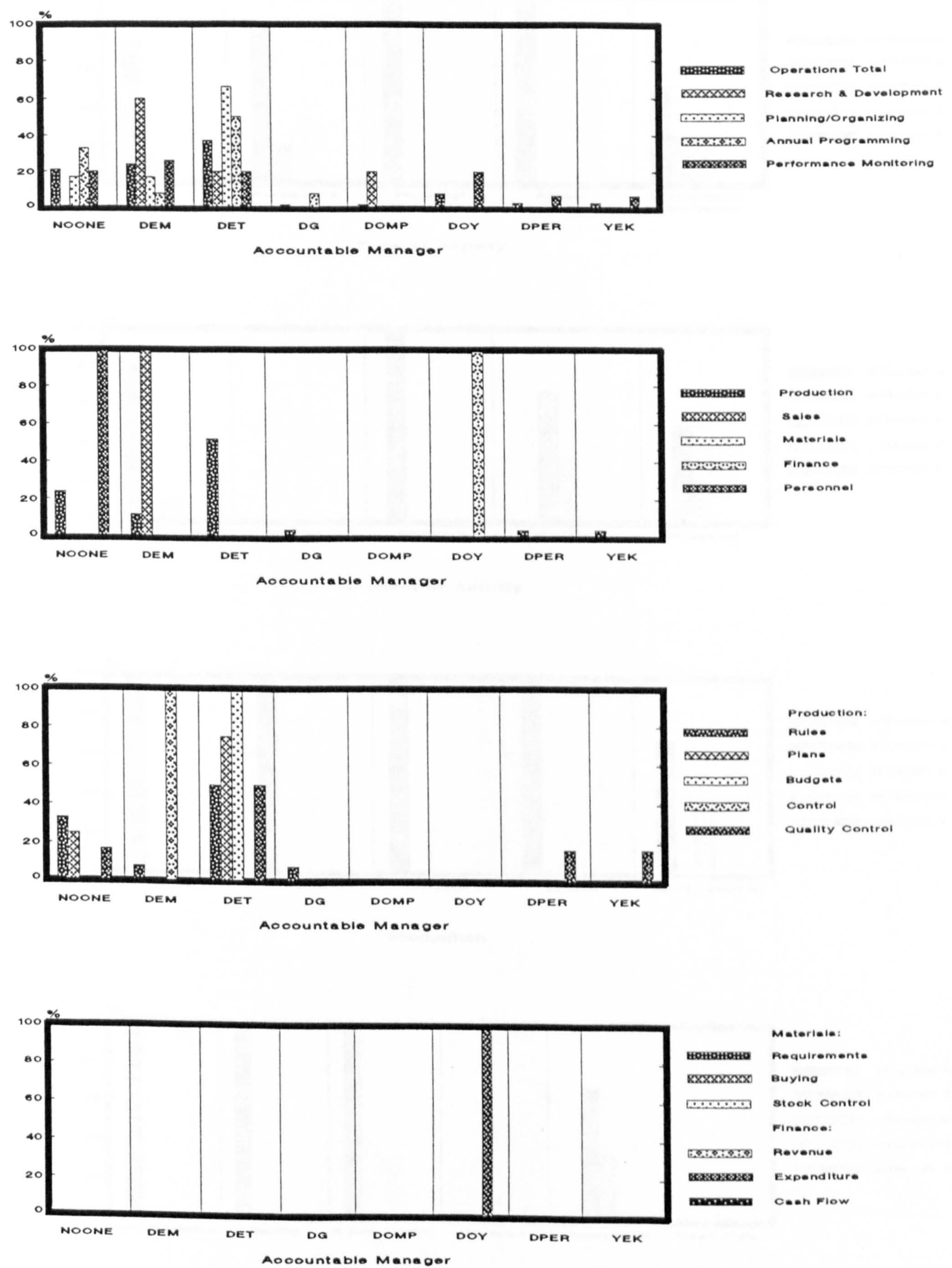


Figure E7: Operations: Accountability Allocation
by Type and Content of Activity

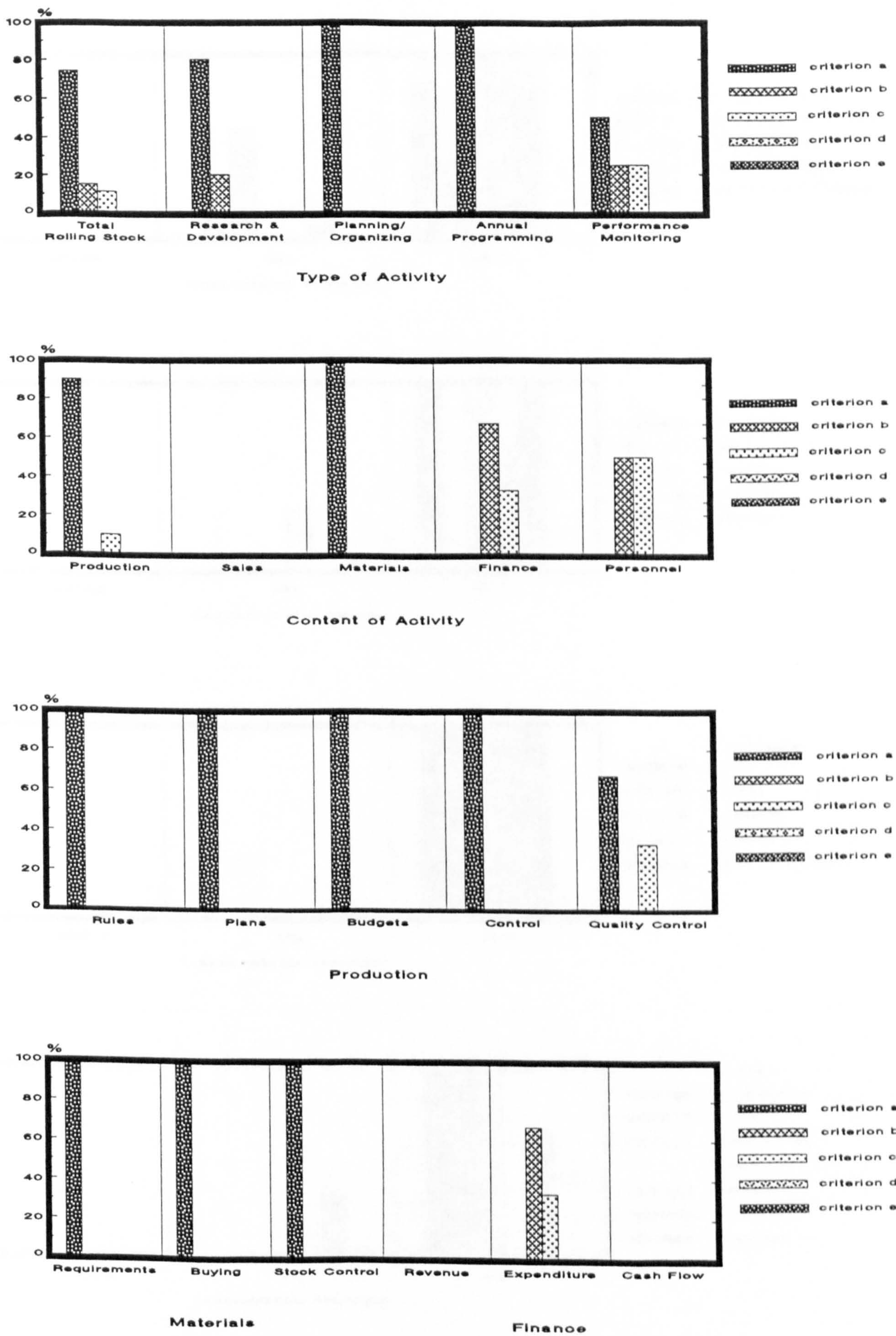


Figure E8: Rolling Stock: Rate of Precision of Accountability Allocation by Type and Content of Activity

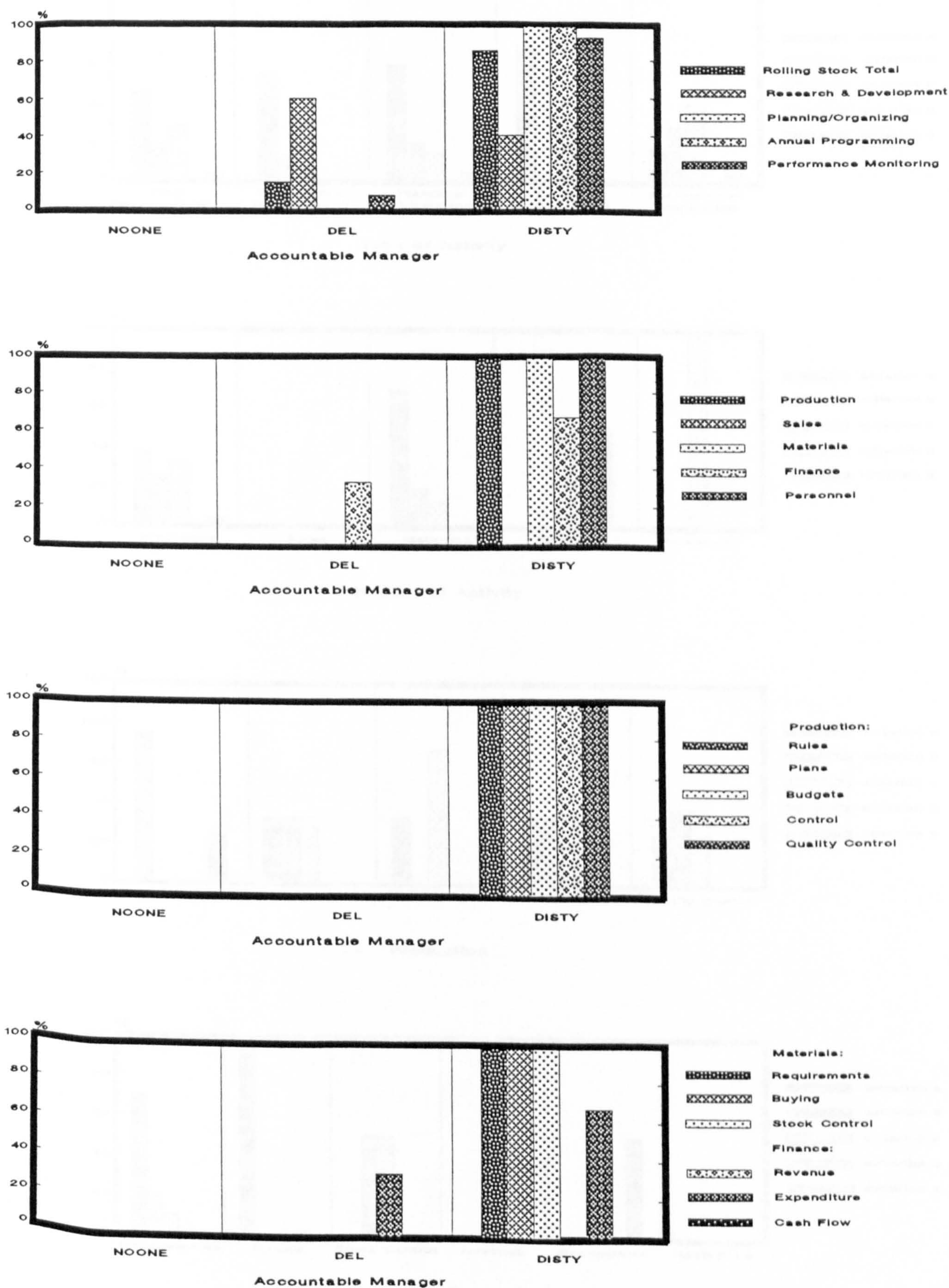


Figure E9: Rolling Stock: Accountability Allocation by Type and Content of Activity

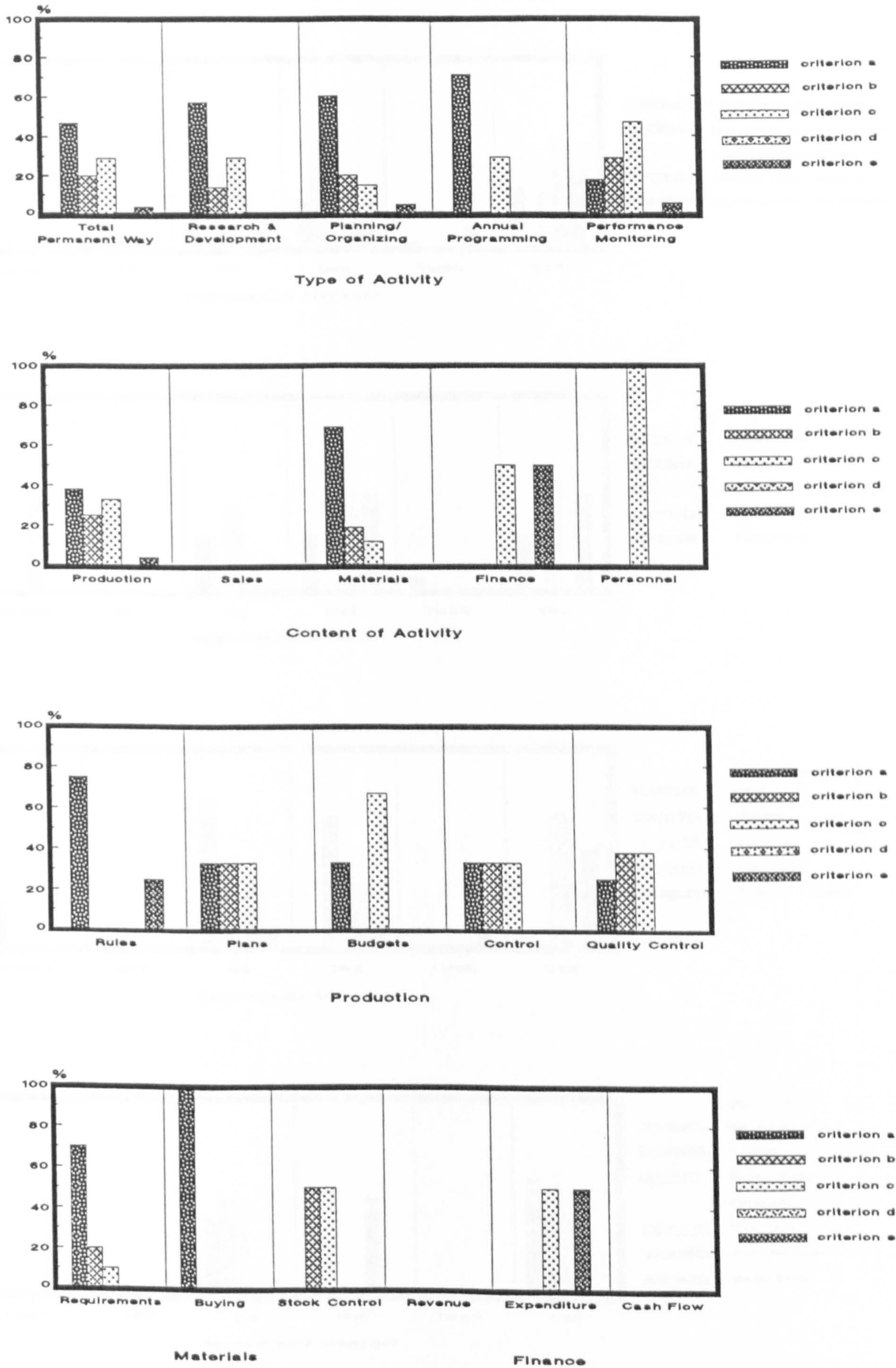


Figure E10: Permanent Way: Rate of Precision of Accountability Allocation by Type and Content of Activity

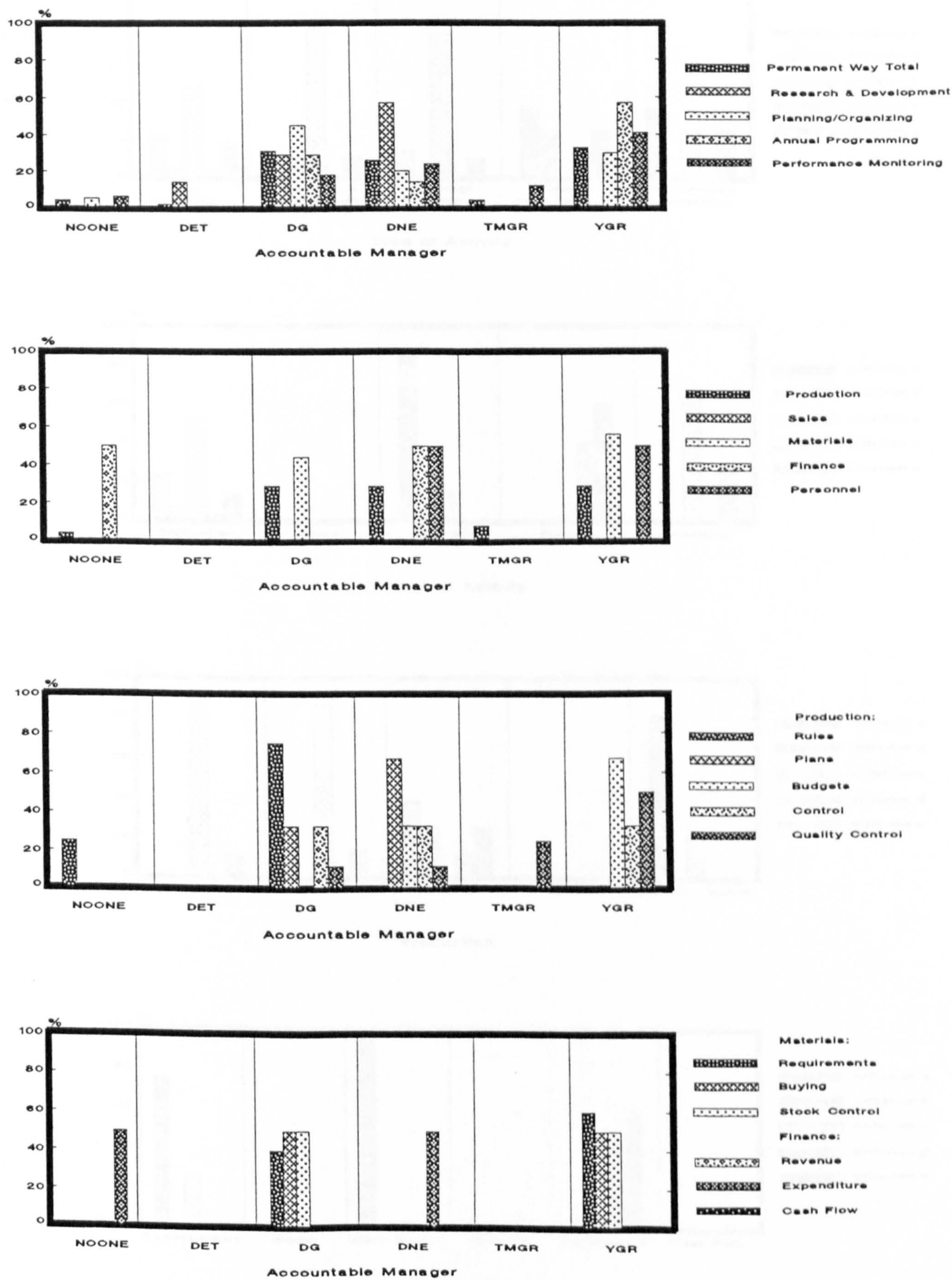


Figure E11: Permanent Way: Accountability Allocation by Type and Content of Activity

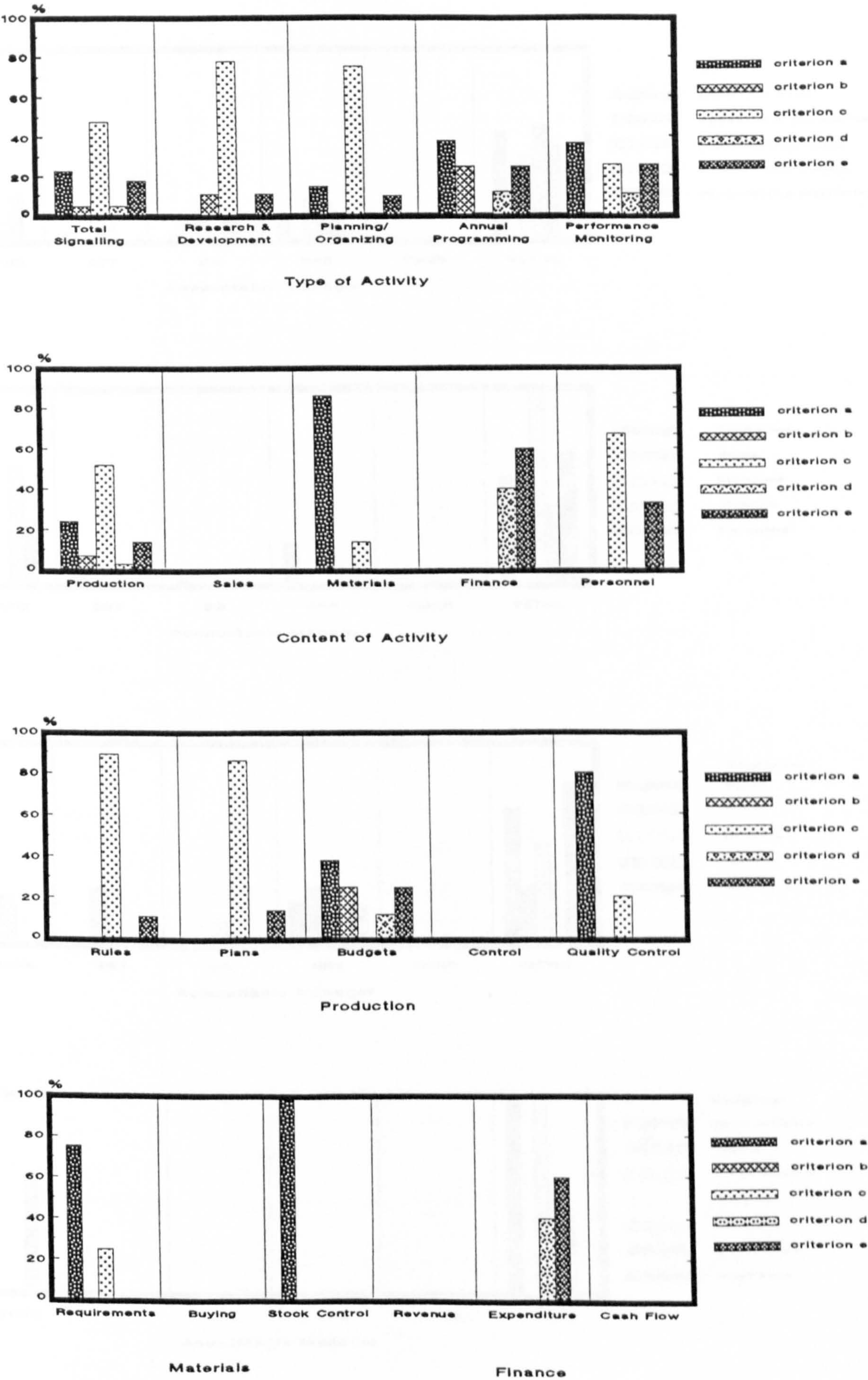


Figure E12: Signalling/Telecom: Rate of Precision of Accountability Allocation by Type and Content of Activity

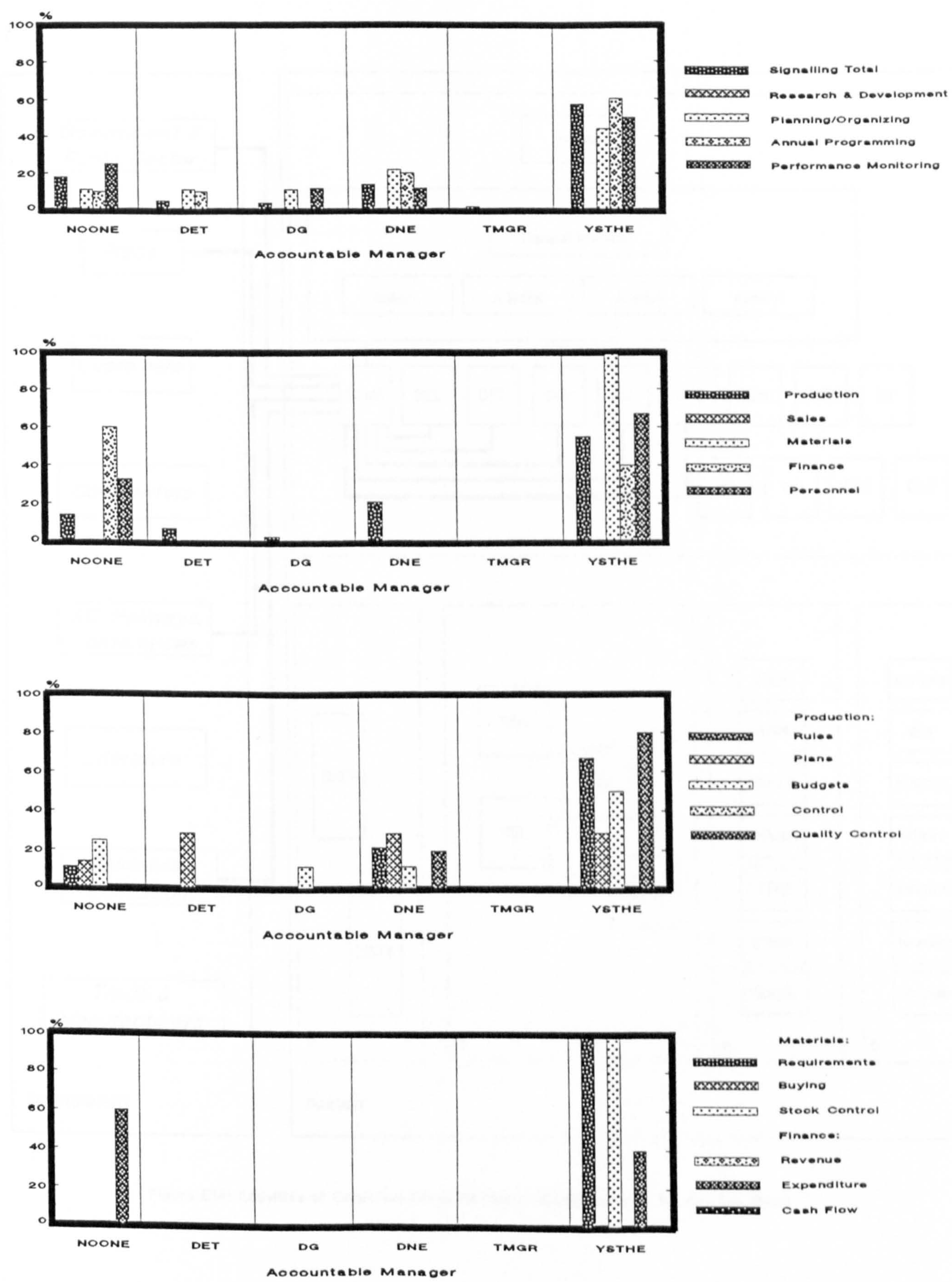


Figure E13: Signalling/Telecommunications: Accountability Allocation by Type and Content of Activity

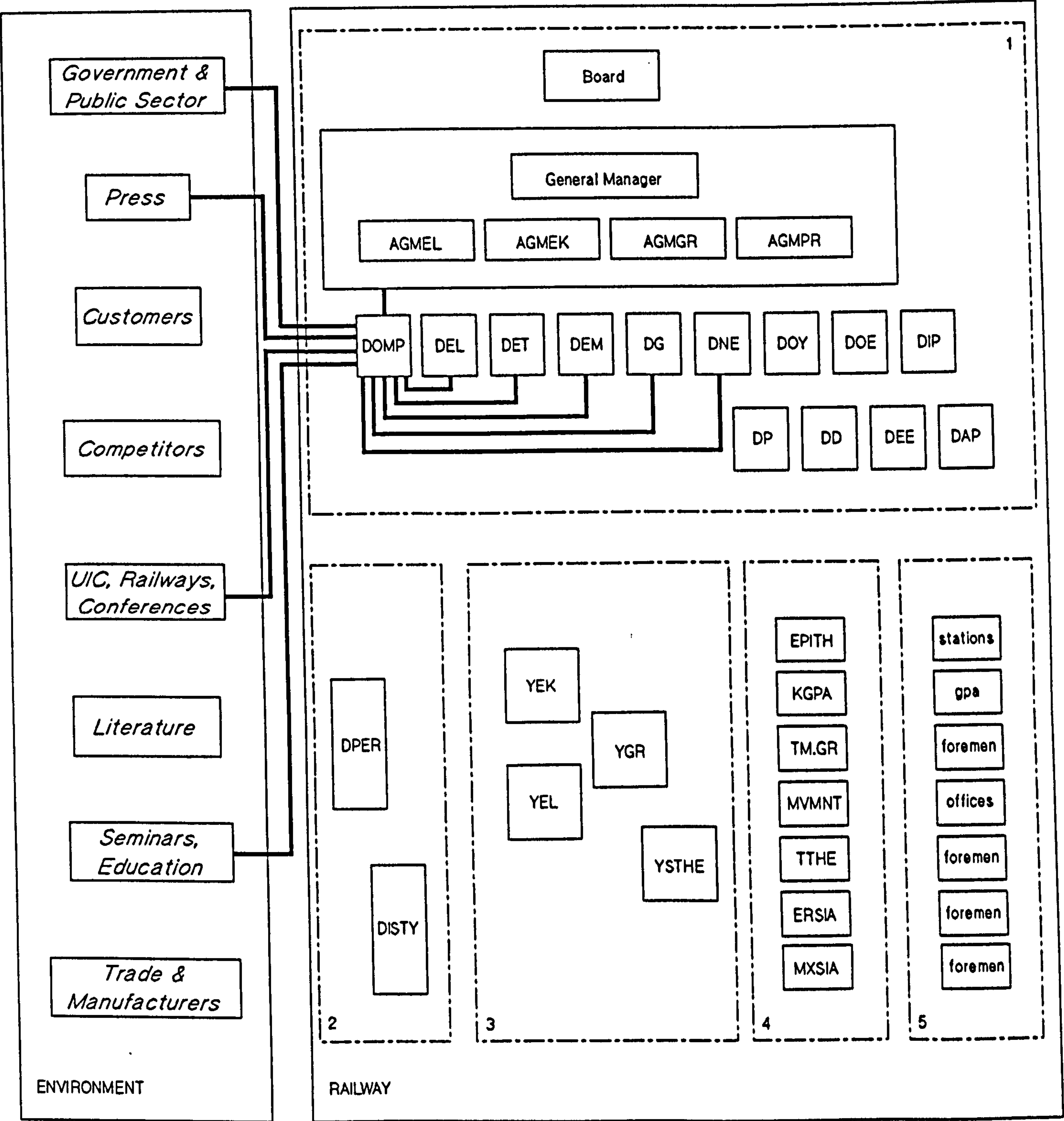


Figure E14: Activities at Corporate Level: Research & Development: Information Flows

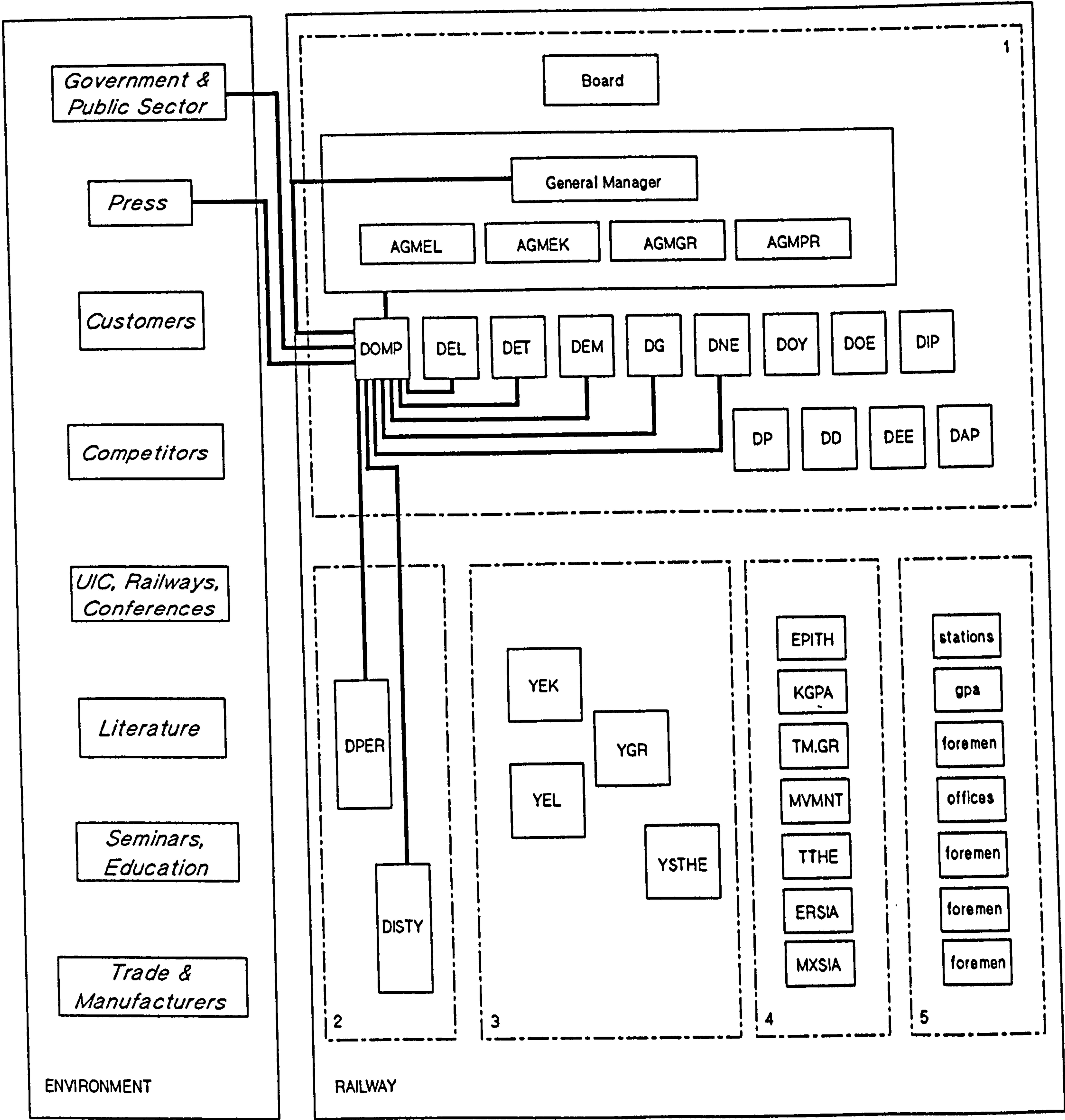


Figure E15: Activities at Corporate Level: Planning/Organizing: Information Flows

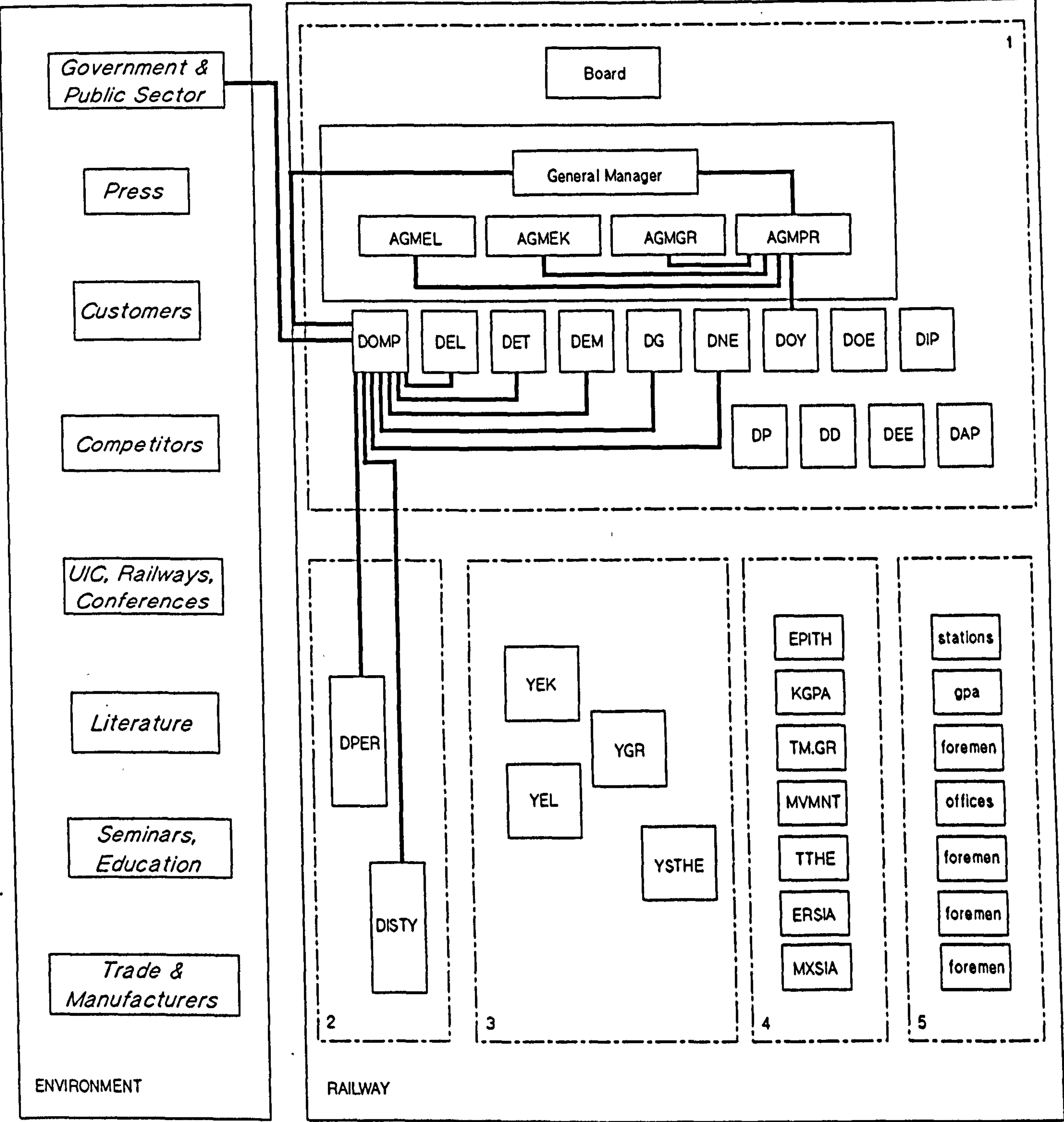


Figure E16: Activities at Corporate Level: Annual Programming: Information Flows

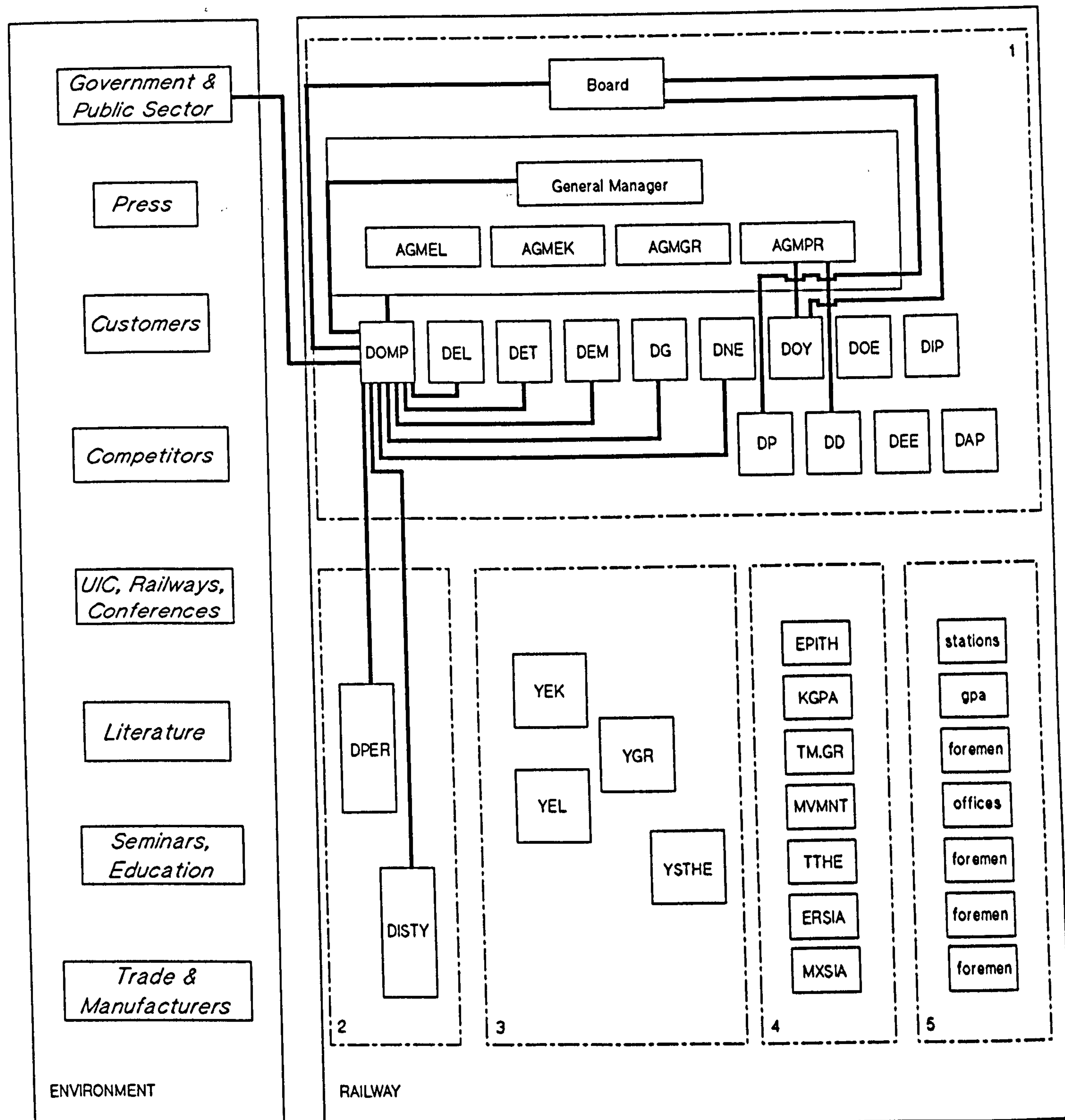


Figure E17: Activities at Corporate Level: Performance Monitoring: Information Flows

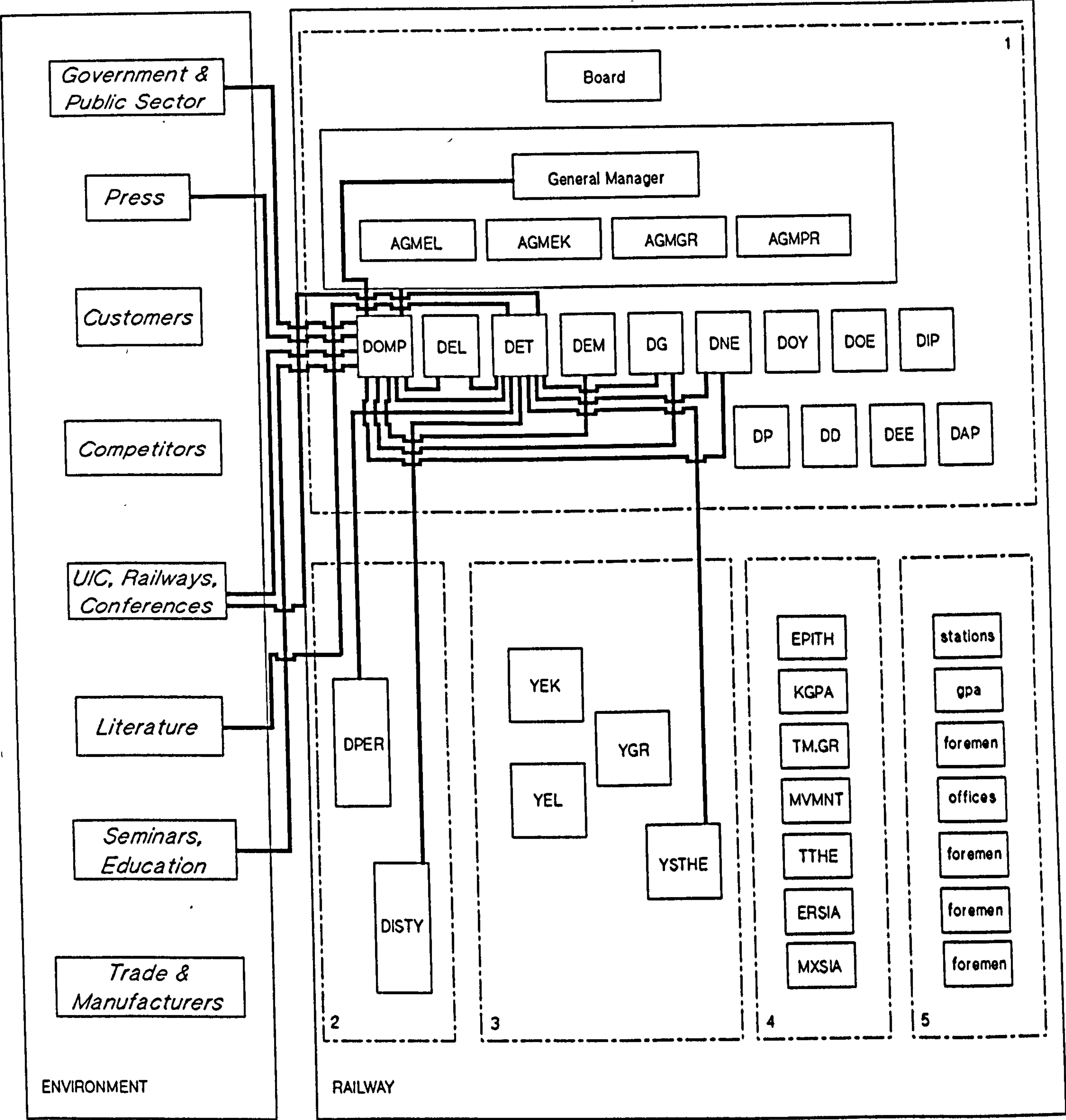


Figure E18: Activities of the Operations System: Research & Development: Information Flows

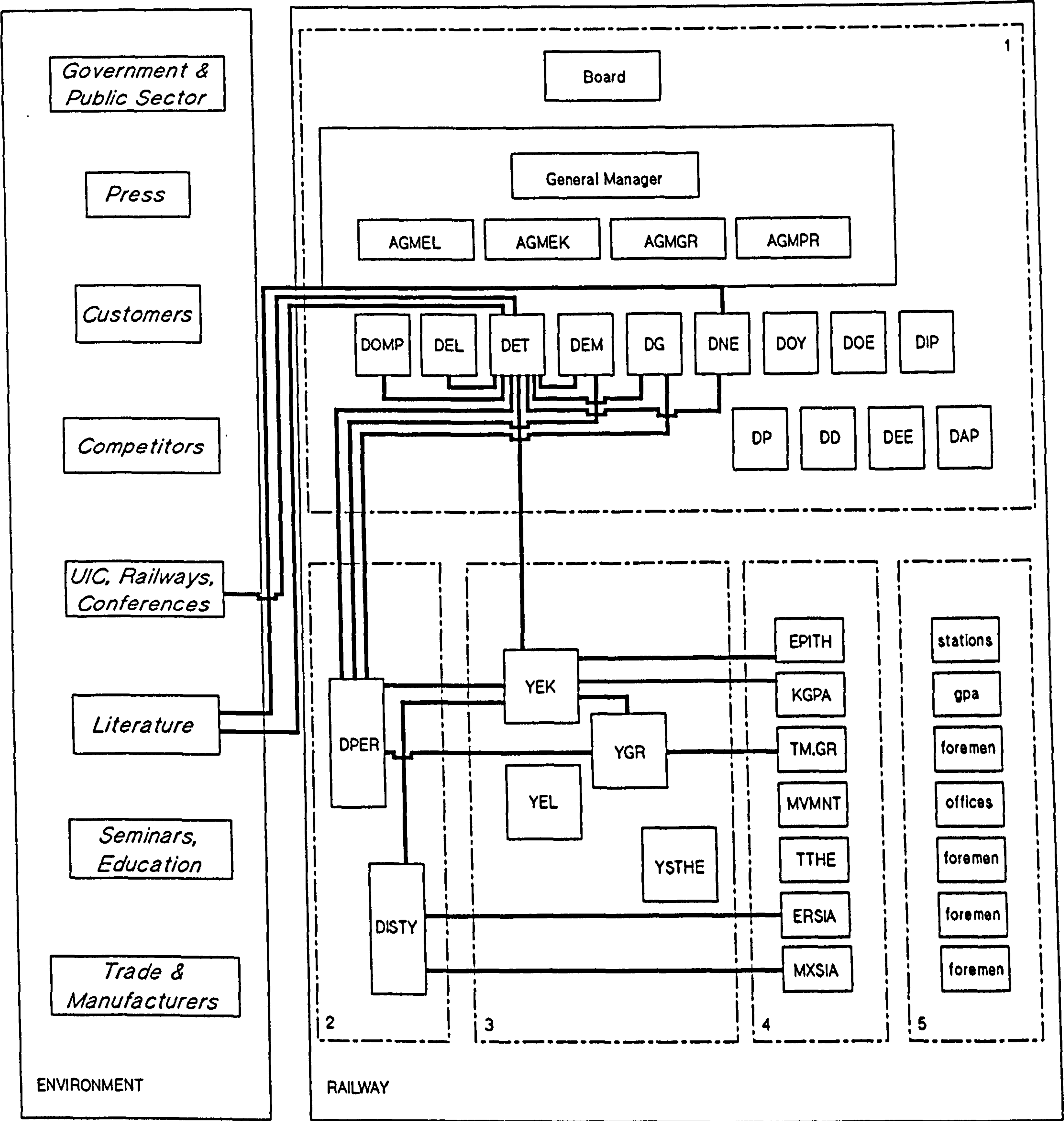


Figure E19: Activities of the Operations system: Planning/Organizing: Information Flows

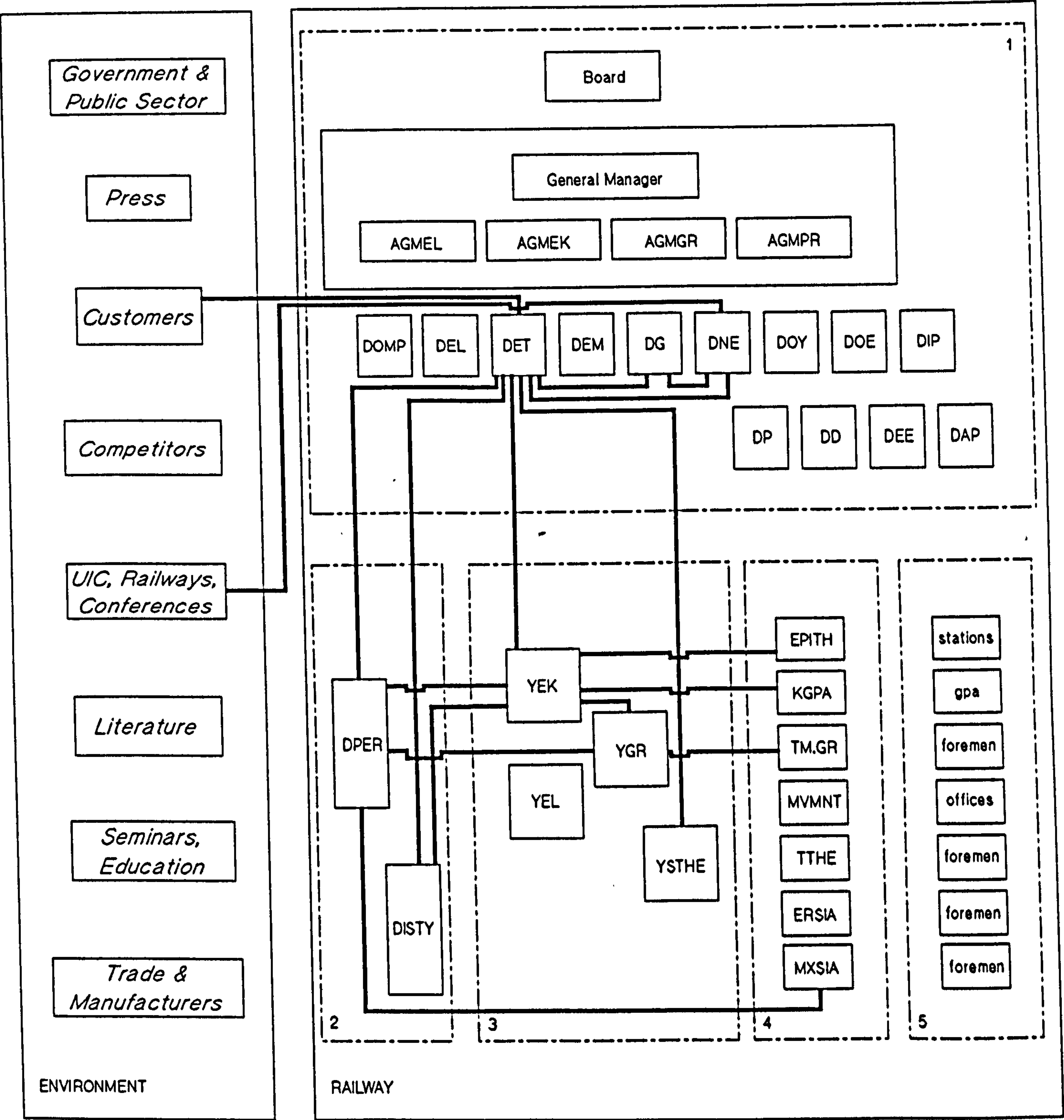


Figure E20: Activities of the Operations system: Annual Programming: Information Flows

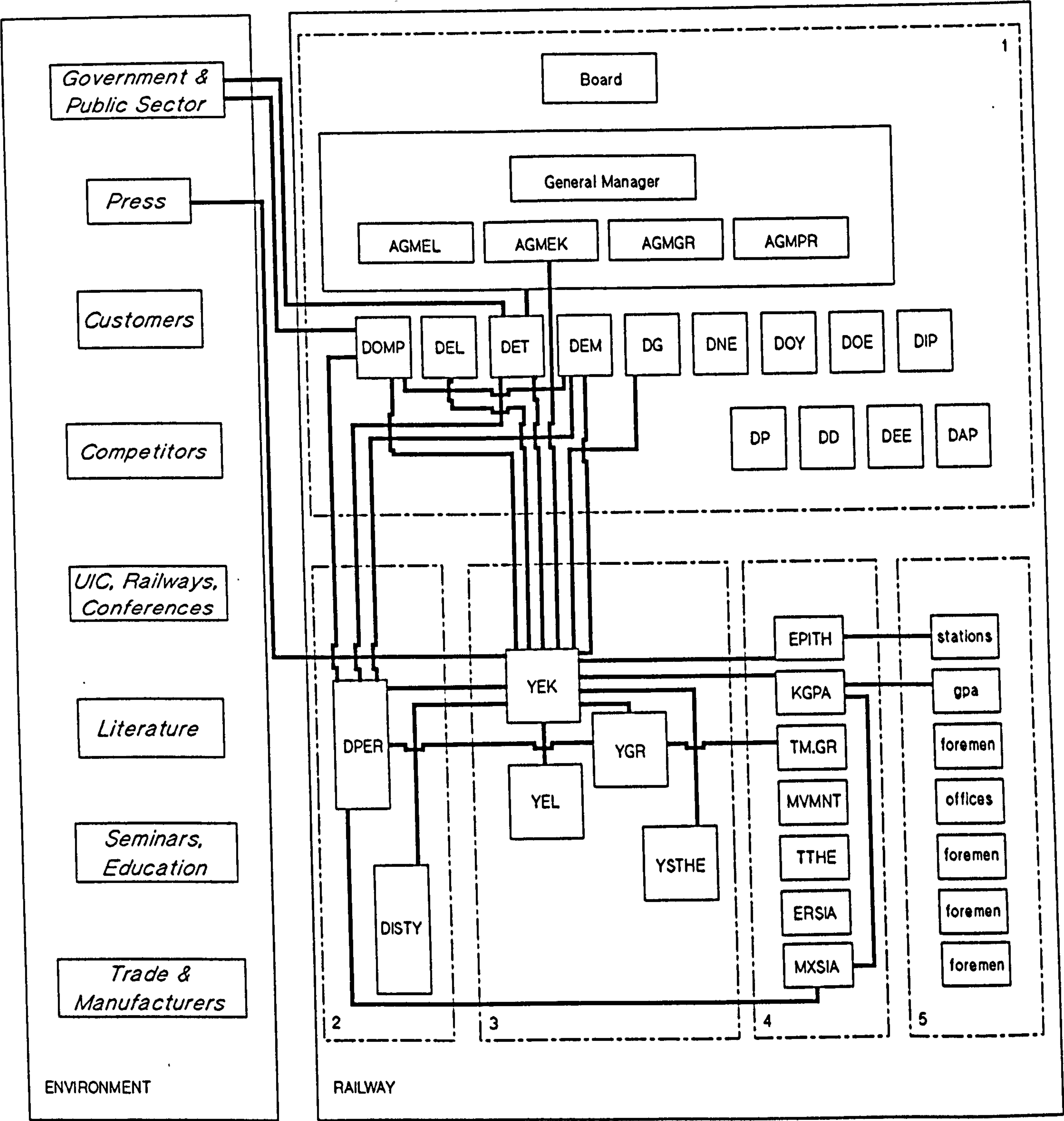


Figure E21: Activities of the Operations system: Performance Monitoring: Information Flows

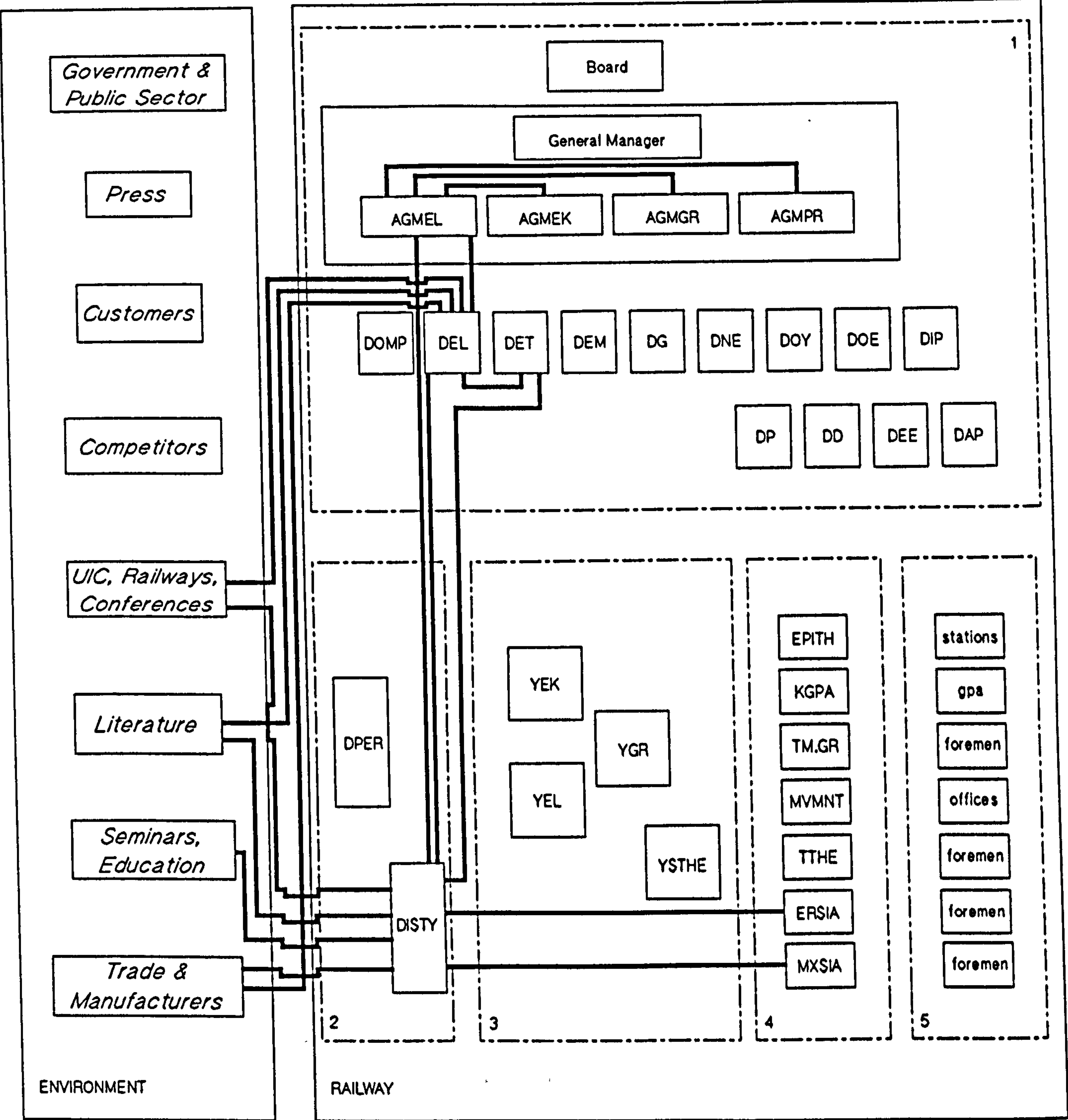


Figure E22: Activities of the Rolling Stock system: Research & Development: Information Flows

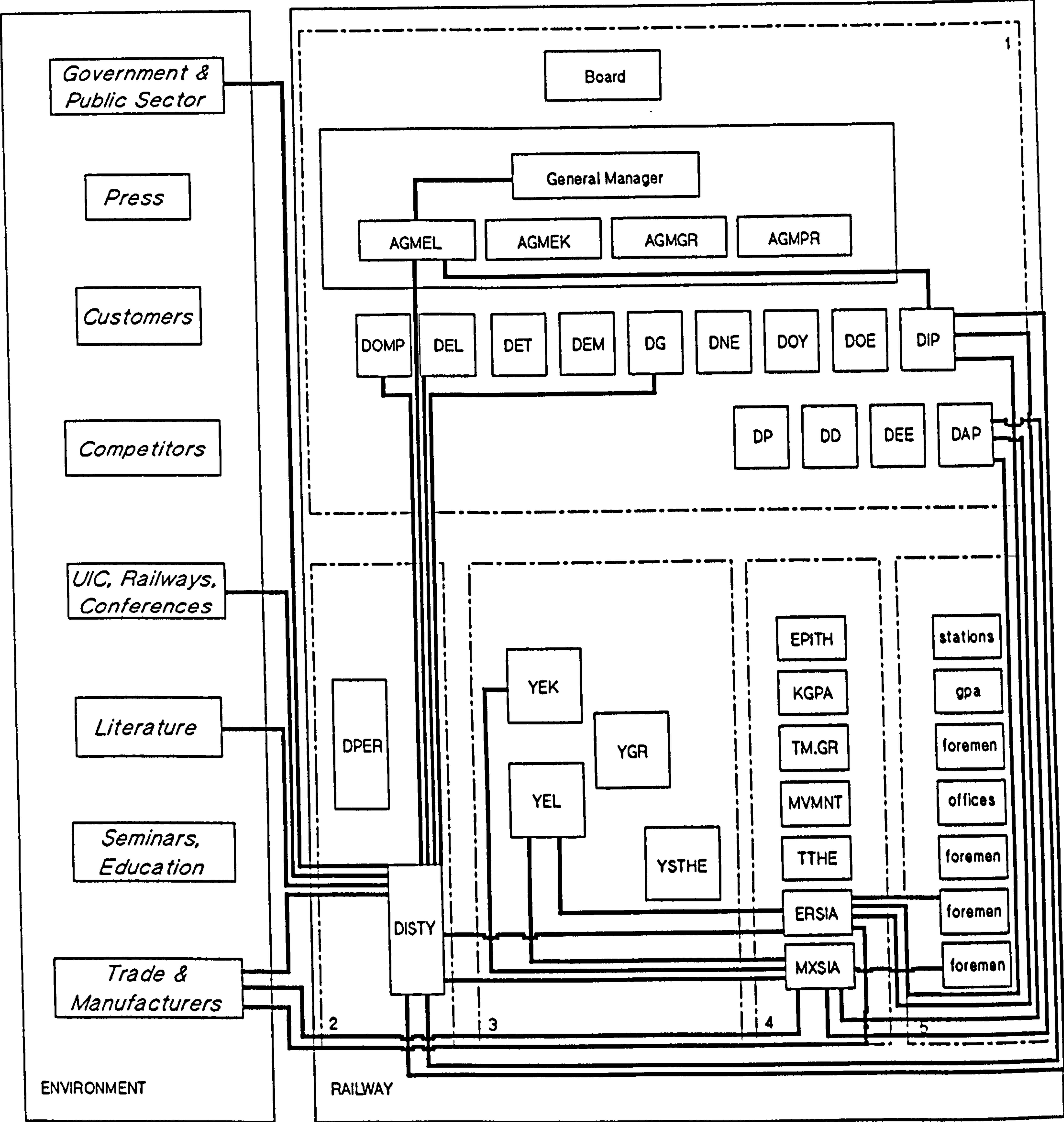


Figure E23: Activities of the Rolling Stock system: Planning/Organizing: Information Flows

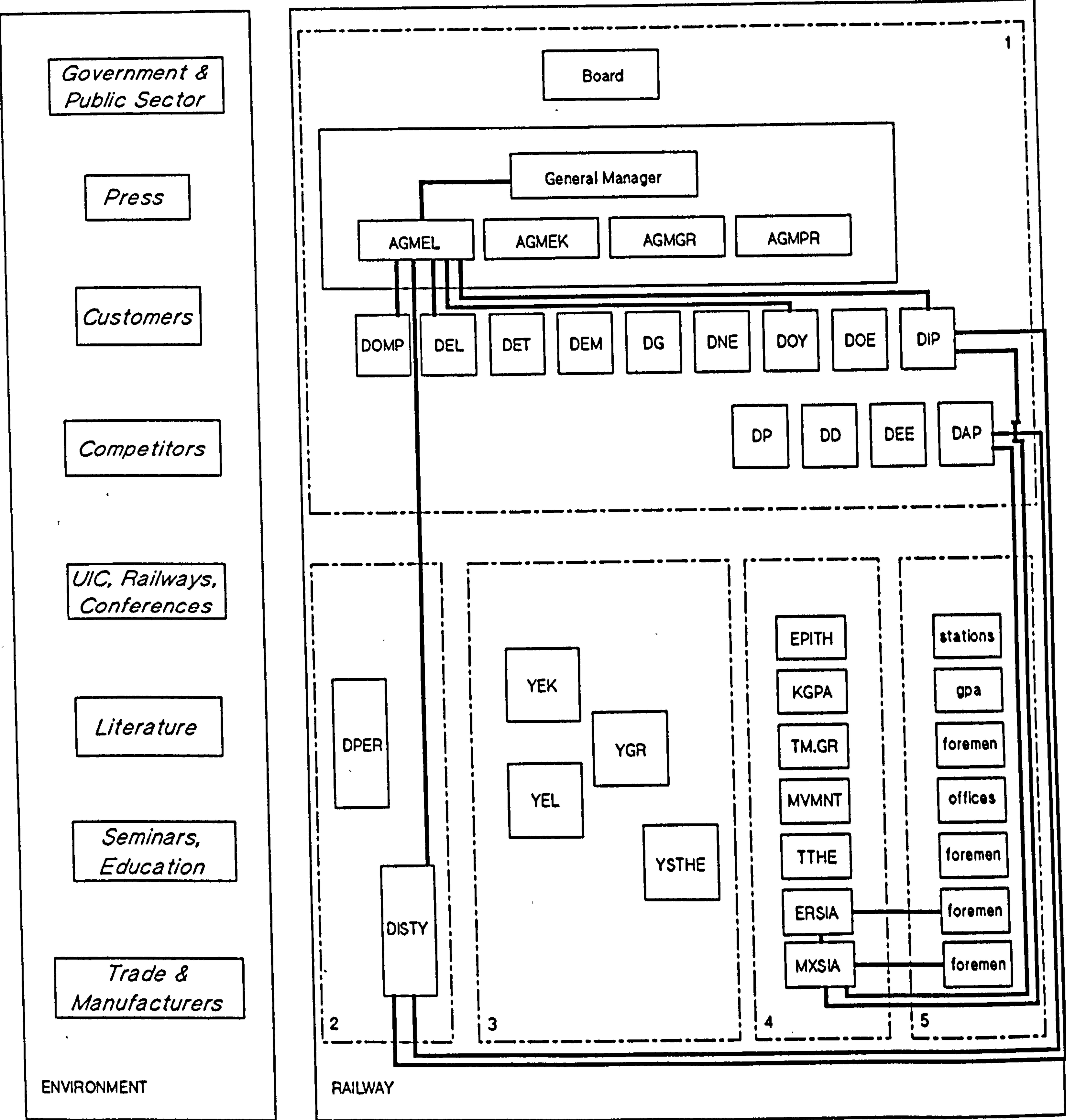


Figure E24: Activities of the Rolling Stock system: Annual Programming: Information Flows

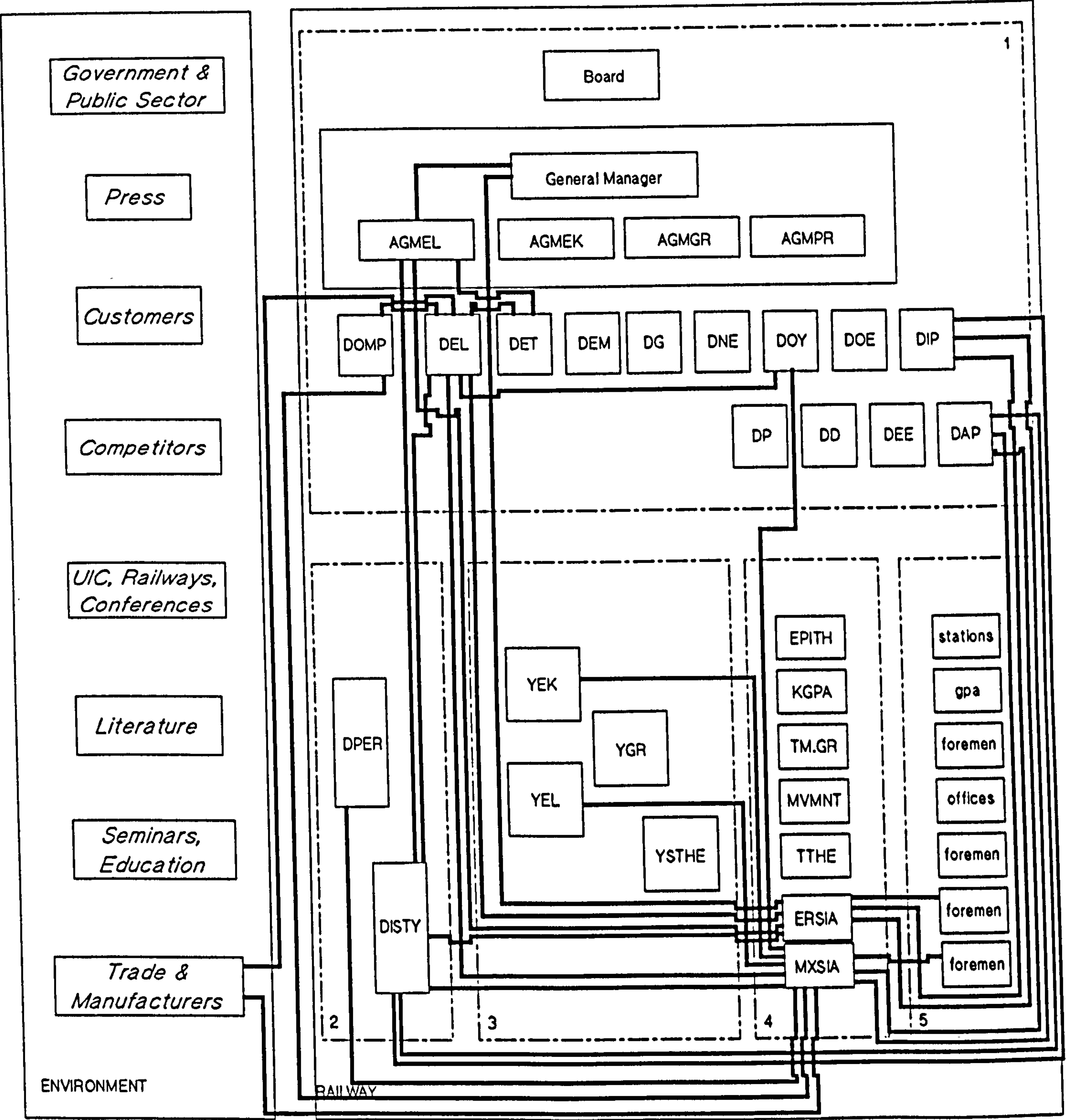


Figure E25: Activities of the Rolling Stock system: Performance Monitoring: Information Flows

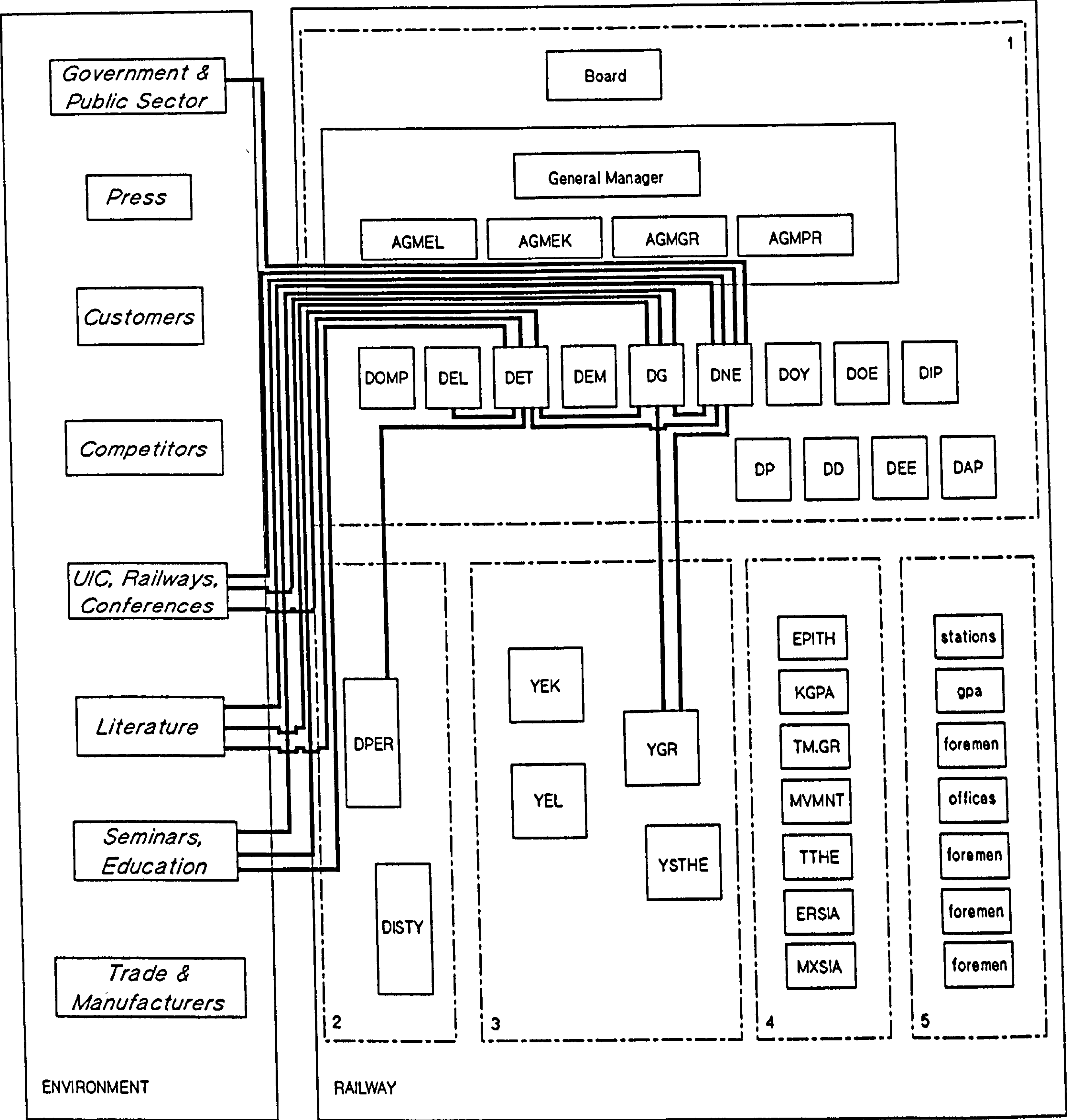


Figure E26: Activities of the Permanent Way system: Research & Development: Information Flows

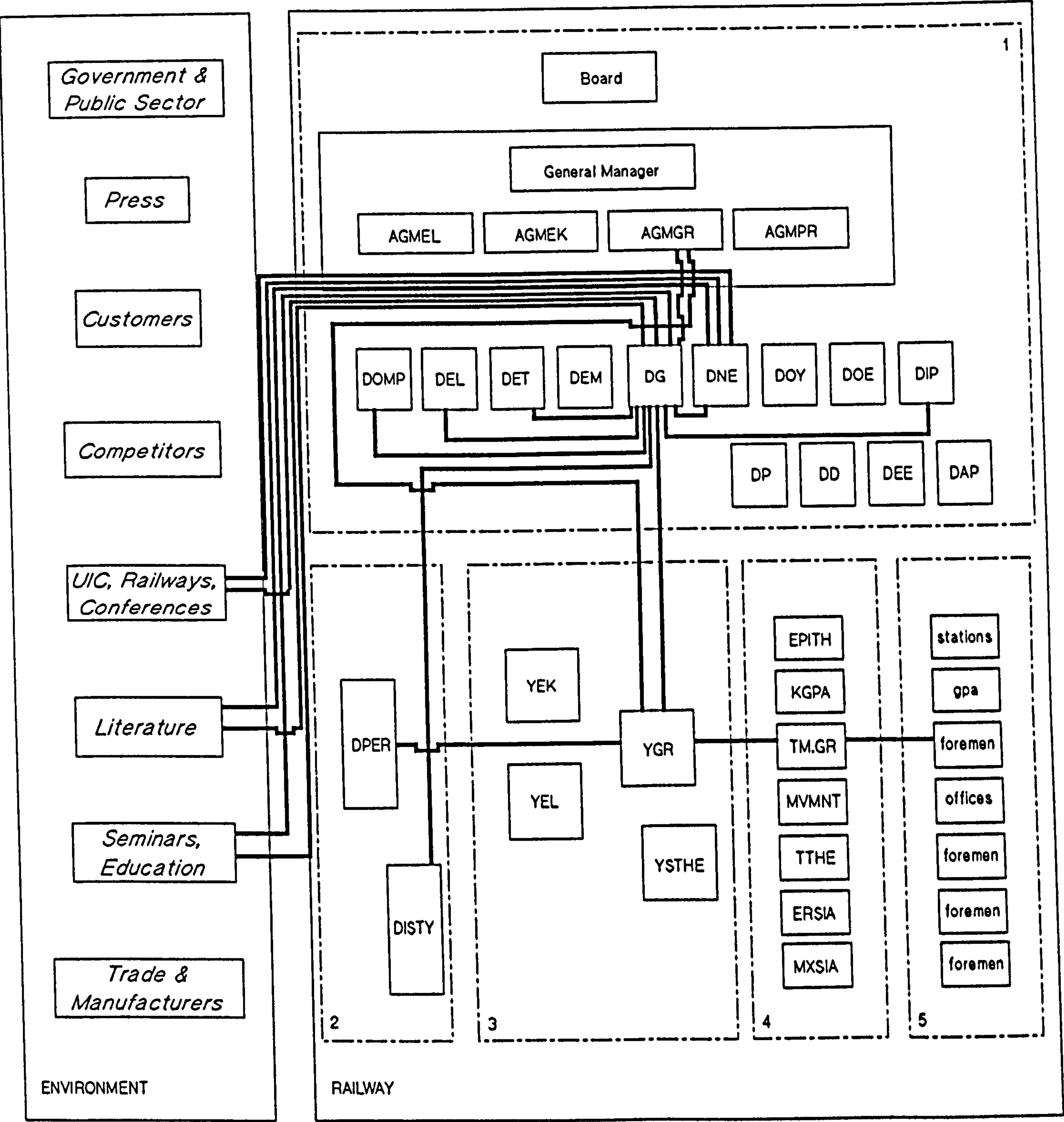


Figure E27: Activities of the Permanent Way system: Planning/Organizing: Information Flows

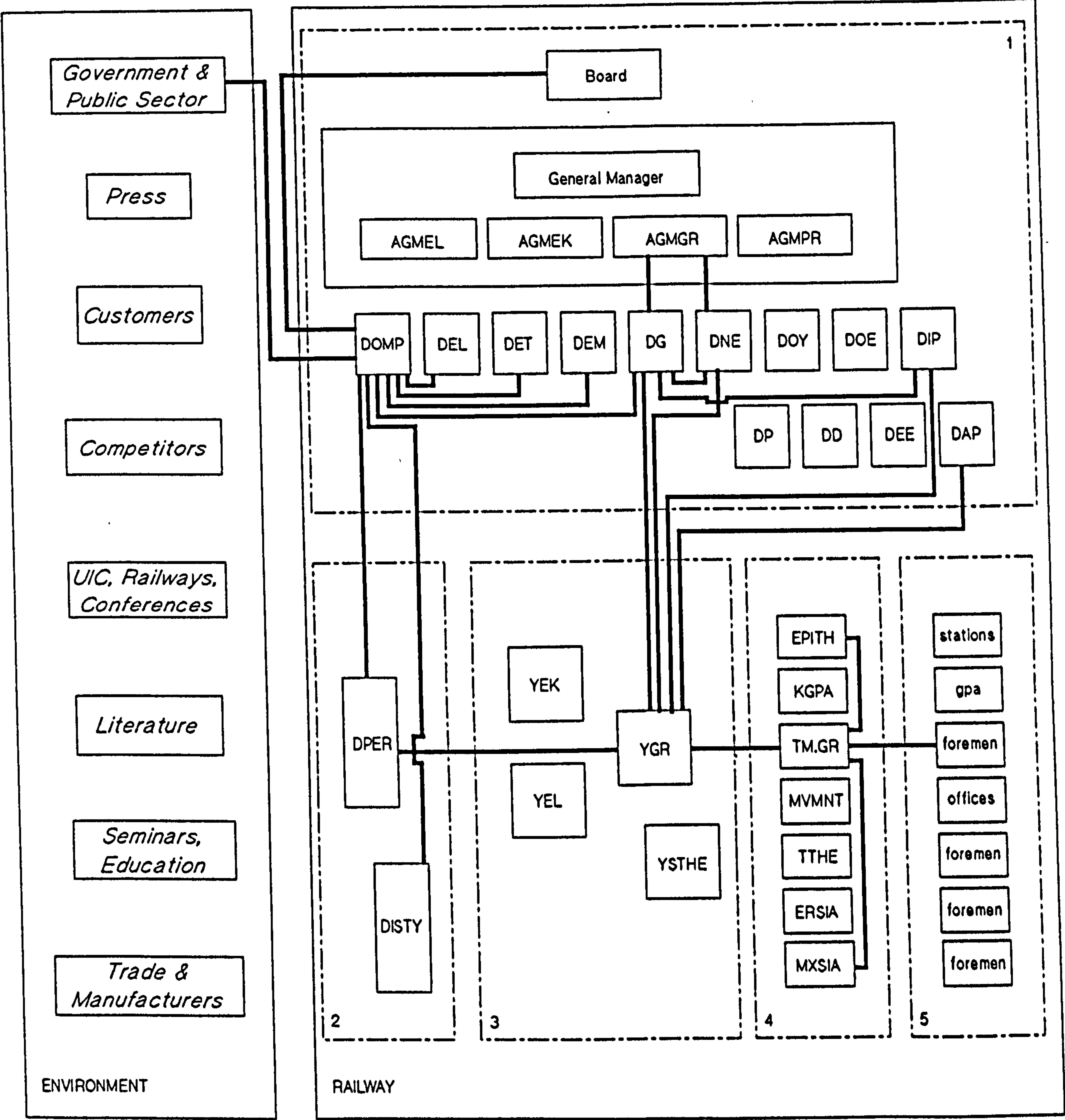


Figure E28: Activities of the Permanent Way system: Annual Programming: Information Flows

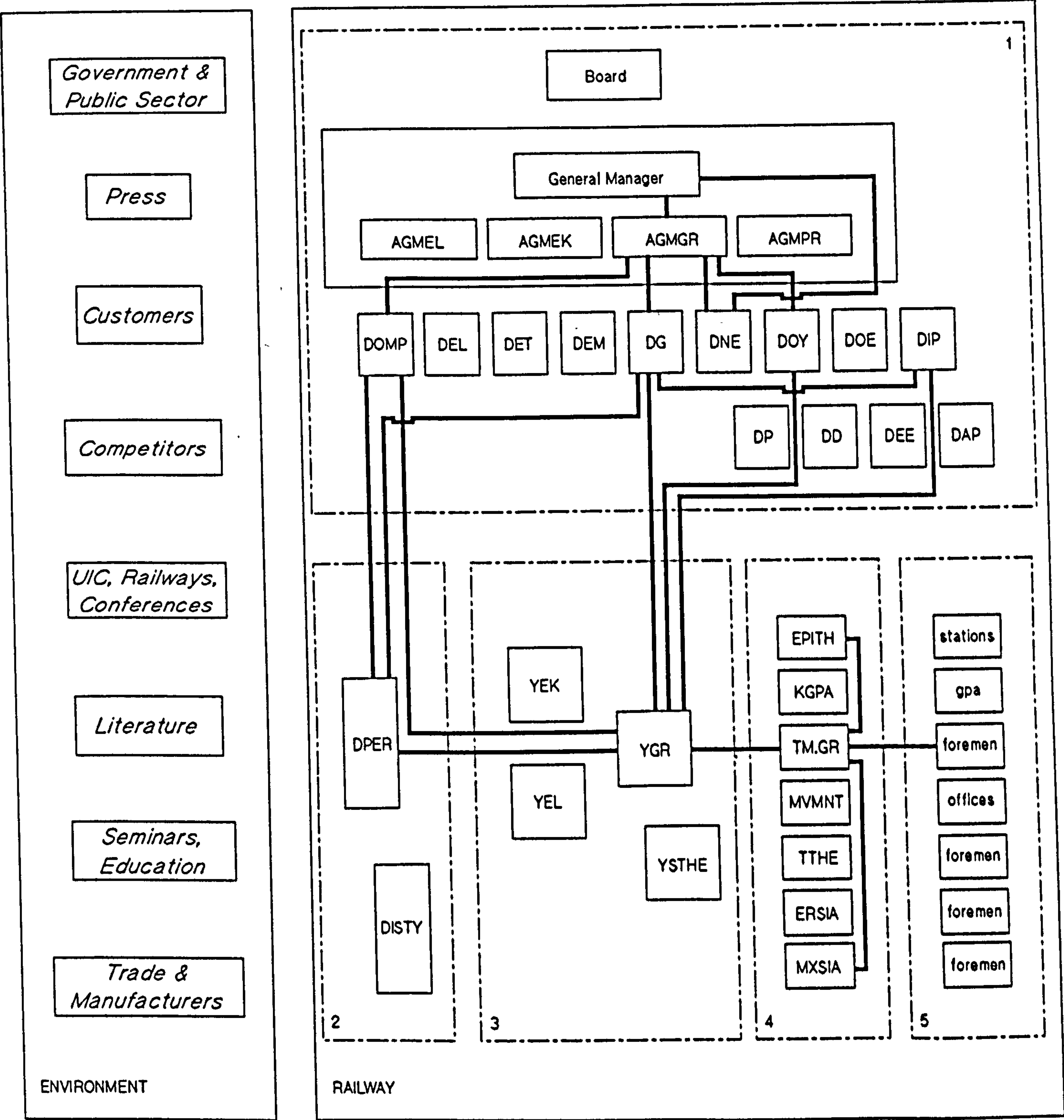


Figure E29: Activities of the Permanent Way system: Performance Monitoring: Information Flows

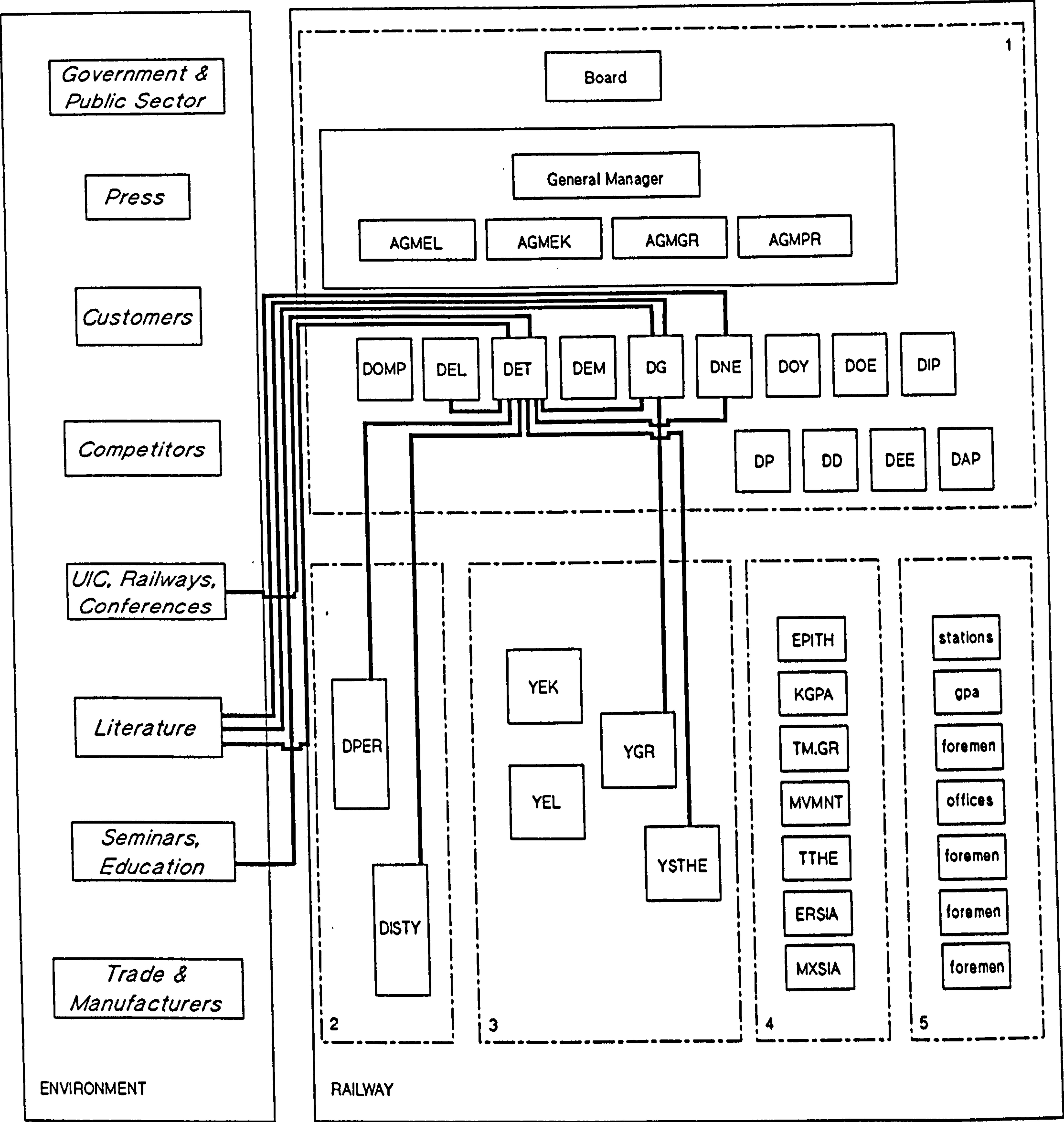


Figure E30: Activities of the Signalling/Telecom system: Research & Development: Information Flows

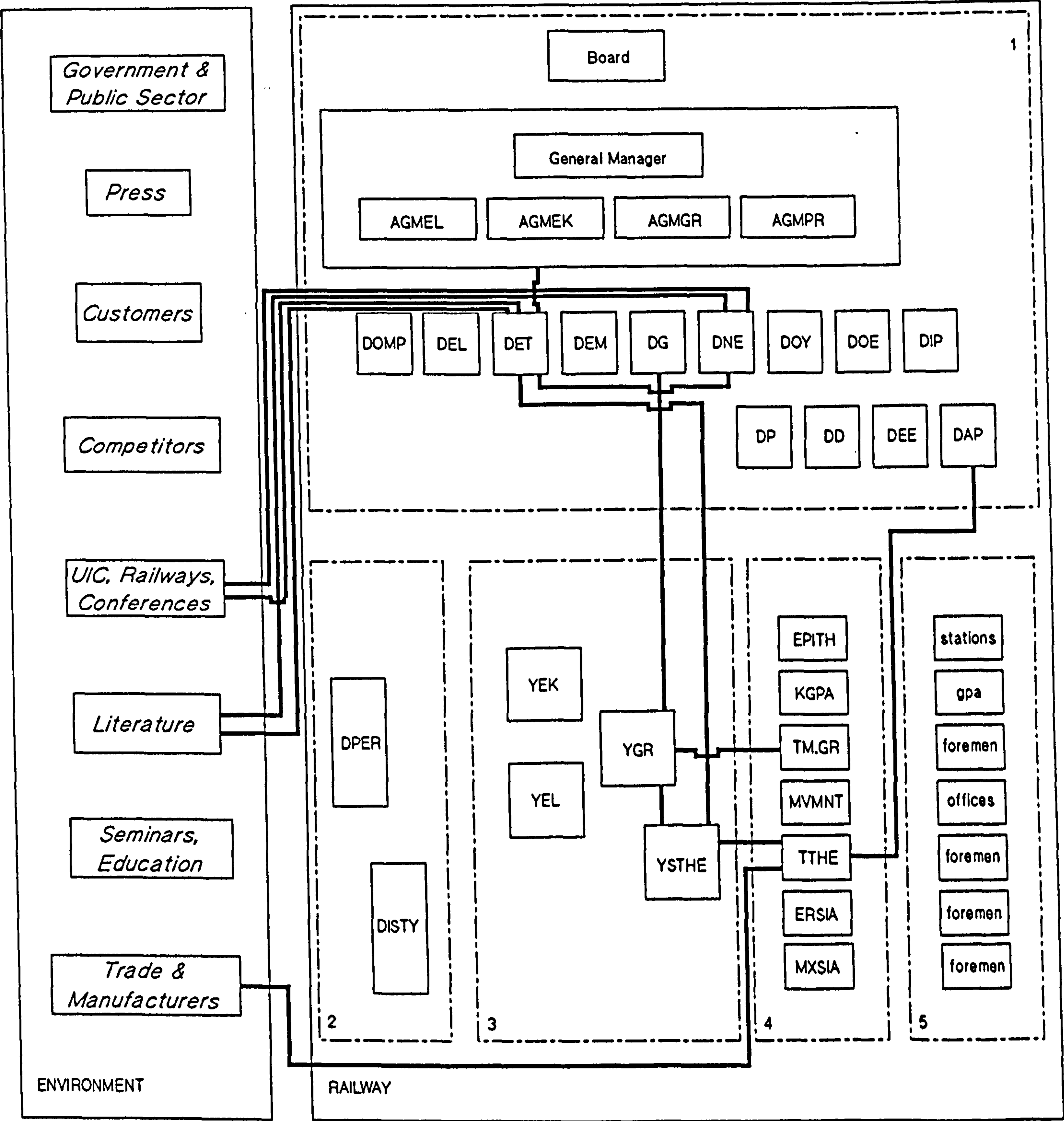


Figure E31: Activities of the Signalling/Telecom system: Planning/Organizing: Information Flows

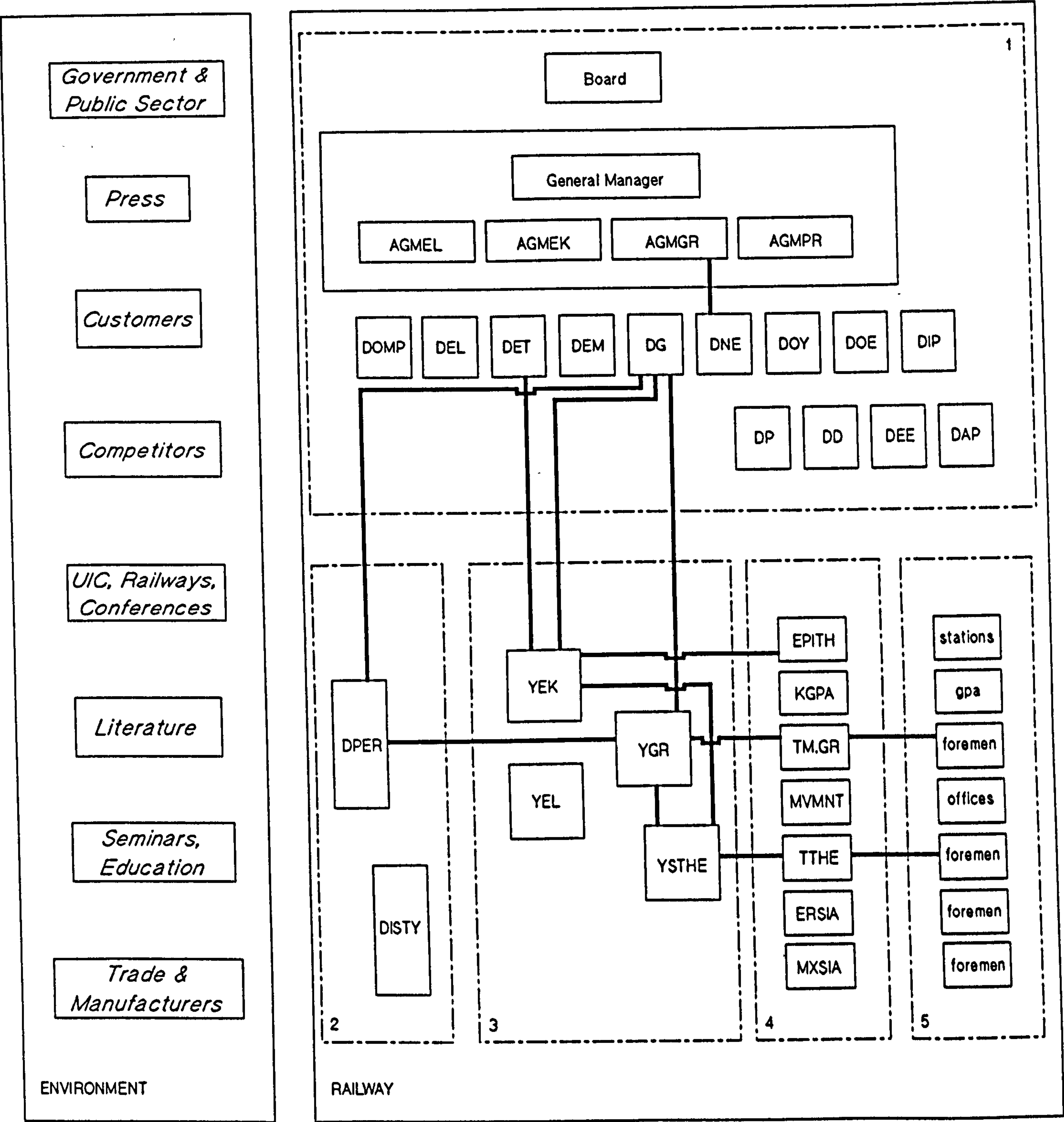


Figure E33: Activities of the Signalling/Telecom system: Performance Monitoring: Information Flows

APPENDIX F

TESTING COHESIVENESS

Information contained in this appendix relates to the 'organizational culture' test undertaken in *Chapter 11* in the form of managerial cohesiveness.

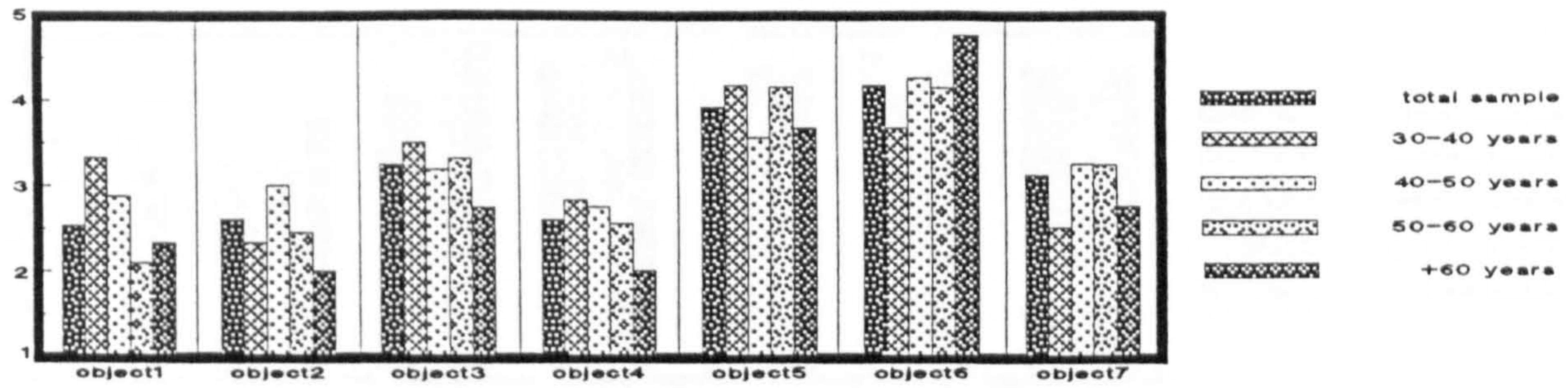
- *Table F1* provides mean values of the variables OBJECT1 to REASON9 (*Survey Questionnaire, Section Two, Questions 3-12*), concerning the total sample as well as the various subgroupings by age, level, function and jobtype, as described in *Chapter 9*.
- *Figures F1 to F7* provide graphical illustration of these mean values.
- *Table F2* provides mean values for variables related to improvement of systemic performance (*Survey Questionnaire, Section Two, Question 13*).
- *Tables F3 to F9* display the two-sample or k-sample median tests involving the 49 variables of this section (variables OBJECT1 to REASON9) against the independent variables age, level, function and jobtype.
- *Tables F10 and F11* display pairwise comparisons for those of the non-dichotomous variables for which the k-sample median tests have indicated significant association.
- *Table F12* provides rank orders of methods for improving performance (*Survey Questionnaire, Section Two, Question 13*).
- *Figure 8* provides a graphical illustration of these rank orders.

indepndt variable		entire sample	age group				level group				function group					jobtype	
value label			+30 -40	+40 -50	+50 -60	+60	top mgmt	dpts mgmt	div mgmt	area mgmt	rail ops	roll stck	perm way	sign tlcm	othr	hdqs	prdc
popltn		50	9	19	13	9	6	7	20	17	8	10	18	3	11	21	29
%		100	18	38	26	18	12	14	40	34	16	20	36	6	22	42	58
c			2	3	4	5	1	2	3	4	1	2	3	4	5	1	2
object	1	2.53	3.33	2.88	2.09	2.33	1.83	2.33	2.37	3.06	2.14	2.88	3.00	1.67	2.00	2.05	2.86
object	2	2.60	2.33	3.00	2.45	2.00	2.00	2.83	2.79	2.50	2.29	3.63	2.50	2.00	2.36	2.37	2.75
object	3	3.25	3.50	3.19	3.32	2.75	3.67	3.43	3.42	2.81	2.86	3.56	3.00	2.67	3.82	3.42	3.14
object	4	2.60	2.83	2.75	2.55	2.00	3.33	2.57	2.89	2.00	2.00	2.67	2.89	2.00	2.64	2.89	2.41
object	5	3.91	4.17	3.56	4.15	3.67	4.50	4.20	3.56	4.00	4.83	3.57	3.56	3.67	4.27	3.83	3.96
object	6	4.17	3.67	4.25	4.14	4.75	4.50	4.71	4.00	4.00	4.14	4.11	4.22	4.00	4.18	4.21	4.14
object	7	3.11	2.50	3.25	3.24	2.75	3.83	3.50	3.05	2.75	3.17	3.11	2.78	3.00	3.64	3.11	3.10
task	1	3.47	3.00	3.44	3.52	4.00	3.67	3.71	3.50	3.25	3.75	2.90	3.33	2.50	4.18	3.90	3.14
task	2	3.08	3.00	3.13	2.96	3.75	2.83	3.29	3.00	3.19	3.00	3.60	2.83	2.50	3.18	3.52	2.75
task	3	4.86	4.67	4.76	4.96	5.00	4.83	5.00	4.85	4.82	5.00	4.60	4.89	5.00	4.91	4.86	4.86
task	4	4.60	4.33	4.53	4.74	4.50	4.50	4.57	4.65	4.59	4.63	4.50	4.56	4.67	4.73	4.71	4.52
task	5	4.28	3.17	4.47	4.39	4.50	4.00	4.00	4.60	4.11	4.13	4.00	4.39	4.00	4.55	4.38	4.21
task	6	4.70	4.17	4.71	4.91	4.25	4.83	4.57	4.75	4.65	4.88	4.50	4.67	4.67	4.82	4.86	4.59
task	7	4.52	4.50	4.41	4.61	4.50	4.50	4.43	4.55	4.53	4.38	4.50	4.56	4.00	4.73	4.62	4.45
contr	1	2.38	2.33	2.06	2.48	3.25	2.67	2.14	2.50	2.23	2.13	2.90	1.61	3.67	3.00	2.81	2.07
contr	2	2.18	2.00	2.00	2.17	3.25	2.17	1.86	2.05	2.47	2.13	2.90	1.39	3.33	2.55	2.33	2.07
contr	3	2.46	3.33	2.06	2.35	3.50	2.67	2.00	2.40	2.65	2.38	4.20	1.94	3.33	1.55	2.10	2.72
contr	4	2.02	2.50	1.71	2.04	2.50	2.67	2.57	1.75	1.88	2.88	2.10	1.67	2.67	1.73	1.81	2.17
contr	5	2.62	1.83	2.88	2.52	3.25	3.00	2.43	2.80	2.35	2.13	2.80	3.00	4.33	1.73	2.43	2.76
contr	6	2.88	3.17	2.88	2.91	2.25	3.50	2.57	2.85	2.82	3.13	3.40	2.61	3.67	2.45	2.81	2.93
contr	7	1.90	2.33	1.41	2.09	2.25	2.83	1.71	1.75	1.82	2.25	2.10	1.72	3.00	1.45	1.86	1.93
plan		2.64	4.25	2.69	2.39	2.25	3.20	2.14	2.50	2.87	2.63	2.78	2.71	2.00	2.60	2.40	2.81
budget		3.22	3.75	2.77	3.60	2.75	3.50	2.83	3.40	3.15	4.00	4.13	2.53	4.00	2.67	3.00	3.31
freqbudg		2.29	2.83	1.87	2.63	1.75	3.50	2.83	1.93	1.93	2.60	1.88	2.00	3.33	2.86	2.94	1.88
view	1	2.02	2.50	2.06	2.00	1.25	1.50	1.71	2.10	2.23	2.00	1.40	2.61	2.67	1.45	1.52	2.38
view	2	3.02	3.83	2.82	2.87	3.50	2.83	3.43	3.15	2.76	3.00	2.90	3.44	3.33	2.36	2.90	3.10
view	3	3.16	3.50	3.06	3.26	2.50	3.83	2.86	3.30	2.88	3.75	3.00	3.22	3.67	2.64	3.10	3.21
view	4	3.46	3.83	3.18	3.43	4.25	4.50	3.86	3.70	2.65	3.38	3.60	3.50	4.00	3.18	3.62	3.34
opin	1	2.40	2.20	2.73	2.30	2.25	2.33	2.00	2.50	2.50	1.88	2.71	2.58	4.00	2.09	2.11	2.64
opin	2	3.29	3.50	3.50	3.16	3.00	3.33	3.00	3.40	3.25	3.00	3.29	3.36	4.50	3.18	3.31	2.27
opin	3	2.59	2.67	2.59	2.59	2.50	2.17	2.71	2.58	2.71	2.75	2.40	2.71	3.33	2.27	2.30	2.79
opin	4	2.18	2.83	2.29	1.91	2.25	2.17	2.00	2.00	2.47	2.00	2.50	2.11	3.00	1.91	2.05	2.28
opin	5	2.06	2.33	2.12	1.87	2.50	2.00	2.00	2.00	2.18	1.75	2.00	2.22	2.67	1.91	1.95	2.14
opin	6	2.81	3.33	2.88	2.68	2.33	3.00	2.50	2.95	2.71	2.38	2.50	3.25	3.33	2.64	2.68	2.90
opin	7	2.81	3.17	2.88	2.63	3.00	2.83	2.83	2.79	2.82	2.50	2.60	3.19	3.00	2.64	2.58	2.97
opin	8	2.94	3.40	2.94	2.76	3.25	3.17	3.00	2.79	3.00	2.88	3.00	3.18	3.00	2.55	2.84	3.00
opin	9	2.67	3.20	2.53	2.64	2.75	2.67	2.57	2.58	2.81	2.63	2.89	2.94	3.00	2.00	2.45	2.82
journ	1	3.44	3.00	3.41	3.70	2.75	2.67	3.29	3.75	3.41	3.50	2.80	3.56	3.33	3.82	3.62	3.31
journ	2	5.24	5.17	5.82	4.91	4.75	3.83	5.00	5.00	5.53	5.13	5.20	5.39	5.33	5.09	4.76	5.59
journ	3	4.30	3.83	4.71	4.04	4.75	4.00	5.00	4.55	3.82	4.00	4.00	4.39	4.67	4.55	4.43	4.21
reason	1	2.24	2.67	2.29	2.13	2.00	1.67	2.00	2.45	2.29	1.50	2.90	2.28	2.67	2.00	2.19	2.28
reason	2	2.56	3.17	2.35	2.65	2.00	2.67	2.71	2.35	2.71	2.25	3.10	2.22	3.33	2.64	2.57	2.55
reason	3	3.22	2.67	2.88	3.52	3.75	2.83	3.71	3.20	3.18	3.38	3.80	2.78	3.33	3.27	3.71	2.86
reason	4	3.18	2.17	3.18	3.39	3.50	3.17	3.57	3.20	3.00	3.25	3.50	2.83	3.33	3.36	3.62	2.86
reason	5	3.30	3.17	3.41	3.26	3.25	3.00	3.29	3.45	3.24	3.00	3.70	3.22	2.67	3.45	3.62	3.07
reason	6	3.40	3.67	3.71	3.26	2.50	3.50	3.00	3.55	3.35	3.00	3.40	3.56	3.33	3.45	3.48	3.34
reason	7	2.36	3.17	2.35	2.35	1.25	2.83	2.14	2.15	2.53	2.50	2.40	2.17	2.33	2.55	2.33	2.38
reason	8	3.12	3.00	3.47	3.17	1.50	3.50	2.43	3.35	3.00	2.63	2.50	3.39	2.67	3.73	3.48	2.86
reason	9	3.76	4.17	4.06	3.57	3.00	4.00	3.29	3.80	3.82	3.25	4.00	4.06	3.33	3.55	4.00	3.59

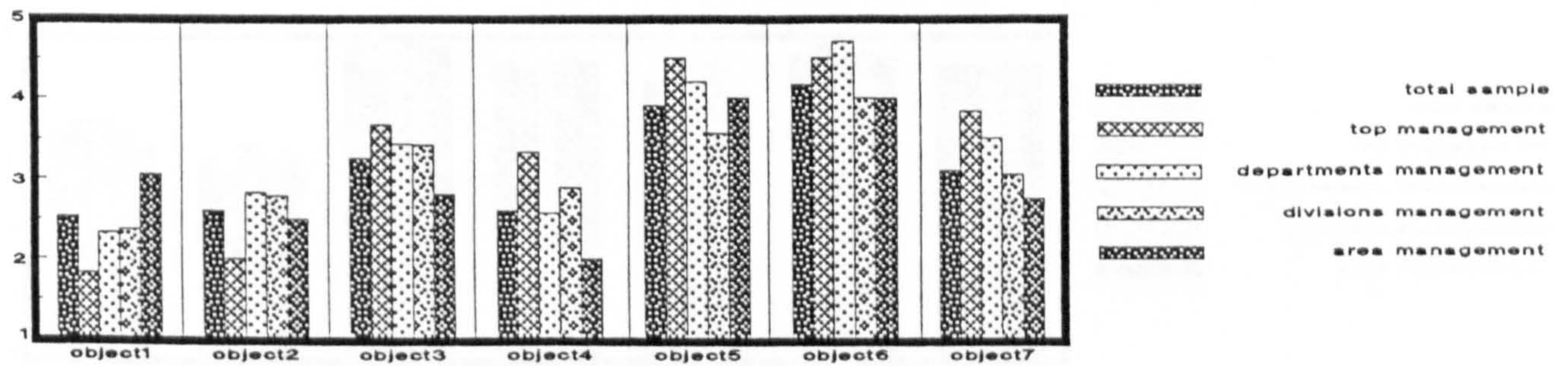
Table F1: Mean Values of Variables: Variables OBJECT1 to REASON9

indepndt variable	entire	age group				level group				function group					jobtype	
value label	sample	+30 -40	+40 -50	+50 -60	+60	top mgmt	dpts mgmt	div mgmt	area mgmt	rail ops	roll stck	perm way	sign tlcm	othr	hdqs	prdc
popltn	50	6	17	23	4	6	7	20	17	8	10	18	3	11	21	29
dependent variable	%	12	34	46	8	12	14	40	34	16	20	36	6	22	42	58
c		2	3	4	5	1	2	3	4	1	2	3	4	5	1	2
improved quality of services by:																
-reorganization	3.53	3.40	3.47	3.20	6.33	2.40	4.33	3.06	4.13	4.13	4.00	3.53	3.00	2.75	3.13	4.00
-changing heads	5.38	4.83	5.47	5.50	5.00	4.33	6.00	5.65	5.25	5.86	5.00	5.33	4.67	5.75	5.71	5.00
-improved planning	3.19	2.60	3.75	3.00	2.75	2.50	3.00	3.32	3.40	2.80	2.50	3.61	3.67	3.25	3.17	3.22
-effective control	3.49	2.17	3.12	4.60	1.50	3.67	3.00	4.17	2.88	3.13	2.50	3.72	5.00	4.00	3.72	3.23
-staff training	2.88	3.83	2.82	2.68	2.75	3.00	2.14	3.11	2.88	2.40	3.10	3.00	2.67	3.00	2.80	2.96
-better work cndtns	4.74	6.00	4.44	4.40	5.75	5.17	5.50	4.56	4.50	4.88	4.78	4.67	5.00	4.63	4.63	4.86
-salary increases	4.65	5.00	5.06	4.30	4.00	6.20	4.20	4.22	4.80	5.29	5.43	4.22	4.00	4.63	4.43	4.90
resources optimum utilization by:																
-reorganization	3.60	3.60	3.47	3.39	5.00	1.67	5.17	3.19	4.21	4.83	3.88	3.82	2.00	2.50	3.09	4.21
-changing heads	5.30	4.33	5.00	5.72	6.00	5.00	6.17	5.56	4.81	6.20	5.30	5.17	3.67	5.63	5.75	4.75
-improved planning	2.76	3.00	2.25	3.00	3.25	3.00	2.57	2.72	2.79	2.13	2.75	2.67	2.33	3.75	2.96	2.55
-effective control	3.44	4.17	3.24	3.67	2.25	5.50	2.67	3.59	2.81	1.83	2.30	3.72	5.67	4.63	3.63	3.24
-staff training	3.06	3.33	3.82	2.55	2.00	2.50	2.14	3.39	3.31	2.88	3.40	3.06	3.67	2.63	2.83	3.30
-better work cndtns	4.66	4.50	4.44	4.67	5.75	4.67	5.00	4.71	4.47	5.00	4.33	4.83	5.33	4.13	4.48	4.86
-salary increases	5.09	5.00	5.63	4.72	4.67	5.67	4.60	4.88	5.29	5.60	5.50	4.89	5.33	4.75	5.00	5.21
improved systems cooperation by:																
-reorganization	2.24	2.75	1.82	2.53	2.25	1.67	2.67	1.94	2.69	3.17	1.43	2.71	1.33	1.63	2.00	2.56
-changing heads	4.79	3.00	4.65	5.18	6.00	4.17	5.67	5.18	4.21	5.67	4.38	5.00	3.67	4.50	4.96	4.60
-improved planning	2.45	2.40	2.69	2.32	2.25	2.50	2.71	2.06	2.85	2.13	1.86	2.89	2.67	2.25	2.36	2.55
-effective control	3.79	3.60	3.75	4.11	2.75	4.83	3.17	3.94	3.43	2.50	3.88	3.56	5.67	4.50	3.96	3.60
-staff training	3.41	3.75	3.69	2.90	4.50	2.83	3.57	3.61	3.31	3.13	4.57	3.28	3.67	2.88	3.30	3.52
-better work cndtns	5.40	6.75	5.44	4.94	6.00	5.83	5.33	5.47	5.15	5.67	4.71	5.39	6.00	5.63	5.35	5.47
-salary increases	5.68	6.00	5.81	5.56	5.33	6.17	5.00	5.71	5.69	5.80	5.86	5.28	5.00	6.63	5.70	5.67
improved subsystem rolling stock by:																
-reorganization	3.06	4.25	3.20	2.09	4.33	2.33	4.25	2.83	3.27	4.00	3.75	3.08	1.67	2.17	2.53	3.63
-changing heads	4.89	4.40	4.60	5.17	6.00	4.50	6.25	5.33	4.23	6.00	5.10	4.92	3.67	4.50	5.06	4.71
-improved planning	2.82	2.20	2.94	2.79	3.33	2.50	3.20	2.43	3.23	2.33	3.00	2.92	3.00	2.67	2.78	2.85
-effective control	3.72	3.20	3.81	4.08	2.67	5.00	3.00	3.62	3.46	2.25	3.30	3.92	6.00	3.83	3.83	3.61
-staff training	3.00	4.00	3.50	2.23	2.00	2.83	2.20	3.07	3.33	2.33	2.89	3.23	2.67	3.50	2.88	3.10
-better work cndtns	4.80	4.60	4.33	5.17	6.00	4.83	5.50	5.08	4.25	6.00	3.67	4.84	5.67	5.17	4.76	4.83
-salary increases	5.42	5.00	5.60	5.42	5.00	6.00	3.67	5.69	5.27	6.00	5.00	5.23	5.33	6.17	5.59	5.25
improved subsystem permanent way by:																
-reorganization	3.50	5.50	3.14	2.69	6.00	3.60	5.40	2.57	3.80	3.75	3.25	3.88	2.00	3.17	3.22	3.81
-changing heads	5.06	3.75	5.21	5.15	5.67	4.20	6.20	5.50	4.30	5.67	5.25	5.33	3.33	4.67	5.56	4.50
-improved planning	2.61	2.00	2.73	2.67	2.50	2.50	2.83	2.19	3.20	2.00	2.20	2.72	3.00	3.00	2.63	2.58
-effective control	3.61	3.25	3.53	4.31	2.00	4.33	2.80	3.73	3.40	2.50	2.20	3.94	5.67	3.50	3.68	3.53
-staff training	2.79	3.75	3.13	2.33	2.25	2.83	1.83	3.13	2.80	2.33	3.80	2.50	3.00	3.17	2.58	3.00
-better work cndtns	5.25	4.75	5.13	5.38	5.75	4.83	5.40	5.67	4.80	6.00	5.00	5.06	5.67	5.33	5.37	5.12
-salary increases	5.23	5.00	5.53	5.15	4.33	5.50	3.75	5.20	5.70	6.67	5.40	4.72	5.33	5.83	4.95	5.56
improved subsystem signalling/tcm by:																
-reorganization	3.33	5.33	3.33	2.50	4.50	2.80	4.50	3.40	3.00	3.50	5.00	3.73	1.67	2.50	3.21	3.46
-changing heads	5.04	5.67	4.75	5.40	4.00	4.20	5.50	5.40	4.88	5.67	5.33	5.00	4.67	4.83	5.36	4.69
-improved planning	2.61	2.33	2.62	2.75	2.33	3.00	2.60	2.17	3.00	2.50	1.75	2.67	2.67	3.17	2.67	2.56
-effective control	3.66	3.00	3.31	4.50	3.00	4.67	3.50	3.45	3.25	2.75	2.50	3.83	5.33	3.83	3.73	3.57
-staff training	2.71	1.67	3.38	2.00	3.67	1.83	2.80	3.00	2.88	2.67	3.25	2.75	2.67	2.33	2.20	3.19
-better work cndtns	5.21	5.00	5.15	5.20	5.67	4.83	5.50	5.28	5.25	5.75	4.50	5.08	5.67	5.33	5.07	5.36
-salary increases	5.39	5.00	5.69	5.30	4.50	5.67	3.67	5.45	5.75	5.67	5.00	5.17	5.33	6.00	5.47	5.31

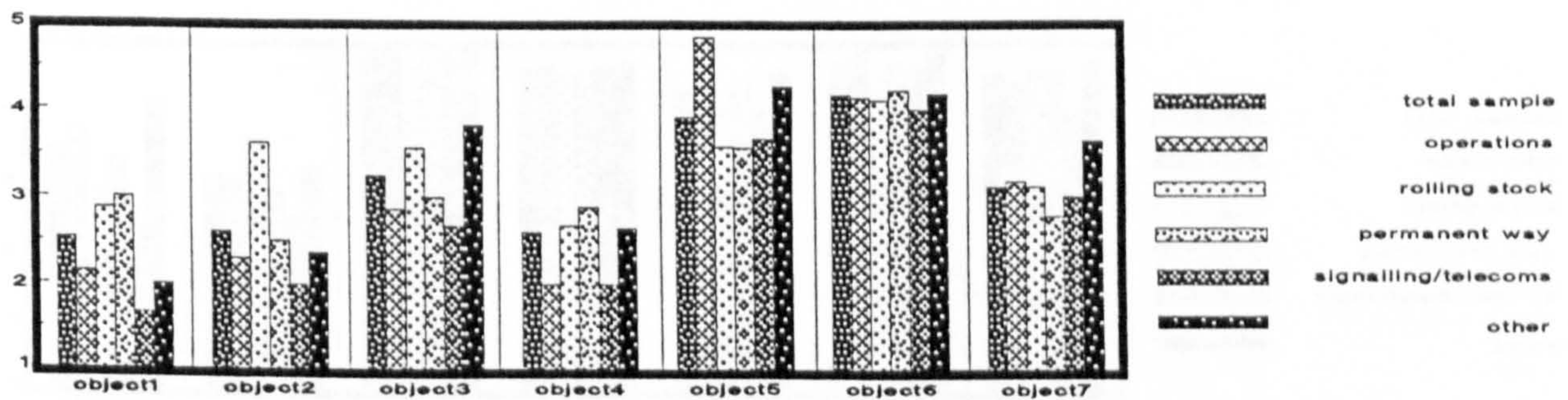
Table F2: Mean Values of Variables: Improvement of Systemic Performance



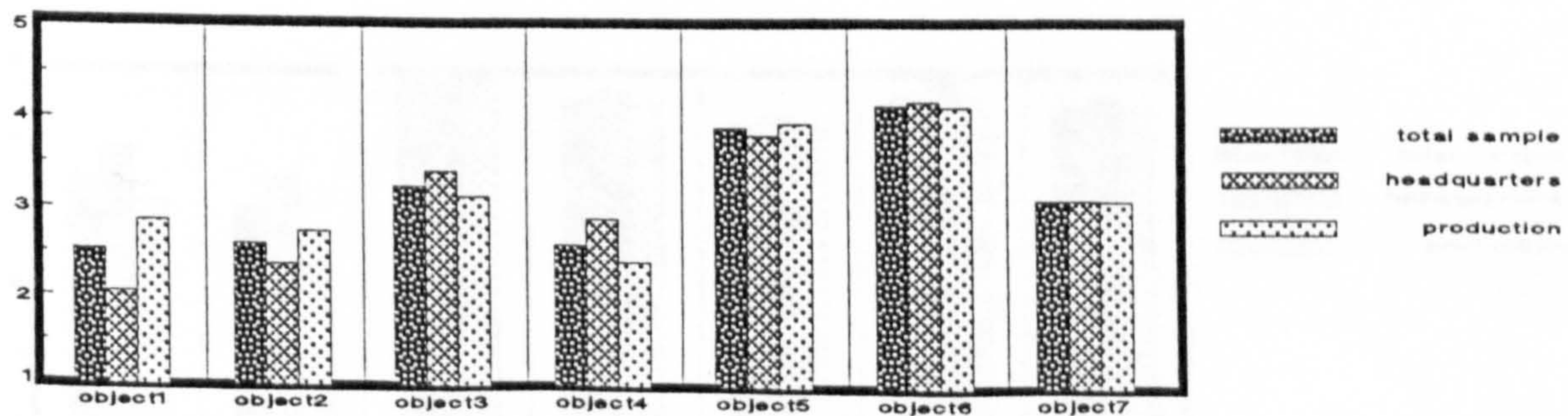
OBJECT1 to OBJECT7 by AGE



OBJECT1 to OBJECT7 by LEVEL

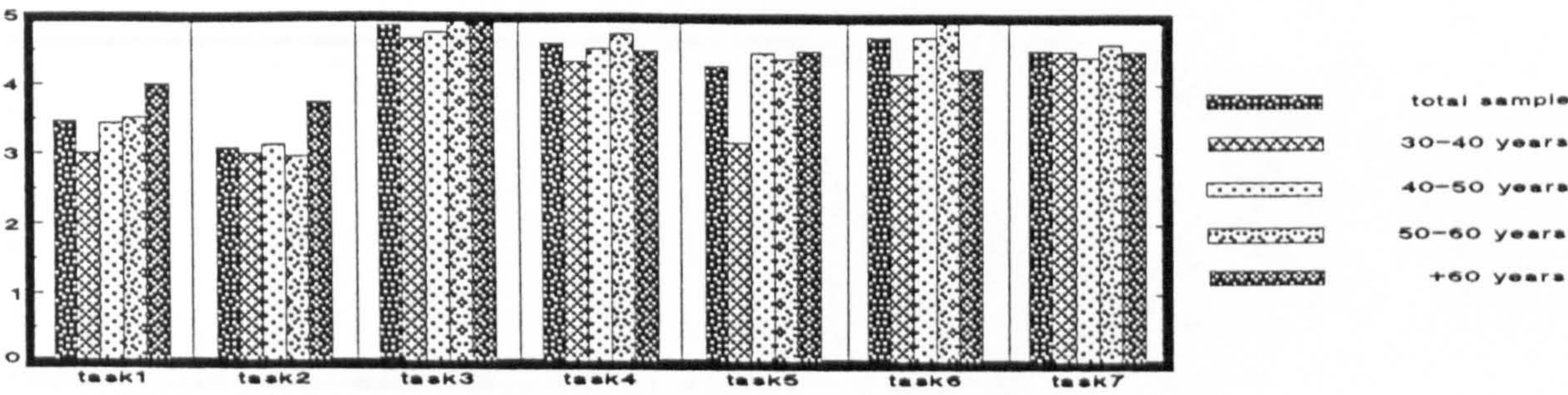


OBJECT1 to OBJECT7 by FUNCTION

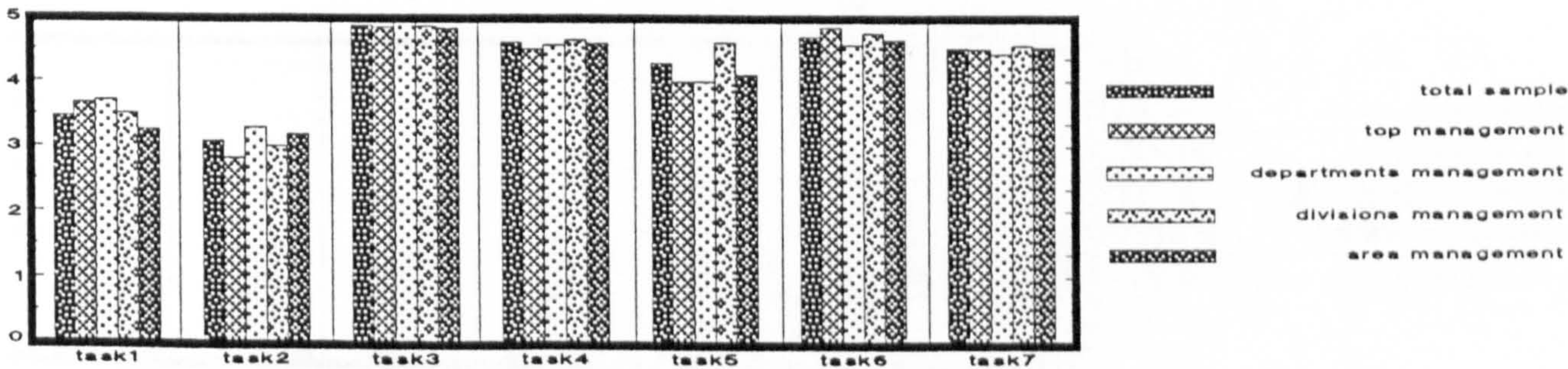


OBJECT1 to OBJECT7 by JOBTYP

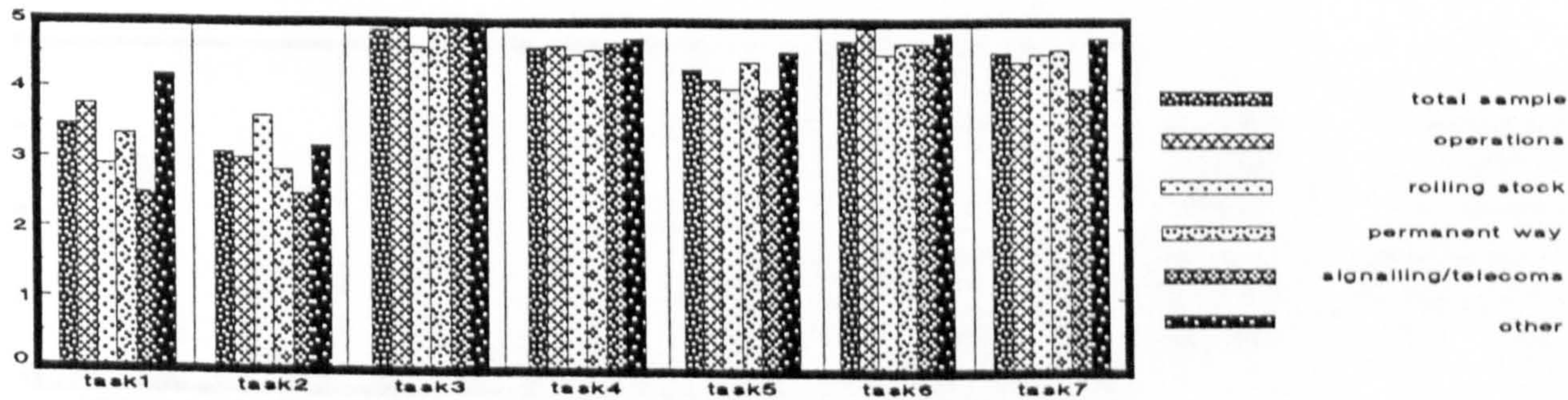
Figure F1: Mean Values of Variables: Variables OBJECT1 to OBJECT7



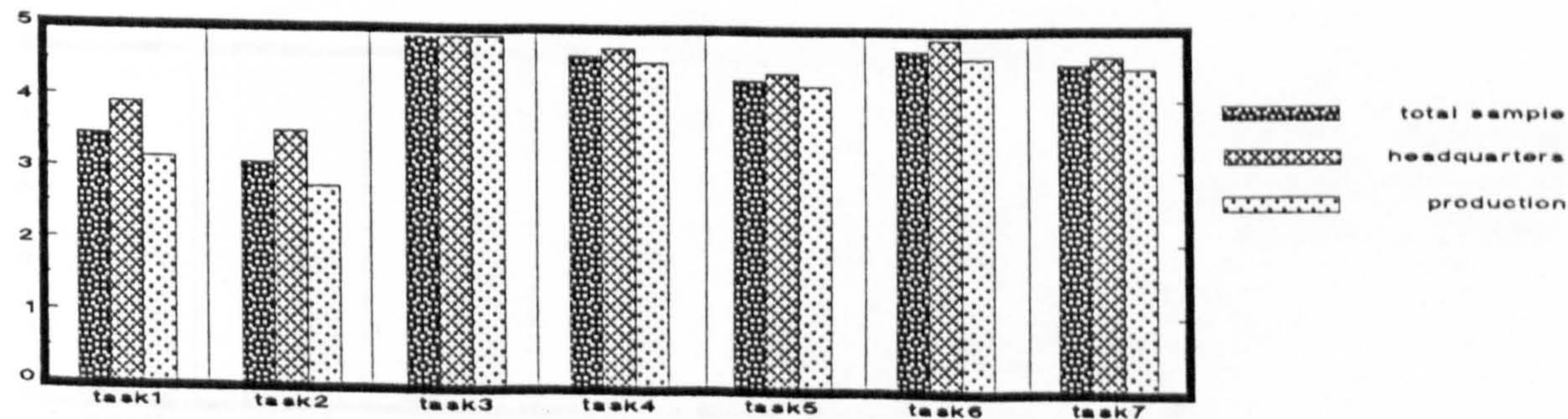
TASK1 to TASK7 by AGE



TASK1 to TASK7 by LEVEL



TASK1 to TASK7 by FUNCTION



TASK1 to TASK7 by JOBTYP

Figure F2: Mean Values of Variables: Variables TASK1 to TASK7

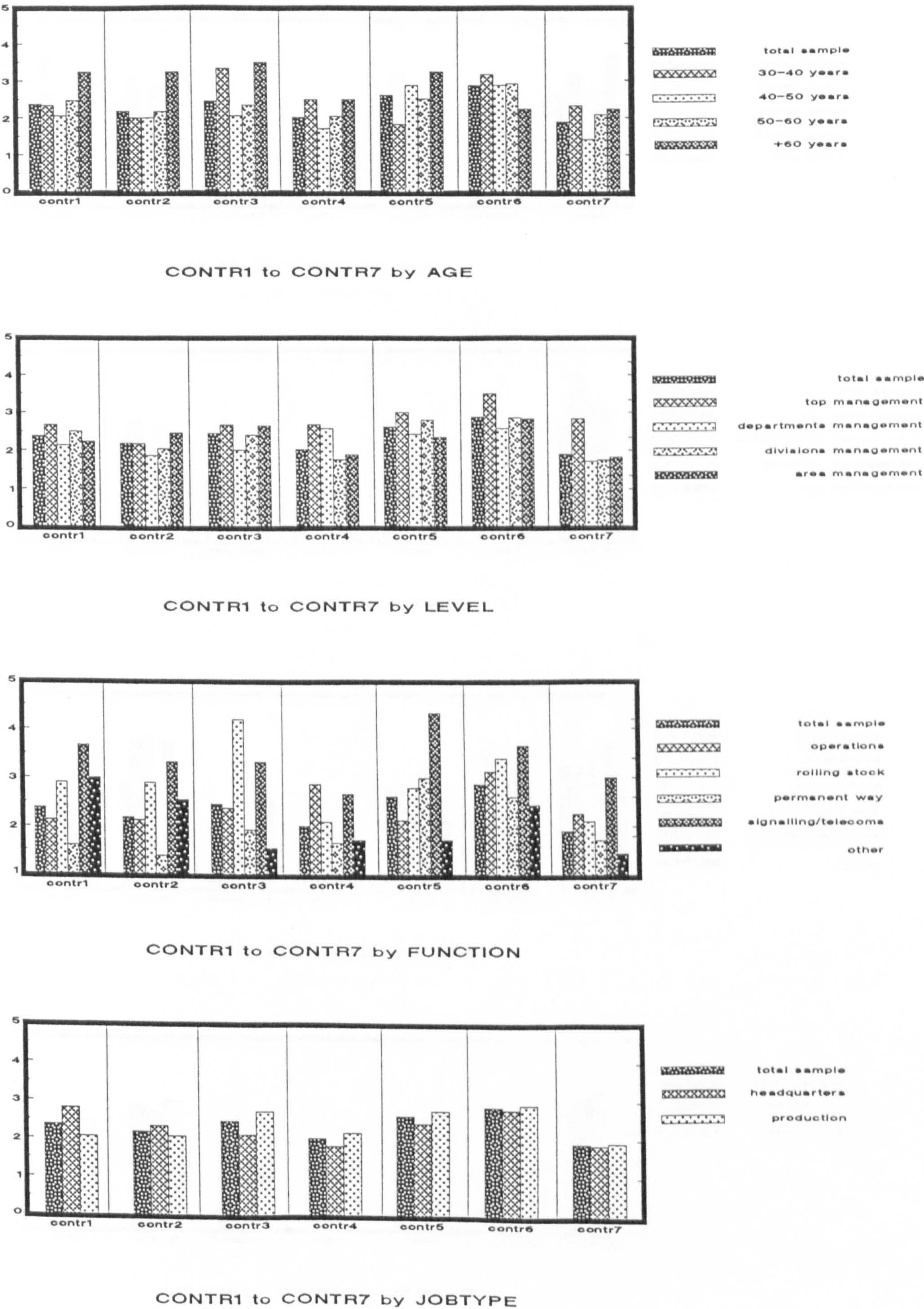


Figure F3: Mean Values of Variables: Variables CONTR1 to CONTR7

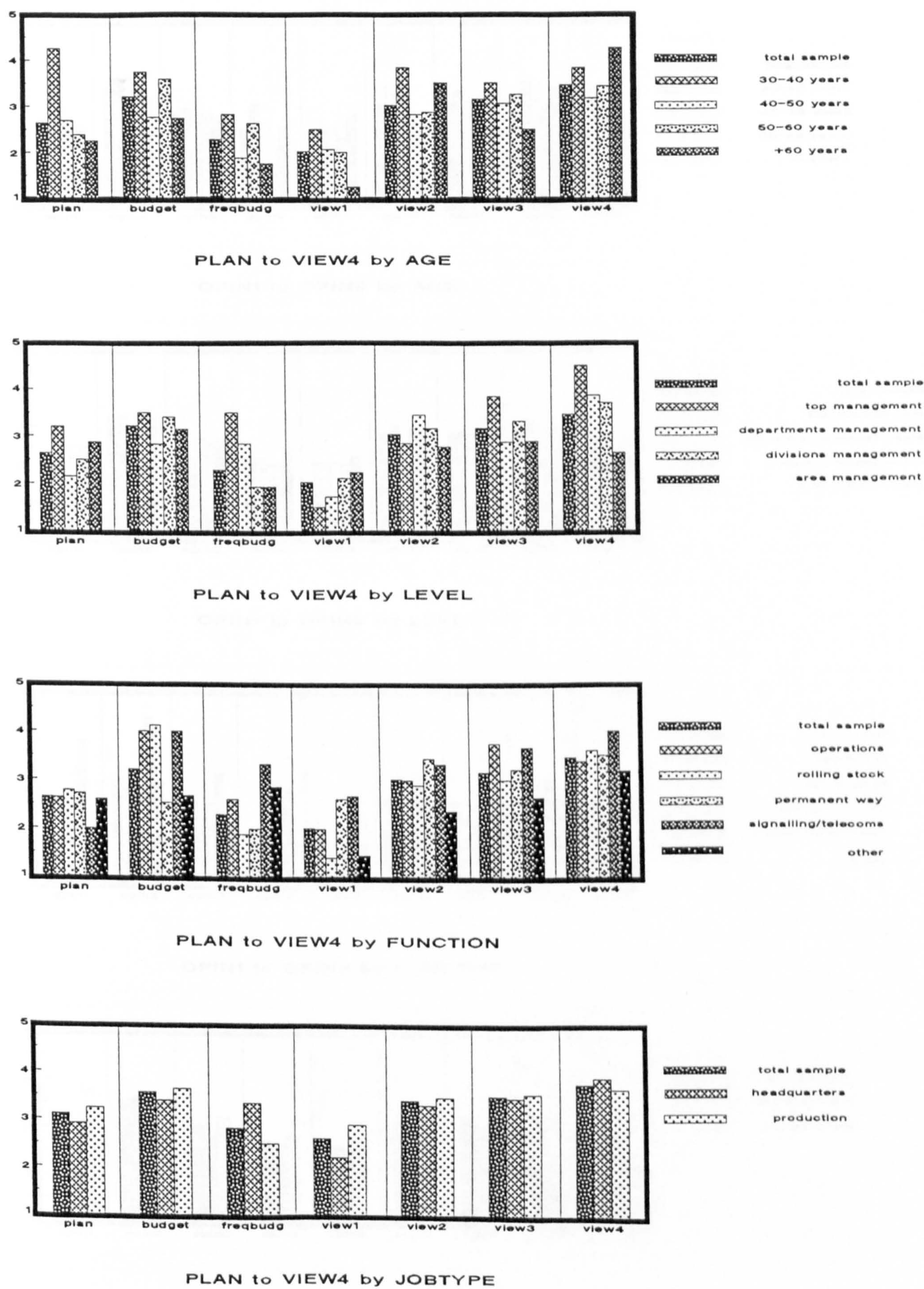
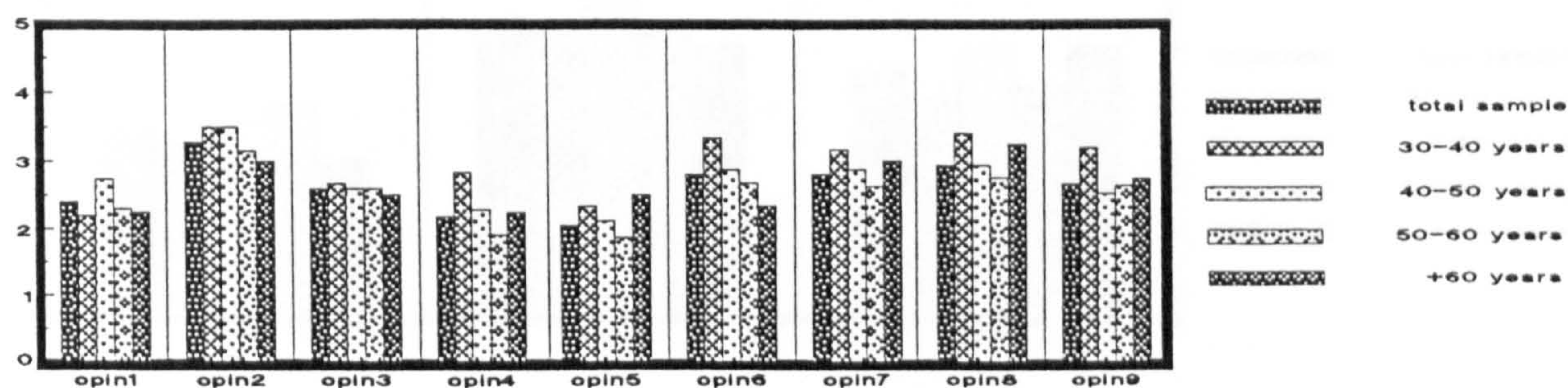
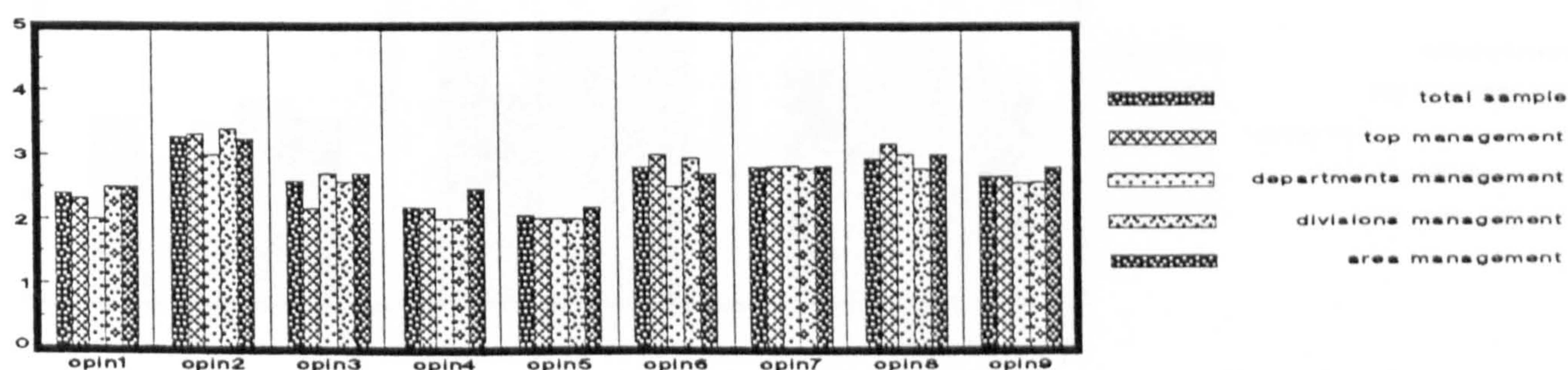


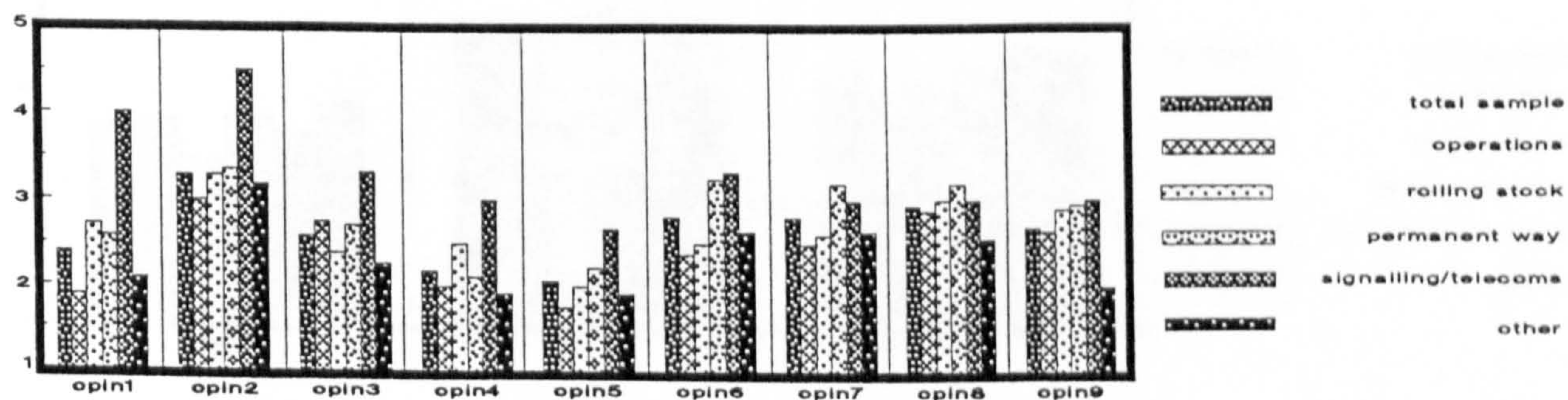
Figure F4: Mean Values of Variables: Variables PLAN to VIEW4



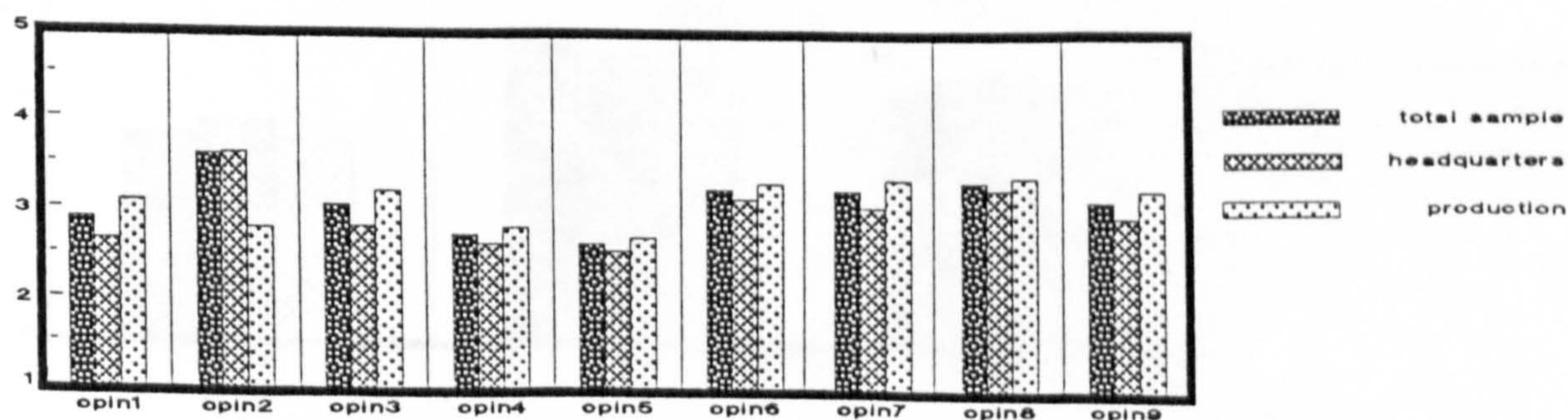
OPIN1 to OPIN9 by AGE



OPIN1 to OPIN9 by LEVEL



OPIN1 to OPIN9 by FUNCTION



OPIN1 to OPIN9 by JOBTYP

Figure F5: Mean Values of Variables: Variables OPIN1 to OPIN9

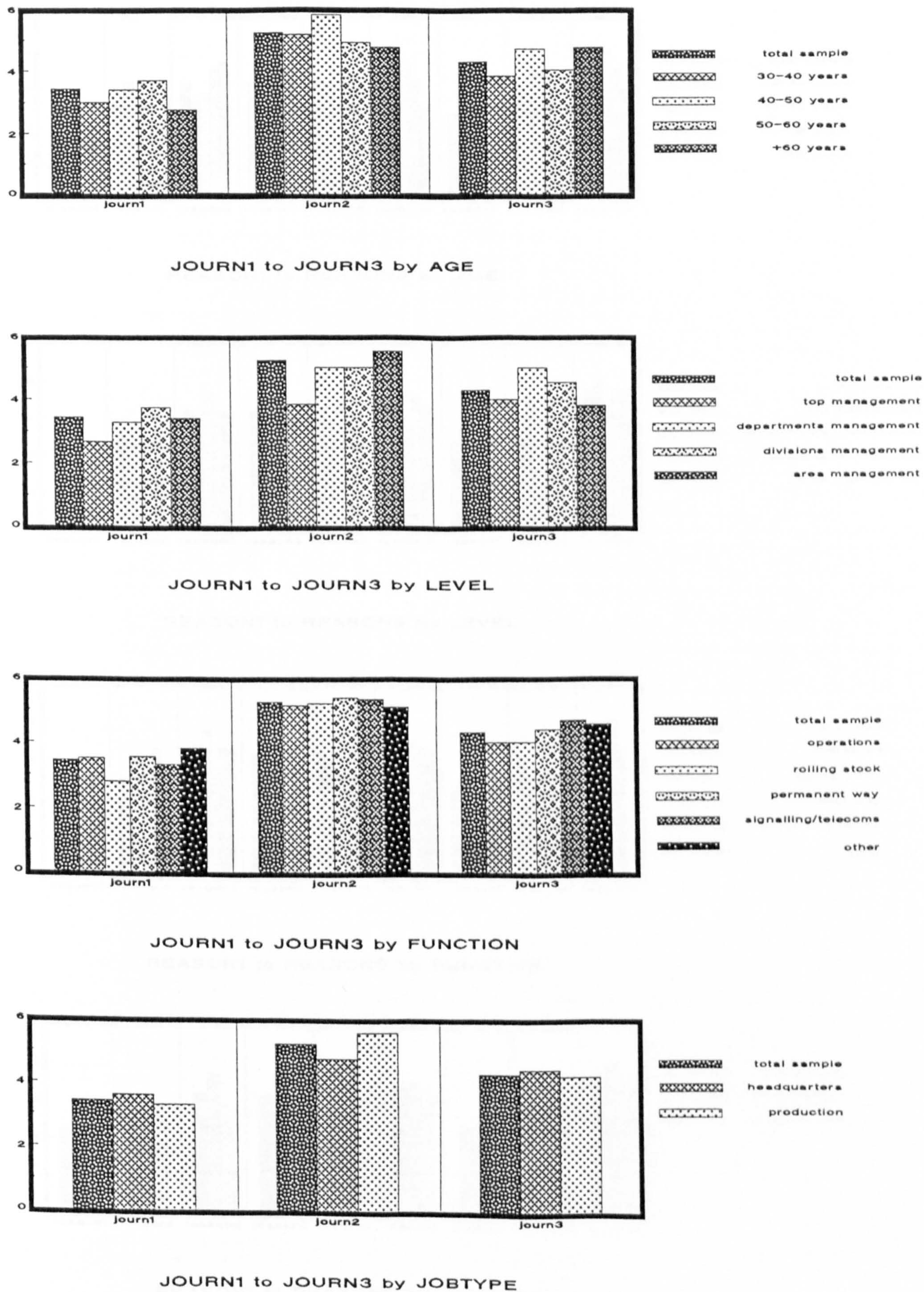


Figure F6: Mean Values of Variables: Variables JOURN1 to JOURN3

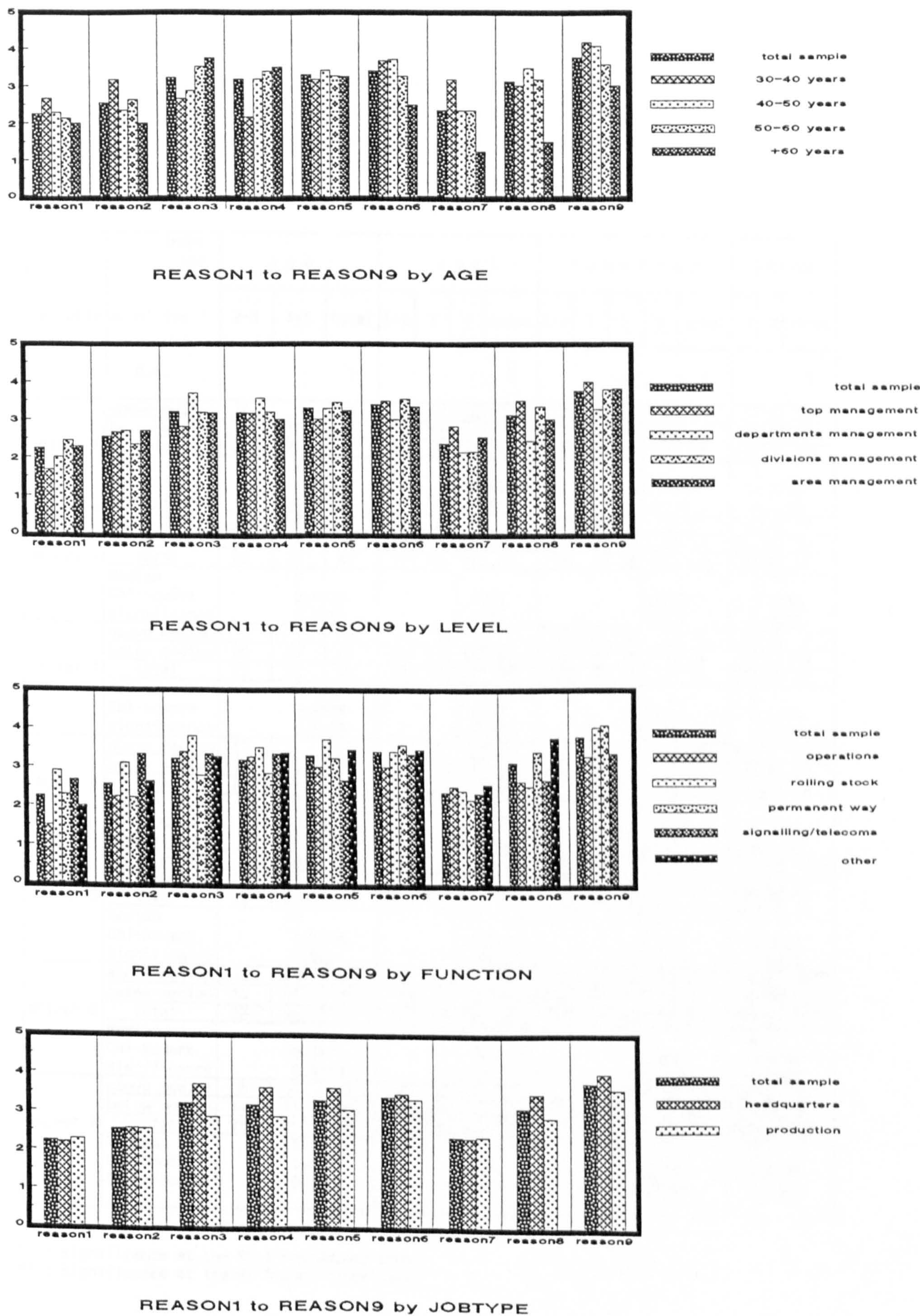


Figure F7: Mean Values of Variables: Variables REASON1 to REASON9

variable	indpt var	a g e			l e v e l				f u n c t i o n					j o b t y p e		
	condition	2+3	4+5	total	1+2	3	4	total	1+4	2	3	5	total	1	2	total
	D.F.	1			2				3					1		
object 1	above median	14	6	20	2	6	12	20	3	4	12	1	20	2	18	20
	below median	8	19	27	10	13	4	27	7	4	6	10	27	17	10	27
	total	22	25	47	12	19	16	47	10	8	18	11	47	19	28	47
	Median	2			2				2					2		
	Chi-Square	7.5206*			11.1163**				10.1461**					11.2733**		
object 2	above median	9	8	17	4	8	5	17	3	5	6	3	17	4	13	17
	below median	13	17	30	8	11	11	30	7	3	12	8	30	15	15	30
	total	22	25	47	12	19	16	47	10	8	18	11	47	19	28	47
	Median	2			2				2					2		
	Chi-Square	0.4023			0.4995				3.0070					2.1536		
object 3	above median	2	2	4	1	2	1	4	1	1	2	0	4	1	3	4
	below median	20	24	44	12	17	15	44	9	8	16	11	44	18	26	44
	total	22	22	48	13	19	16	48	10	9	18	11	48	19	29	48
	Median	4			4				4					4		
	Chi-Square	0.0305			0.2175				1.3091					0.0079		
object 4	above median	11	11	22	8	11	3	22	2	4	10	6	22	11	11	22
	below median	11	15	26	5	8	13	26	8	5	8	5	26	8	18	26
	total	22	26	48	13	19	16	48	10	9	18	11	48	19	29	48
	Median	2			2				2					2		
	Chi-Square	0.2840			7.1322**				3.7167					1.1264		
object 5	above median	4	8	12	5	1	6	12	5	1	3	3	12	4	8	12
	below median	18	15	33	6	17	10	33	4	6	15	8	33	14	19	33
	total	22	23	45	11	18	16	45	9	7	18	11	45	28	27	45
	Median	4			4				4					4		
	Chi-Square	1.5846			7.0480**				5.3121					0.0426		
object 6	above median	8	11	19	9	4	6	19	4	4	8	3	19	7	12	19
	below median	14	15	29	4	15	10	29	6	5	10	8	29	12	17	29
	total	22	26	48	13	19	16	48	10	9	18	11	48	19	29	48
	Median	4			4				4					4		
	Chi-Square	0.1761			7.5352**				0.9646					0.0002		
object 7	above median	8	14	22	8	9	5	22	4	4	6	8	22	10	12	22
	below median	14	11	25	4	10	11	25	5	5	12	3	25	8	17	25
	total	22	25	47	12	19	16	47	9	9	18	11	47	18	29	47
	Median	3			3				3					3		
	Chi-Square	1.8123			3.4586				4.3211					0.4175		
	Significance	0.1782			0.1774				0.2288					0.5182		

* : significance at the 90 % confidence level
** : significance at the 95 % confidence level

Table F3: k-Sample Median Test: Variables OBJECT1 to OBJECT7

variable	indpt var	a g e			l e v e l				f u n c t i o n					j o b t y p e		
	condition	2+3	4+5	total	1+2	3	4	total	1+4	2	3	5	total	1	2	total
	D.F.	1			2				3					1		
task 1	above median	10	9	19	5	8	6	19	3	4	5	7	19	9	10	19
	below median	12	18	30	8	12	10	30	7	6	13	4	30	12	18	30
	total	22	27	49	13	18	16	49	10	10	18	11	49	21	28	49
	Median	4			4				4					4		
	Chi-Square Significance	0.7502 0.3864			0.0241 0.9880				4.1116 0.2497					0.0448 0.8324		
task 2	above median	9	8	17	3	7	7	17	2	6	6	3	17	8	9	17
	below median	13	19	32	10	13	9	32	8	4	12	8	32	13	19	32
	total	22	27	49	13	20	16	49	10	10	18	11	49	21	28	49
	Median	3			3				3					3		
	Chi-Square Significance	0.6807 0.4093			1.3543 0.5081				4.0615 0.2549					0.0169 0.8966		
task 3	above median	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	below median	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	total	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	Median	5			5				5					5		
	Chi-Square Significance	0.0 1.0			0.0 1.0				0.0 1.0					0.0 1.0		
task 4	above median	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	below median	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	total	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	Median	5			5				5					5		
	Chi-Square Significance	0.0 1.0			0.0 1.0				0.0 1.0					0.0 1.0		
task 5	above median	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	below median	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	total	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	Median	5			5				5					5		
	Chi-Square Significance	0.0 1.0			0.0 1.0				0.0 1.0					0.0 1.0		
task 6	above median	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	below median	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	total	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	Median	5			5				5					5		
	Chi-Square Significance	0.0 1.0			0.0 1.0				0.0 1.0					0.0 1.0		
task 7	above median	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	below median	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	total	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	Median	5			5				5					5		
	Chi-Square Significance	0.0 1.0			0.0 1.0				0.0 1.0					0.0 1.0		

* : significance at the 90 % confidence level
 ** : significance at the 95 % confidence level

Table F4: k-Sample Median Test: Variables TASK1 to TASK7

variable	indpt var	a g e			l e v e l				f u n c t i o n					j o b t y p e		
	condition	2+3	4+5	total	1+2	3	4	total	1+4	2	3	5	total	1	2	total
	D.F.	1			2				3					1		
contr 1	above median	11	13	24	5	12	7	24	5	6	6	7	24	12	12	24
	below median	12	14	26	8	8	10	26	6	4	12	4	26	9	17	26
	total	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	Median	2			2				2					2		
	Chi-Square	0.0005			1.9448				3.2343					0.6633		
contr 2	above median	7	14	21	6	8	7	21	5	6	4	6	21	10	11	21
	below median	16	13	29	7	12	10	29	6	4	14	5	29	11	18	29
	total	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	Median	2			2				2					2		
	Chi-Square	2.3386			0.1297				4.9850					0.1558		
contr 3	above median	8	9	17	2	8	7	17	3	9	4	1	17	5	12	17
	below median	15	18	33	11	12	10	33	8	1	14	10	33	16	17	33
	total	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	Median	3			3				3					3		
	Chi-Square	0.0116			2.7186				18.3511**					0.9841		
contr 4	above median	10	13	23	9	8	6	23	8	5	6	4	23	10	13	23
	below median	13	14	27	4	12	11	27	3	5	12	7	27	11	16	27
	total	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	Median	2			2				2					2		
	Chi-Square	0.1090			3.8986				4.8016					0.0085		
contr 5	above median	9	13	22	6	10	6	22	4	5	10	3	22	9	13	22
	below median	14	14	28	7	10	11	28	7	5	8	8	28	12	16	28
	total	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	Median	3			3				3					3		
	Chi-Square	0.4099			0.8396				2.6310					0.0225		
contr 6	above median	7	10	17	4	9	4	17	3	5	6	3	17	8	9	17
	below median	16	17	33	9	11	13	33	8	5	12	8	33	13	20	33
	total	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	Median	3			3				3					3		
	Chi-Square	0.2413			1.9695				1.5881					0.0474		
contr 7	above median	8	12	20	7	8	5	20	6	3	7	4	20	9	11	20
	below median	15	15	30	6	12	12	30	5	7	11	7	30	12	18	30
	total	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	Median	2			2				2					2		
	Chi-Square	0.4831			1.8326				1.4562					0.0034		
	Significance	0.4870			0.4000				0.6924					0.9534		

* : significance at the 90 % confidence level
** : significance at the 95 % confidence level

Table F5: k-Sample Median Test: Variables CONTR1 to CONTR7

variable	indpt var	a g e			l e v e l				f u n c t i o n					j o b t y p e		
	condition	2+3	4+5	total	1+2	3	4	total	1+4	2	3	5	total	1	2	total
	D.F.	1			2				3					1		
plan	above median	13	8	21	5	9	7	21	3	4	10	4	21	6	15	21
	below median	7	19	26	7	11	8	26	8	5	7	6	26	14	12	26
	total	20	27	47	12	20	15	47	11	9	17	10	47	20	27	47
	Median	2			2				2					2		
	Chi-Square	5.8154**			0.0689				2.8132					2.0899		
budget	above median	5	8	13	3	6	4	13	5	7	1	0	13	3	10	13
	below median	12	11	23	5	9	9	23	3	1	16	3	23	7	16	23
	total	17	19	36	8	15	13	36	8	8	17	3	36	10	26	36
	Median	3			3				3					3		
	Chi-Square	0.6266			0.2658				20.0008**					0.0074		
freqbudg	above median	9	11	20	7	7	6	20	5	3	8	4	20	11	9	20
	below median	12	9	21	5	8	8	21	3	5	10	3	21	5	16	21
	total	21	20	41	12	15	14	41	8	8	18	7	41	16	25	41
	Median	1			1				1					1		
	Chi-Square	0.6045			0.6617				1.3415					2.9799*		
view 1	above median	9	7	16	2	7	7	16	4	1	11	0	16	2	14	16
	below median	14	20	34	11	13	10	34	7	9	7	11	34	19	15	34
	total	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	Median	2			2				2					2		
	Chi-Square	0.9952			2.3899				14.5072**					6.7192**		
view 2	above median	8	10	18	5	8	5	18	5	2	8	3	18	6	12	18
	below median	15	17	32	8	12	12	32	6	8	10	8	32	15	17	32
	total	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	Median	3			3				3					3		
	Chi-Square	0.0274			0.4933				2.4586					0.4004		
view 3	above median	9	12	21	6	11	4	21	7	3	7	4	21	9	12	21
	below median	14	15	29	7	9	13	29	4	7	11	7	29	12	17	29
	total	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	Median	3			3				3					3		
	Chi-Square	0.1440			3.8605				2.9200					0.0345		
view 4	above median	7	9	16	6	7	3	16	5	3	6	2	16	7	9	16
	below median	16	18	34	7	13	14	34	6	7	12	9	34	14	20	34
	total	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	Median	4			4				4					4		
	Chi-Square	0.0480			2.8890				1.9134					0.0183		
	Significance	0.8267			0.2359				0.5906					0.8925		

* : significance at the 90 % confidence level

** : significance at the 95 % confidence level

Table F6: k-Sample Median Test: Variables PLAN to VIEW4

variable	indpt var	a g e			l e v e l				f u n c t i o n					j o b t y p e		
	condition	2+3	4+5	total	1+2	3	4	total	1+4	2	3	5	total	1	2	total
	D.F.	1			2				3					1		
opin 1	above median	8	8	16	3	7	6	16	3	4	6	3	16	4	12	16
	below median	8	16	24	9	9	6	24	7	3	6	8	24	14	10	24
	total	16	24	40	12	16	12	40	10	7	12	11	40	18	22	40
	Median	2			2				2					2		
	Chi-Square	1.1111			1.7188				2.5162					3.0682*		
opin 2	above median	7	9	16	5	7	4	16	5	3	4	4	16	6	10	16
	below median	9	13	22	6	8	8	22	4	4	7	7	22	10	12	22
	total	16	22	38	11	15	12	38	9	7	11	11	38	16	22	38
	Median	3			3				3					3		
	Chi-Square	0.0307			0.5574				0.9671					0.0248		
opin 3	above median	13	10	23	6	7	10	23	6	4	10	3	23	6	17	23
	below median	10	16	26	7	12	7	26	5	6	7	8	26	14	12	26
	total	23	26	49	13	19	17	49	11	10	27	11	49	20	29	49
	Median	2			2				2					2		
	Chi-Square	1.5982			1.7450				3.1211					2.8287*		
opin 4	above median	10	4	14	3	4	7	14	3	4	5	2	14	4	10	14
	below median	13	23	36	10	16	10	36	8	6	13	9	36	17	19	36
	total	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	Median	2			2				2					2		
	Chi-Square	5.0616**			2.2553				1.2436					0.7756		
opin 5	above median	7	5	12	3	3	6	12	2	2	6	2	12	2	10	12
	below median	16	22	38	10	17	11	38	9	8	12	9	38	19	19	38
	total	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	Median	2			2				2					2		
	Chi-Square	0.9669			2.0831				1.3557					2.9040		
opin 6	above median	4	2	6	1	4	1	6	1	0	4	1	6	2	4	6
	below median	19	23	42	11	15	16	42	10	10	12	10	42	17	25	42
	total	23	25	48	12	19	17	48	11	10	16	11	48	19	29	48
	Median	3			3				3					3		
	Chi-Square	9.9660			2.1418				3.9481					0.0124		
opin 7	above median	3	4	7	2	4	1	7	2	0	3	2	7	2	5	7
	below median	20	21	41	10	15	16	41	9	10	13	9	41	17	24	41
	total	23	25	48	12	19	17	48	11	10	16	11	48	19	29	48
	Median	3			3				3					3		
	Chi-Square	0.0841			1.7134				2.1590					0.0513		
	Significance	0.7719			0.4246				0.5401					0.8208		

* : significance at the 90 % confidence level

Table F7: k-Sample Median Test: Variables OPIN1 to OPIN7

variable	indpt var	a g e			l e v e l				f u n c t i o n					j o b t y p e		
	condition	2+3	4+5	total	1+2	3	4	total	1+4	2	3	5	total	1	2	total
	D.F.	1			2				3					1		
opin 8	above median	4	3	7	2	4	1	7	1	1	3	2	7	2	5	7
	below median	18	22	40	11	15	14	40	10	7	14	9	40	17	23	40
	total	22	25	47	13	19	15	47	11	8	17	11	47	19	28	47
	Median	3			3				3					3		
	Chi-Square	0.3528			1.3720				0.5239					0.0758		
opin 9	above median	2	2	4	0	3	1	4	1	1	2	0	4	1	3	4
	below median	20	24	44	13	16	15	44	10	8	15	11	44	19	25	44
	total	22	26	48	13	19	16	48	11	9	17	11	48	20	28	48
	Median	3			3				3					3		
	Chi-Square	0.0305			2.6555				1.3612					0.0312		
Journ 1	above median	9	13	22	4	10	8	22	6	2	8	6	22	10	12	22
	below median	14	14	28	9	10	9	28	5	8	10	5	28	11	17	28
	total	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	Median	3			3				3					3		
	Chi-Square	0.4099			1.2803				3.3320					0.0225		
Journ 2	above median	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	below median	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	total	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	Median	6			6				6					6		
	Chi-Square	0.0			0.0				0.0					0.0		
Journ 3	above median	13	12	25	8	10	7	25	4	4	10	7	25	10	15	25
	below median	10	15	25	5	10	10	25	7	6	8	4	25	11	14	25
	total	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	Median	4.5			4.5				4.5					4.5		
	Chi-Square	0.7246			1.2217				2.2586					0.0		
reason 1	above median	7	6	13	1	6	6	13	2	5	4	2	13	5	8	13
	below median	16	21	37	12	14	11	37	9	5	14	9	37	16	21	37
	total	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	Median	2			2				2					2		
	Chi-Square	0.4354			3.1942				3.8262					0.0007		
reason 2	above median	11	8	19	4	6	9	19	5	5	5	4	19	7	12	19
	below median	12	19	31	9	14	8	31	6	5	13	7	31	14	17	31
	total	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	Median	2			2				2					2		
	Chi-Square	1.7455			2.4426				1.6825					0.0803		
	Significance	0.1864			0.2948				0.6411					0.7769		

* : significance at the 90 % confidence level
 ** : significance at the 95 % confidence level

Table F8: k-Sample Median Test: Variables OPIN8 to REASON2

variable	indpt var	a g e			l e v e l				f u n c t i o n					j o b t y p e		
	condition	2+3	4+5	total	1+2	3	4	total	1+4	2	3	5	total	1	2	total
	D.F.	1			2				3					1		
reason 3	above median	7	17	24	6	10	8	24	7	6	5	6	24	15	9	24
	below median	16	10	26	7	10	9	26	4	4	13	5	26	6	20	26
	total	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	Median	3			3				3					3		
	Chi-Square	5.2650**			0.0558				4.7923					6.4262**		
reason 4	above median	7	17	24	6	11	7	24	6	5	7	6	24	13	11	24
	below median	16	10	26	7	9	10	26	5	5	11	5	26	8	18	26
	total	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	Median	3			3				3					3		
	Chi-Square	5.2650**			0.7275				0.9923					1.9264		
reason 5	above median	10	14	24	6	12	6	24	5	4	8	7	24	13	11	24
	below median	13	13	26	7	8	11	26	6	6	10	4	26	8	18	26
	total	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	Median	3			3				3					3		
	Chi-Square	0.3489			2.2711				1.4536					1.9264		
reason 6	above median	4	1	5	1	2	2	5	0	2	2	1	5	3	2	5
	below median	19	26	45	12	18	15	45	11	8	16	10	45	18	27	45
	total	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	Median	4			4				4					4		
	Chi-Square	2.5854			0.1357				2.3681					0.1460		
reason 7	above median	8	8	16	8	2	6	16	5	3	3	5	16	8	8	16
	below median	15	19	34	5	18	11	34	6	7	15	6	34	13	21	34
	total	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	Median	2			2				2					2		
	Chi-Square	0.1516			9.7460**				3.7934					0.2296		
reason 8	above median	10	6	16	5	6	5	16	2	2	7	5	16	8	8	16
	below median	13	21	34	8	14	12	34	9	8	11	6	34	13	21	34
	total	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	Median	3			3				3					3		
	Chi-Square	2.5789			0.3385				2.9347					0.2296		
reason 9	above median	8	1	9	2	3	4	9	0	3	4	2	9	4	5	9
	below median	15	26	41	11	17	13	41	11	7	14	9	41	17	24	41
	total	23	27	50	13	20	17	50	11	10	18	11	50	21	29	50
	Median	4			4				4					4		
	Chi-Square	8.1277**			0.5343				3.6079					0.0436		
	Significance	0.0044			0.7655				0.3070					0.8346		

* : significance at the 90 % confidence level
 ** : significance at the 95 % confidence level

Table F9: k-Sample Median Test: Variables REASON3 to REASON9

variable	indpt var	f u n c t i o n																	
	condition	1+4	2	total	1+4	3	total	1+4	5	total	2	3	total	2	5	total	3	5	total
D.F.		1			1			1			1			1			1		
object 1	above median	3	4	7	3	12	15	3	1	4	4	12	16	4	1	5	12	1	13
	below median	7	4	11	7	6	13	7	10	17	4	6	10	4	10	14	6	10	16
	total	10	8	18	10	18	28	10	11	21	8	18	26	8	11	19	18	11	29
	Median Significance	2 0.6305			2 0.0623			2 0.3108			2 0.6645			2 0.1108			2 0.0025**		
contr 3	above median	3	9	12	3	4	7	3	1	4	9	4	13	9	1	10	4	1	5
	below median	8	1	9	8	14	22	8	10	18	1	14	15	1	10	11	14	10	24
	total	11	10	21	11	18	29	11	11	22	10	18	28	10	11	21	18	11	29
	Median Significance	3 0.0075**			3 0.7578			3 0.5865			3 0.0011**			3 0.003**			3 0.3637		
budget	above median	5	7	12	5	1	6	5	0	5	7	1	8	7	0	7	1	0	1
	below median	3	1	4	3	16	19	3	3	6	1	16	17	1	3	4	16	3	19
	total	8	8	16	8	17	25	8	3	11	8	17	25	8	3	11	17	3	20
	Median Significance	3 0.5692			3 0.0020**			3 0.1818			3 0.0001**			3 0.0242			3 0.6665		
view 1	above median	4	1	5	4	11	15	4	0	4	1	11	12	1	0	1	11	0	11
	below median	7	9	16	7	7	14	7	11	18	9	7	16	9	11	20	7	11	18
	total	11	10	21	11	18	29	11	11	22	10	18	28	10	11	21	18	11	29
	Median Significance	2 0.3108			2 0.1956			2 0.0902			2 0.0159*			2 0.4762			2 0.0010**		

* : significance at the 90 % confidence level

** : significance at the 95 % confidence level

Table F10: Pairwise Comparisons by FUNCTION: Variables OBJECT1 to VIEW1

variable	indpt var	l e v e l								
	condition	1+2	3	total	1+2	4	total	3	4	total
	D.F.	1			1			1		
object1	above median	2	6	8	2	12	14	6	12	18
	below median	10	13	23	10	4	14	13	4	17
	total	12	19	31	12	16	28	19	16	35
	Median Significance	2 0.3554			2 0.0023**			2 0.0264*		
object4	above median	8	11	19	8	3	11	11	3	14
	below median	5	8	13	5	13	18	8	13	21
	total	13	19	32	13	16	29	19	16	35
	Median Significance	2 0.8367			2 0.0182*			2 0.0446		
object5	above median	5	1	6	5	6	11	1	6	7
	below median	6	17	23	6	10	16	17	10	27
	total	11	18	29	11	16	27	18	16	34
	Median Significance	4 0.0101**			4 0.6794			4 0.0609		
object6	above median	9	4	13	9	6	15	4	6	10
	below median	4	15	19	4	10	14	15	10	25
	total	13	19	32	13	16	29	19	16	35
	Median Significance	4 0.0064**			4 0.0890			4 0.4855		
reason7	above median	8	2	10	8	6	14	2	6	8
	below median	5	18	23	5	11	16	18	11	29
	total	13	20	33	13	17	30	20	17	37
	Median Significance	2 0.0016**			2 0.1533			2 0.1438		

* : significance at the 90 % confidence level

** : significance at the 95 % confidence level

Table F11: Pairwise Comparisons by LEVEL: Variables OBJECT1 to REASON7

indepndt variable	entire sample	age group				level group				function group					jobtype	
		+30 -40	+40 -50	+50 -60	+60	top mgmt	dpts mgmt	div mgmt	area mgmt	rail ops	roll stck	perm way	sign tlcm	othr	hdqs	prdc
		6	17	23	4	6	7	20	17	8	10	18	3	11	21	29
		12	34	46	8	12	14	40	34	16	20	36	6	22	42	58
dependent variable	popltn %	2	3	4	5	1	2	3	4	1	2	3	4	5	1	2
improved quality of services by:																
-reorganization	4	3	3	3	7	1	5	1	4	4	4	2	2	1	2	4
-changing heads	7	5	7	7	5	5	7	7	7	7	6	7	5	7	7	7
-improved planning	2	2	4	2	2*	2	2*	3	3	2	1*	3	3	3	3	2
-effective control	3	1	2	6	1	4	2*	4	1*	3	1*	4	6*	4	4	3
-staff training	1	4	1	1	2*	3	1	2	1*	1	3	1	1	2	1	1
-better work cndtns	6	7	5	5	6	6	6	6	5	5	5	6	6*	5*	6	5
-salary increases	5	6	6	4	4	7	4	5	6	6	7	5	4	5*	5	6
resources optimum utilization by:																
-reorganization	4	3	3	3	5	1	6	2	4	4	4	4	1	1	3	4
-changing heads	7	5	6	7	7	5	7	7	6	7	6	7	3*	7	7	5
-improved planning	1	1	1	2	3	3	2	1	1	2	2	1	2	3	2	1
-effective control	3	4	2	4	2	6	3	4	2	1	1	3	7	5	4	2
-staff training	2	2	4	1	1	2	1	3	3	3	3	2	3*	2	1	3
-better work cndtns	5	6	5	5	6	4	5	5	5	5	5	5	5*	4	5	6
-salary increases	6	7	7	6	4	7	4	6	7	6	7	6	5*	6	6	7
improved systems cooperation by:																
-reorganization	1	2	1	2	1*	1	1	1	1	4	1	1	1	1	1	2
-changing heads	5	3	5	6	6*	4	7	5	5	5*	4	5	3*	4*	5	5
-improved planning	2	1	2	1	1*	2	2	2	2	1	2	2	2	2	2	1
-effective control	4	4	4	4	3	5	3	4	4	2	3	4	6	4*	4	4
-staff training	3	5	3	3	4	3	4	3	3	3	5	3	3*	3	3	3
-better work cndtns	6	7	6	5	6*	6	6	6	6	5*	6	7	7	6	6	6
-salary increases	7	6	7	7	5	7	5	7	7	7	7	6	5	7	7	7
improved subsystem rolling stock by:																
-reorganization	3	4	2	1	4	1	5	2	2	4	5	2	1	1	1	4
-changing heads	6	5	6	5*	6*	4	7	6	5	5*	7	6	4	5	6	5
-improved planning	1	1	1	3	3	2	3	1	1	2*	2	1	3	2	2	1
-effective control	4	2	4	4	2	6	2	4	4	1	3	4	7	4	4	3
-staff training	2	3	3	2	1	3	1	3	3	2*	1	3	2	3	3	2
-better work cndtns	5	6	5	5*	6*	5	6	5	6	5*	4	5	6	6	5	6
-salary increases	7	7	7	7	5	7	4	7	7	5*	6	7	5	7	7	7
improved subsystem permanent way by:																
-reorganization	3	7	3	3	7	3	5*	2	4	4	3	3	1	2*	3	4
-changing heads	5	3*	6	5*	5	4	7	6	5	5	7	7	4	5	7	5
-improved planning	1	1	1	2	3	1	3	1	2	1	1*	2	2*	1	2	1
-effective control	4	2	4	4	1	5	2	4	3	3	1*	4	6*	4	4	3
-staff training	2	3*	2	1	2	2	1	3	1	2	4	1	2*	2*	1	2
-better work cndtns	7	5	5	7	6	6	5*	7	6	6	5	6	6*	6	6	6
-salary increases	6	6	7	5*	4	7	4	5	7	7	6	5	5	7	5	7
improved subsystem signalling/tcm by:																
-reorganization	3	6	3	2	5*	2	5	3	2*	4	5*	3	1	2	3	3
-changing heads	5	7	5	7	4	4	6*	6	5	5*	7	5	4	5	6	5
-improved planning	1	2	1	3	1	3	1	1	2*	1	1	1	2*	3	2	1
-effective control	4	3	2	4	2	5	3	4	4	3	2	4	5*	4	4	4
-staff training	2	1	4	1	3	1	2	2	1	2	3	2	2*	1	1	2
-better work cndtns	6	4*	6	5	7	6	6*	5	6	7	4	6	7	6	5	7
-salary increases	7	4*	7	6	5*	7	4	7	7	5*	5*	7	5*	7	7	6

*: tied ranks

Table F12: Methods of Improving Performance: Rank Orders

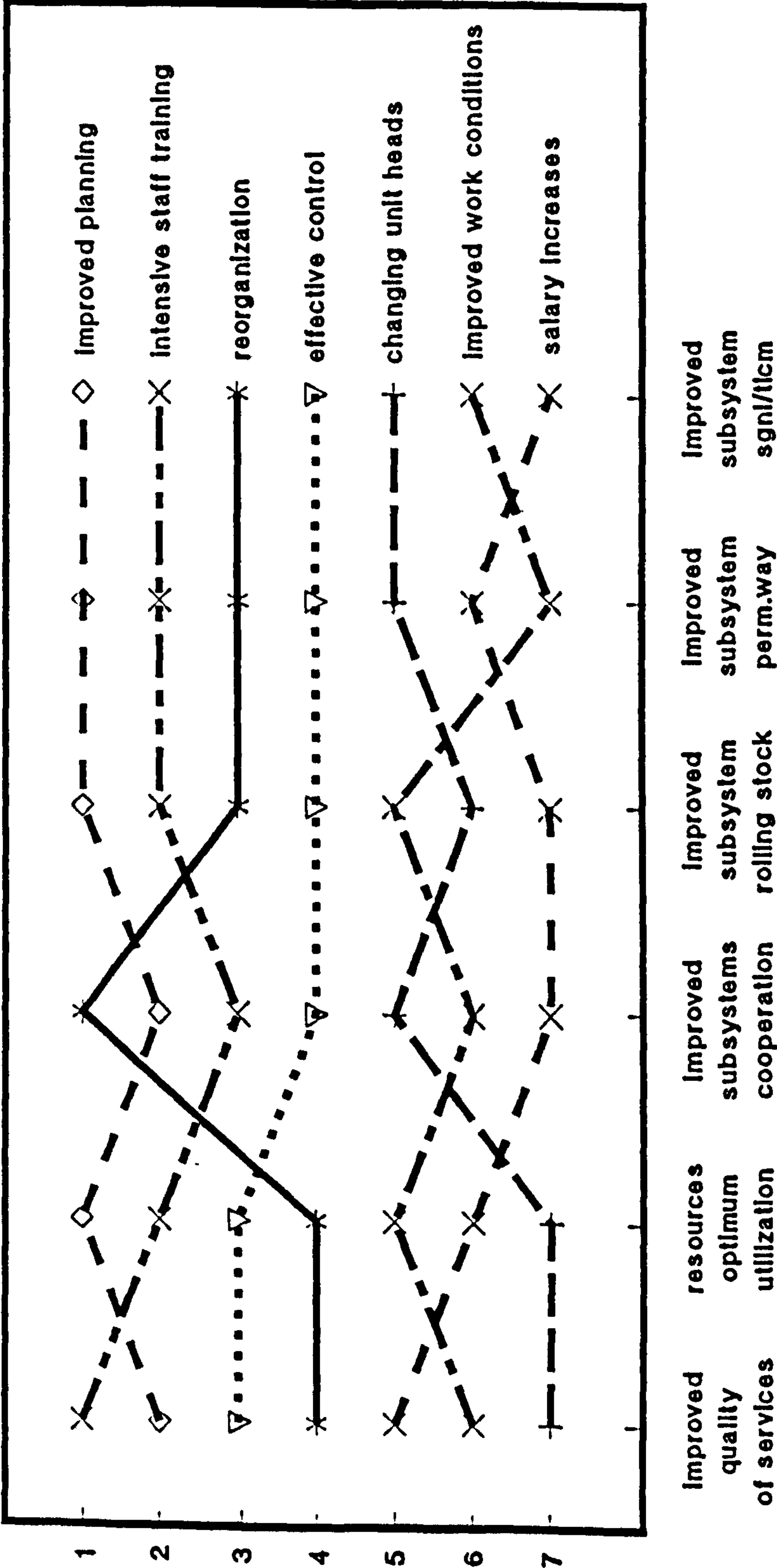


Figure F8: Ranks of Methods for Improving Performance