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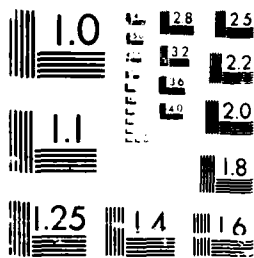
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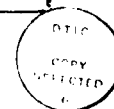
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March 1987

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by

Lieutenant S A Dowle RN

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Abstract

This report describes the derivation of a Viewpoint Structure for a Submarine Combat System using techniques based on soft systems theory. The techniques were developed and applied by ARE/UDP to assist CNOCS(SM) who are using the resulting structure during the development of a generic user specification. The report demonstrates how systemic techniques such as those based on soft systems theory provide a valuable adjunct to traditional systematic techniques during the requirements analysis stage of projects whose application domain is soft.

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Derivation of Viewpoint Structure for a Submarine Combat System1 Introduction

- 1.1 The importance of the requirements stage in the development life cycle of software intensive systems is widely accepted. Associated with this is the need to use systematic methods to structure and control the requirements specification process. However, for large and complex systems the production of a requirements specification can be very costly. To gain the benefits of rigorous specification without repeatedly incurring high costs the Captain Naval Operational Command Systems (CNOCS) and the Admiralty Research Establishment (ARE) at Portsmouth have pioneered a so called generic approach to the specification of requirements for surface ship command systems. [1,2] In this way a specification is built up which can be tailored to any particular hull.
- 1.2 The part of CNOCS which deals with Submarine requirements, CNOCS(SM), have recently begun to generate a generic user requirement for a Submarine Command System. The method they are using is similar to that being used by CNOCS for surface ships and is loosely based on the Controlled Requirements Expression (CORE) method. The output produced by CNOCS(SM) can be used by analysts applying the CORE method proper to arrive at a Logical System Description. This is made possible because both users and analysts share the same viewpoint structure. This paper describes how ARE/UDP at Portland provided support to CNOCS(SM) in deriving a viewpoint structure for a Submarine Combat System, which includes the Command System. The method used by UDP drew on a number of ideas from soft systems theory with results that clearly demonstrate the usefulness of these ideas applied to the requirements analysis stage of large complex systems. The emphasis in this paper is the description of the method used to arrive at a viewpoint structure, for a full description of the resulting structure reference [8] should be read.
- 1.3 This paper is in six main sections. The first two sections provide the background and major concepts of soft systems theory. The third section deals with the project life cycle as a particular example of the more general problem solving process and shows how the ideas behind soft systems theory can be transferred from one to the other. The next two sections deal with the particular application of soft systems theory to arrive at a CORE viewpoint diagram of a Submarine Combat System. The final major section discusses the results and provides a brief description of some future work.

2 Systems Thinking

- 2.1 The term system is probably one of the most overworked in

current use. Everybody knows one when they see one and possibly because of this a universally accepted definition of a system is not easily arrived at. The dictionary defines a system as a structured set of objects and/or attributes together with the relationships between them. A system contains elements which have some reason for being taken together, but it is more than just a set, it also includes the relationships that exist between the elements of that set. Systems thinking comprises all the ideas and concepts which derive from the definition of a system.

- 2.2 The noun system gives rise to the two adjectives systemic and systematic which describe the ways in which systems thinking is currently applied. Checkland [3] defined the following mutually exclusive paradigms which attempt to make the distinction clear
- a. Paradigm I. The real world is composed of systems; therefore methods for dealing with it may be systematic.
 - b. Paradigm II. The true nature of the real world is uncertain; however, it can be modelled by systems using systemic methods.
- 2.3 Systematic methods need have little or no systems content, they merely rely on the fact that systems exist. Much of current systems engineering is based upon paradigm I. Systemic methods actively and explicitly use systems to achieve their aim. The application of systems thinking to the problem solving process demonstrates each paradigm and identifies the need for systemic methods to deal with situations where paradigm II applies.
- 2.4 A model of the problem solving process is shown in figure 1. The problem formulation stage is about deciding what has to be done, whilst the decision making stage is about deciding how to do it. Models are used in both stages. During problem formulation models are used to record and structure knowledge of the application domain whilst during decision making models are used to experiment with various candidate solutions.
- 2.5 If the problem solving process is itself designed to be a system then it can be understood and managed by the use of systematic rules and procedures. During problem formulation the important question is whether systems exist within the application domain as objective entities? If the application domain is a designed physical system, for example a radio receiver, then it may be safe to assume that systems exist in the required sense and so the problem formulation stage becomes no more than expressing the detail of a system which already exists. Obviously systematic procedures can be

employed to do this. If however the application domain cannot with certainty be said to contain systems then a simple systematic approach to problem formulation cannot be taken. Problem formulation then becomes a much more difficult activity which involves modelling in its proper sense. Rather than simply describing something which already exists a structure must be found which is applicable to the problem under consideration. This is where systemic principles are of use.

- 2.6 Application domains which are structured and within which systems exist as objective entities are referred to as being hard. Application domains whose true nature is uncertain are referred to as soft. Hard application domains require less problem formulation than soft and are more often capable of being described in purely mathematical terms. However, it should not be thought that domains are simply hard or soft, rather it is the limits put on the application domain which determine its nature. For example considering a motor car as a mechanical device provides a hard domain, whereas considering a motor car as a means of transport makes the domain much softer.
- 2.7 Further understanding of the differences between hard and soft domains can be obtained by considering the types of system used to model each. This requires a classification scheme for systems and the one used in this report is as follows
- a. Natural Systems. Natural systems are physical systems which make up the Universe in a hierarchy from subatomic systems through the systems of ecology to galactic systems.
 - b. Designed Systems. Designed systems can be both physical (tools, bridges) and abstract (mathematics, language).
 - c. Human Activity Systems. Human activity systems are human beings undertaking purposeful activity such as man-machine systems, industrial activity and political systems.
 - d. Social and Cultural Systems. Most human activity will exist within a social system where the elements will be human beings and the relationships will be interpersonal. An example of a social system would be the family.
- 2.8 Hard application domains are normally described in terms of designed systems. The most important systems for modelling soft application domains are human activity systems. However, human activity systems do not exist in isolation. A human activity system will also involve a social system and will

probably make use of a designed system.

- 2.9 Soft systems theories are about human activity systems and how they can be used to model soft application domains. The next section describes a number of specific techniques which can be used in building such models.

3 Soft Systems Theory

- 3.1 This section begins with a more detailed definition of a human activity system (HAS) which is summarised in the formal systems model. This is followed by a description of the soft systems techniques which were adapted for use in deriving the submarine combat system viewpoint structure.
- 3.2 The most basic characteristic of a HAS is that it is concerned with transformation processes. A HAS is therefore modelled as the interconnected set of activities which are required to transform some inputs into some outputs. This transformation must be to some purpose and this gives rise to the concept that a HAS is purposeful. The existence of purpose means that the system can measure its performance and use these measurements to make decisions that will improve future performance. These characteristics are combined with others applicable to all systems to define the following formal systems model which states that a HAS
- a. has an on-going purpose.
 - b. exhibits connectivity between activities.
 - c. can define measures of performance.
 - d. has monitoring and controlling mechanisms.
 - e. has decision-taking procedures.
 - f. exists within a boundary.
 - g. makes available and uses resources.
 - h. is part of a systems hierarchy.
- 3.3 Unlike designed systems human activity systems do not exist as objective realities. What do exist are perceptions of them in the heads of observers. Returning to the example of a motor car first introduced in section 2 above, if it is taken as a designed physical system then, given the same degree of competence in observers, complete agreement could be obtained on a description of it. If, however, the motor car is considered in terms of its use as part of a human activity system then no degree of competence amongst observers would

necessarily result in the same description. Some might see it in terms of a profit producing system, others a pollution producing system and yet others as a system to provide mobility.

- 3.4 The fact that there are multiple views of the application domain which are possible and valid is of crucial importance in attempting to use human activity systems as a modelling formalism. This concept of multiple views is described by the German word Weltanschauung, which means world view. It is an individual's world view which enables him to attribute meaning to what is observed. There will therefore be many possible human activity system models relevant to a given soft domain, each corresponding to a different observer's world view.
- 3.5 Human activity systems are defined by root definitions. A root definition should detail the following about the system it specifies
 - a. Ownership. The owners of the system or a wider system which may discourse about the system.
 - b. Actors. The agents who carry out, or cause to be carried out, the transformation processes or activities of the system.
 - c. Transformations. The core of the root definition; transformation processes carried out by the system.
 - d. Customer. Client, beneficiary or victim affected by the main activities of the system.
 - e. Environment. Environmental impositions and interactions.
 - f. World View. The outlook and framework which makes the root definition a meaningful one.
- 3.6 Root definitions and the formal systems model provide the basis for a soft systems modelling technique developed by Checkland [4] called issue based analysis. This technique aims to help solve problems within an essentially soft applications domain. As such it covers problem formulation (stages 1 - 5), decision making (stage 6) and taking action (stage 7). The major stages in Checkland's approach are shown in figure 2 and described below
 - a. Stages 1 and 2. Stages 1 and 2 are an expression phase during which time an attempt is made to build up the richest possible picture of the application domain.
 - b. Stage 3. Stage 3 involves preparing root definitions

of some human activity systems which might be relevant to the application domain. The use of several root definitions recognises the multiple and perhaps conflicting perceptions of the domain.

c. Stage 4. Stage 4 constructs models for each of the root definitions. The modelling language is based upon verbs and the model consists of interconnected activities (described by the verbs). The model is compared with the formal systems model (see para 3.5 above) to ensure it is not fundamentally flawed in some way.

d. Stage 5. Stage 5 compares the conceptual models built in stage 4 with the situation expressed in stage 2 in order to generate debate with relevant people from the application domain.

e. Stages 6 and 7. The debate generated during stage 5 should result in the definition of desirable and feasible changes during stage 6. Stage 7 then involves taking action based on stage 6 to improve the situation.

- 3.7 Wilson [5] has introduced the idea of a primary task root definition. A primary task root definition attempts to arrive at a description of a human activity system which all observers can agree upon. In as far as is possible primary task root definitions should be independent of any particular world view. In [5] Wilson gives the example of a prison which was taken to be 'a system for the receipt, storage and despatch of prisoners'. Such definitions have been found to be useful in carrying out requirements analysis for information systems in soft domains. Wilson goes on to state that a primary task definition is always preceded by an issue based analysis which helps decide what should be taken as the primary task definition.
- 3.8 Wilson models his primary task root definitions in the same way as Checkland. Validation of the resulting model is carried out by comparing it with the application domain. If, as is intended, the primary task root definition somehow expresses the essential nature of an organisation then for each 'what' in the model there should be a corresponding 'how' in the application domain. It is sufficient to identify a 'how' no matter how inefficient or ineffective it is. Failure to identify a 'how' would indicate that the primary task root definition is wrong.
- 3.9 Each of the activities in the model of a root definition may itself become the object of analysis, first issue based and then primary task. In this way an application domain can be decomposed as shown in figure 3.

3.10 In the next section the need for soft systems ideas in the development of computer based management systems is identified prior to a discussion of how this need has been met at ARE Portland by adapting the techniques just described.

4 Requirements Analysis and the Project Life Cycle

- 4.1 The software crisis of the 1960's led to the growth of software engineering and the adoption of a number of established ideas from traditional engineering disciplines. Amongst the most important of these ideas was a model of the development process called the project life cycle. A waterfall model of the life cycle is shown in figure 4.
- 4.2 The project life cycle can be considered a particular case of the more general problem solving process, where requirements analysis equates to problem formulation (what to do), design equates to decision making (how to do it) and implementation equates to taking action (do it). Given the similarities between the project life cycle and the problem solving process the nature of the application domain can be seen to have the same importance for both in the selection of methods.
- 4.3 Existing methods for requirements analysis tend to be systematic rather than systemic, being more concerned with expressing the requirement than with structuring the application domain. For some hard application domains a purely systematic approach can be used, for example in specifying the requirement for an automatic reactor control system, although even here the application domain is made hard only by a suitably narrow definition of the system's boundary. However, for soft application domains, such as Naval Command and Control, a systemic approach is necessary.
- 4.4 The requirements phase of the life cycle is therefore at the minimum a two stage activity, the first being to structure the application domain and the second to express the structure obtained. Application domains are hard or soft depending on the amount of structuring required, hard domains requiring less structuring than soft. Purely systematic approaches are suitable for hard domains but systemic approaches are required in soft domains.
- 4.5 The classification of domains as hard or soft together with the realisation that different techniques are required to deal with each has important consequences for software engineering. As an example consider the transformational model of the project life cycle, where software development is seen as a series of transformations between different system representations. If these transformations and system representations are in some sense formal then so are the processes of verification and validation. Verification is

defined as checking for the correctness between one system representation and the next, whilst validation is seen as checking for correctness (or correspondence) between any transformed system representation and the application domain. If, however, the application domain is not an objective system then the form of validation proposed by this model is not possible. This issue is further discussed in [6].

- 4.6 The difficulty of arriving at a satisfactory specification of soft application domains using purely systematic methods has already been recognised by software engineers, many of whom have seen the answer to be the building of prototypes. However, this is really no more than a form of issue based analysis where the models are not on paper but are actually built. They are then compared with the application domain by allowing actors to use the prototype. From this experience the model may be modified (another prototype built) or a design developed. Checkland style issue based analysis followed by a primary task analysis provide an alternative to prototyping in soft application domains and is the approach adopted for the initial requirements analysis of Submarine Combat Systems.
- 4.7 The Controlled Requirements Expression (CORE) method [7] is essentially a systematic approach to requirements analysis. However, it has the advantage over many other methods of formally recognising and dealing with the fact that there may be many different views of the system. These different views are combined and recorded in a viewpoint diagram which then becomes the basis of subsequent analysis. Many different views are exactly the characteristics of soft application domains. Unfortunately CORE gives only very general advice on how to arrive at the viewpoints themselves or extract information relevant to each.
- 4.8 ARE/UDP decided to use soft systems techniques based on root definitions to arrive at the viewpoints of a submarine combat system and establish the framework for the collection of data about each one. In the next section the use of CORE by CNOCS and ARE Portsdown is reviewed, followed by a description of how soft systems theory has been integrated with CORE at ARE Portland.

5 Method for Viewpoint Analysis

- 5.1 ARE Portsdown decided to use CORE as the means of arriving at a logical system description of a surface ship command system. They made a number of improvements to the basic method amongst which was the development of internal viewpoints. Conventionally the viewpoint structure breaks the environment of the proposed system into its component parts. The proposed system can be analysed from the viewpoint of each of the

entities that exchange information with it. These viewpoints may be termed external. ARE Portsdown also introduced the idea of having internal viewpoints which represent a decomposition of the target system. The required functionality is described in terms of each of these internal viewpoints. Data collection is based upon the internal leaf viewpoints and is provided by users nominated by CNOCS.

- 5.2 Users found that the provision of data to the CORE analysts for each of the required internal viewpoints was excessively difficult. CNOCS therefore developed a technique to obtain the required data. This involved developing templates of the generic activities which must take place within each viewpoint for which data were needed, the so called leaf viewpoints within the command system. These templates were then instantiated by considering the specific tasks required of each viewpoint and naming the functions which are implied by the relevant activity template in order that the task can be done. The CNOCS output became known as the user requirements specification and is used by ARE Portsdown to produce a logical system description.
- 5.3 The initial work required at ARE Portland in order that CNOCS(SM) could begin to generate the submarine user requirement was therefore the development of
 - a. a submarine viewpoint diagram, incorporating the concept of internal viewpoints.
 - b. activity templates for leaf viewpoints within the command system.
- 5.4 The same method was used to arrive at the viewpoint structure and the activity templates. The method comprises cycles of issue based analysis followed by primary task analysis. The overall method is shown in figure 5 and described below.
- 5.5 For each cycle of application of the method an object system was chosen and a number of root definitions developed and modelled. These were then used to arrive at a primary task root definition and model. This primary task model was partitioned into subsystems which became viewpoints and potential objects for analysis during subsequent cycles of the method. At the lowest level of decomposition the primary task models became the basis for activity templates of the relevant viewpoints.
- 5.6 The derivation of root definitions and models as part of the issue based analysis was carried out during structured interviews with a number of Submarine Qualified Officers serving within CNOCS(SM), FOSM, DNW and The First Submarine Squadron. Primary task root definitions and models were

developed by CNOCS(SM) with ARE/UDP assistance.

5.7 In the next section the results of applying this method are presented.

6 Derivation of a Submarine Combat System Viewpoint Diagram

6.1 The ARE Portsdown definition and decomposition of the operational maritime environment was initially accepted without further analysis. This decomposition consisted of five viewpoints as follows

a. Higher Level Command, which comprises those parts of the operational maritime environment which are superior to and can direct the operations of the subject combat system.

b. Subordinate Combat Systems, which comprises those combat systems under the direction of the subject combat system.

c. Combat System, which is the subject of study and the CORE target system.

d. Other Combat Systems, which comprises those friendly combat systems over whom the subject combat system has no control and who in turn exercise no control over it.

e. Environment, which comprises all other factors which influence or are influenced by the subject combat system.

6.2 Work began with the decomposition of the Combat System viewpoint. Application of the method described in section 5 above resulted in the primary task root definition of a Submarine Combat System which identified it as

'A Higher Level Command owned, Submarine crew operated system which receives and transforms directives from higher command into successfully completed actions making use of Combat System resources and taking account of the perceived operational maritime environment derived within the Combat System from reports received and measurements taken'.

6.3 This root definition has the following elements, based on para 3.5 above

a. Owners: Higher Level Command.

b. Actors: The Submarine (crew).

c. Transformation: Directives into actions.

- d. Customer: Higher Level Command.
- e. Environment: The Operational Maritime Environment.
- f. World View: The combat system provides a means for higher level command to carry out its objectives.

6.4 This root definition resulted in the model of figure 6. The model activities were grouped together to form three sub-systems or viewpoints for further analysis, giving rise to the viewpoint structure of figure 7.

6.5 Subsequent analysis of the resource system viewpoint showed that in fact it was two viewpoints. One, which retained the name resource system, interfaced directly with the operational maritime environment and provided the primary means by which the combat system carried out actions to meet the needs of higher level command. The other system, which was termed the support system, did not interface directly with the operational maritime environment but was concerned with providing services to other combat system components. The information system previously identified as a separate level 2 viewpoint was more correctly seen to be part of the support system and was merged with it. The modified viewpoint diagram is shown in figure 8.

6.6 The following primary task root definitions were developed for each of the level 2 viewpoints shown in figure 8

‘The management system is a combat system owned, command team operated system which plans, co-ordinates and directs the operations of the support and resource systems to meet the needs of higher level command and in response to events in the perceived operational maritime environment’

‘The resource system is a combat system owned, submarine crew operated system which acts in the Operational Maritime Environment to fulfil tasks allocated by the management system’

‘The support system is a combat system owned, submarine crew operated system which responds to demands from other combat system components to provide the services they require to carry out their allocated tasks’

6.7 Each of the root definitions in para 6.6 was modelled and the activities grouped to give level 3 sub-systems or viewpoints. The resulting viewpoint structure is shown in figure 9.

6.8 It can be seen that each of the management, resource and support systems consists of three viewpoints. These are a

management viewpoint (configuration management, resource system management and support system management), an information handling viewpoint (management information system, resource information system and support information system) and an action viewpoint (mission management, take action system and provide services system). Configuration management is the name chosen for what might be termed management system management. Configuration management organises management system activities and resources in order that they can carry out their tasks.

- 6.9 The level 2 management system manages the whole combat system whilst each of the level 3 management viewpoints manages a level 2 system. Equally the original level 2 information system handled information for the whole combat system, whilst each of the level 3 information systems handles information within a level 2 system. It should be noted that the support system includes the information system which serves the whole combat system, but this is conceptually different from the support information system which is only concerned with handling information within the support system.
- 6.10 The viewpoint structure of figure 9 represents an important stage in the analysis of a Submarine viewpoint structure in that a number of different decompositions could be made from it. The actual decomposition chosen was based upon the following pragmatic decisions
- a. that all management viewpoints would be grouped under a single dedicated management system.
 - b. that all information viewpoints would be taken to form part of a wider information system that forms the major part of the support system.
- 6.11 The first decision was taken in an attempt to retain some degree of commonality with the Surface Ship Viewpoint Structure. The second decision followed from the first. If the level 3 information viewpoints were primarily handling information between the action and management viewpoints, by moving the management viewpoints in the way described above this information flow changed from being internal to the level 2 systems to being across the whole combat system. It therefore made sense to merge the level 3 information viewpoints into the level 2 support system.
- 6.12 With the level 3 management and information viewpoints rearranged the support and resource systems become no more than action viewpoints which need no level 3 decomposition at this stage of the analysis. The resulting modified viewpoint structure is shown in figure 10.

- 6.13 Further root definitions and models were developed for each of the leaf viewpoints within the management system. The models developed at this stage became the basis for the activity templates shown in figures 11-13.
- 6.14 The viewpoint structure of figure 10 was further extended pragmatically to reflect the physical systems and domain experts known to exist and forming parts of the support and resource systems. Inspection of figure 10 also led to a minor change in the breakdown of the Operational Maritime Environment. This involved removing subordinate combat systems and other combat systems, and introducing the new viewpoint representing assigned combat systems. The final form of the Submarine Combat System Viewpoint Structure is shown in figure 14 and described in detail in [8].

7 Discussion

- 7.1 The resulting viewpoint structure of figure 14 is not unique. From the structure of figure 9 a very different decomposition could have been undertaken, the actual decomposition used being heavily influenced by pragmatic considerations. The fact that it is not immediately obvious whether the description of figure 14 is in some objective sense better or worse than any alternative decomposition based on figure 9 illustrates the soft nature of a Submarine Combat System as an application domain for information systems analysis. CORE only requires that the viewpoint structure be sufficiently rich to capture the whole requirement and it is considered that figure 14 meets this criteria.
- 7.2 The level of decomposition at which the viewpoint analysis was terminated was an arbitrary decision. The method described in this paper could certainly have been applied to decompose the structure further. Nevertheless the structure has been decomposed sufficiently to demonstrate the usefulness of soft systems theory as applied to the analysis of requirements in essentially soft application domains.
- 7.3 However, by stopping at level 4 certain issues remain insufficiently well addressed. Each of the models of leaf viewpoints contains activities which themselves represent on a smaller scale the full range of application domains from hard to soft. For example 'monitor status' represents a relatively hard activity, whereas 'assess the situation' and 'determine planning requirements' represent soft activities. CORE is very good at expressing the requirement in terms of these hard activities but the complete specification of the softer activities is more problematic. The softer activities are in many respects equivalent to the non-programmed decisions of Simon [9] and represent potential areas for decision support. As described in Keen and Scott Morton [10] the methods for

specifying and designing decision support are very different from the techniques provided by CORE. There is therefore the need first to provide techniques for identifying the soft activities at level 4 and below, and second to find methods for arriving at adequate requirements specifications for these activities.

- 7.4 By rearranging the viewpoint structure of figure 9 in the way described in paras 6.10 - 6.12 most of the soft activities have been concentrated within the management system. It is therefore possible that subsequent analysis will show a progression from hard activities to increasingly soft activities in moving from the resource system, through the support system and into the management system. Systematic techniques such as CORE applied without modification may be able to adequately specify resource system and many support system requirements, however, considerable difficulty may be encountered arriving at a satisfactory requirement for the management system in this way.
- 7.5 Further application of soft systems ideas may help in arriving at an adequate requirements within the management system. The identification and specification of soft activities will be the subject of future work and papers as part of the logical system description of a Submarine combat system being produced by ARE Portland for DGCC.

8 Conclusions and Recommendations

- 8.1 Conclusions. The structuring of soft application domains provides a non-trivial problem which is inadequately dealt with by systematic methods for requirements analysis and specification. Soft systems theory provides a set of techniques which can be adapted for use with systematic methods, in this case CORE, to overcome the deficiencies of the latter. A specific example of how this can be done is provided by the derivation of a viewpoint structure of a Submarine Combat System described in this report.
- 8.2 Recommendations. It is recommended that the viewpoint structure of figure 14 be adopted by ARE/UDP and CNOCS(SM) for all future work concerned with the specification of requirements for submarine combat systems.

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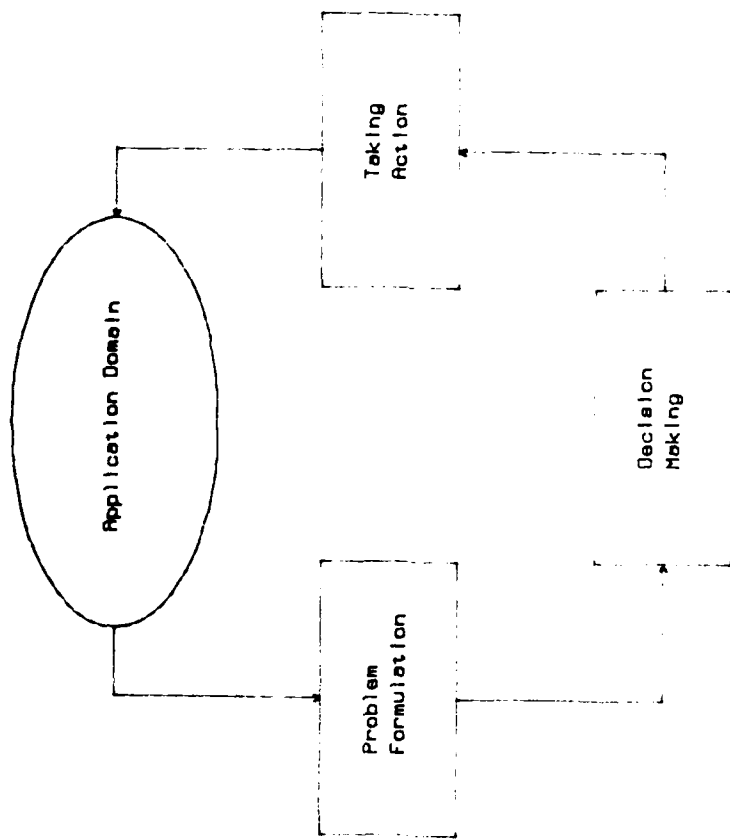


Figure 1: The Problem Solving Process

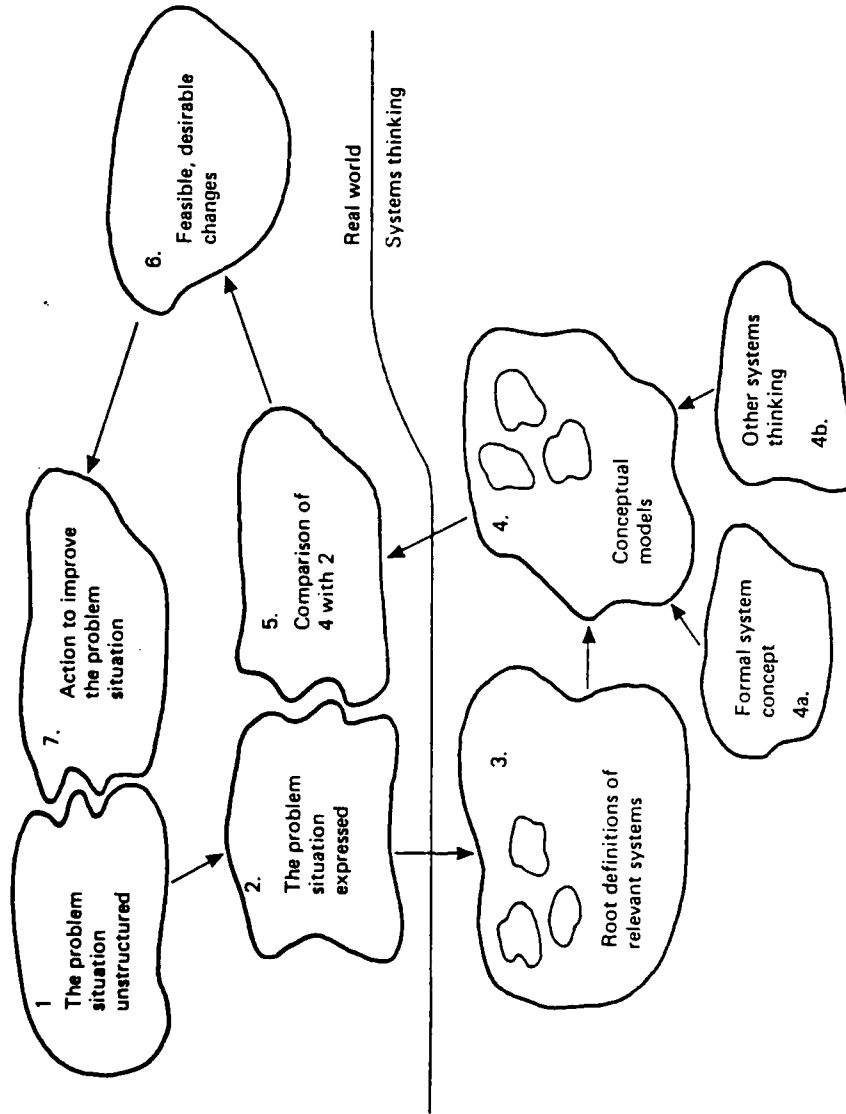


Figure 2: CHECKLANDS' SOFT SYSTEMS METHODOLOGY

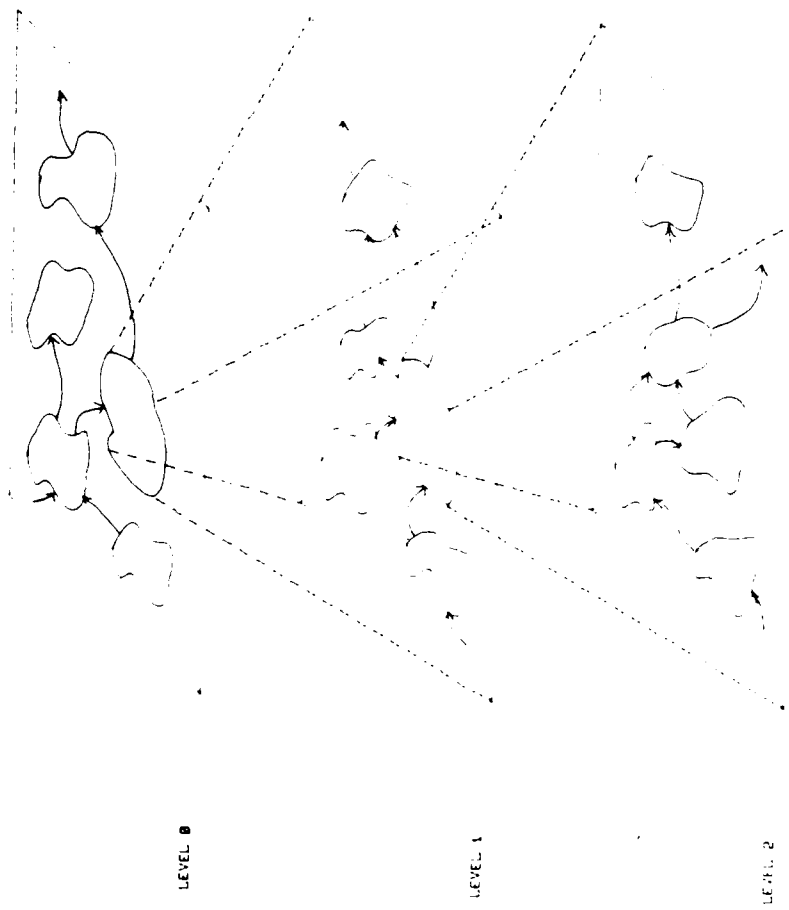


Figure 3: Decomposition of Application Domains

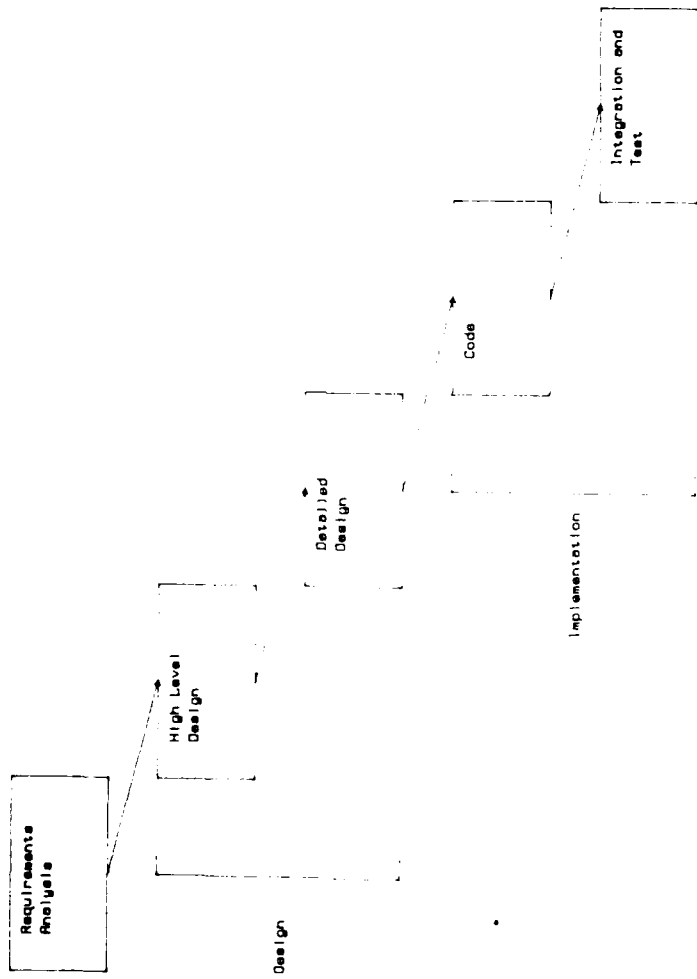
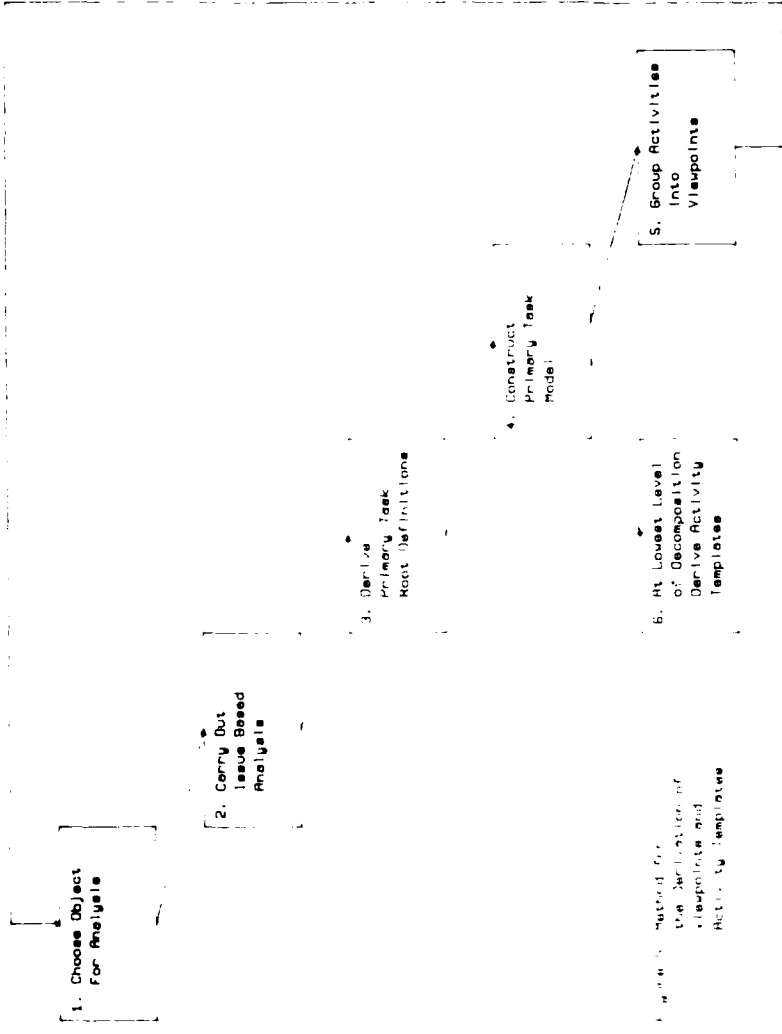


Figure 4: Project Life Cycle



6. At Lowest Level of Decomposition Derive Activity Templates

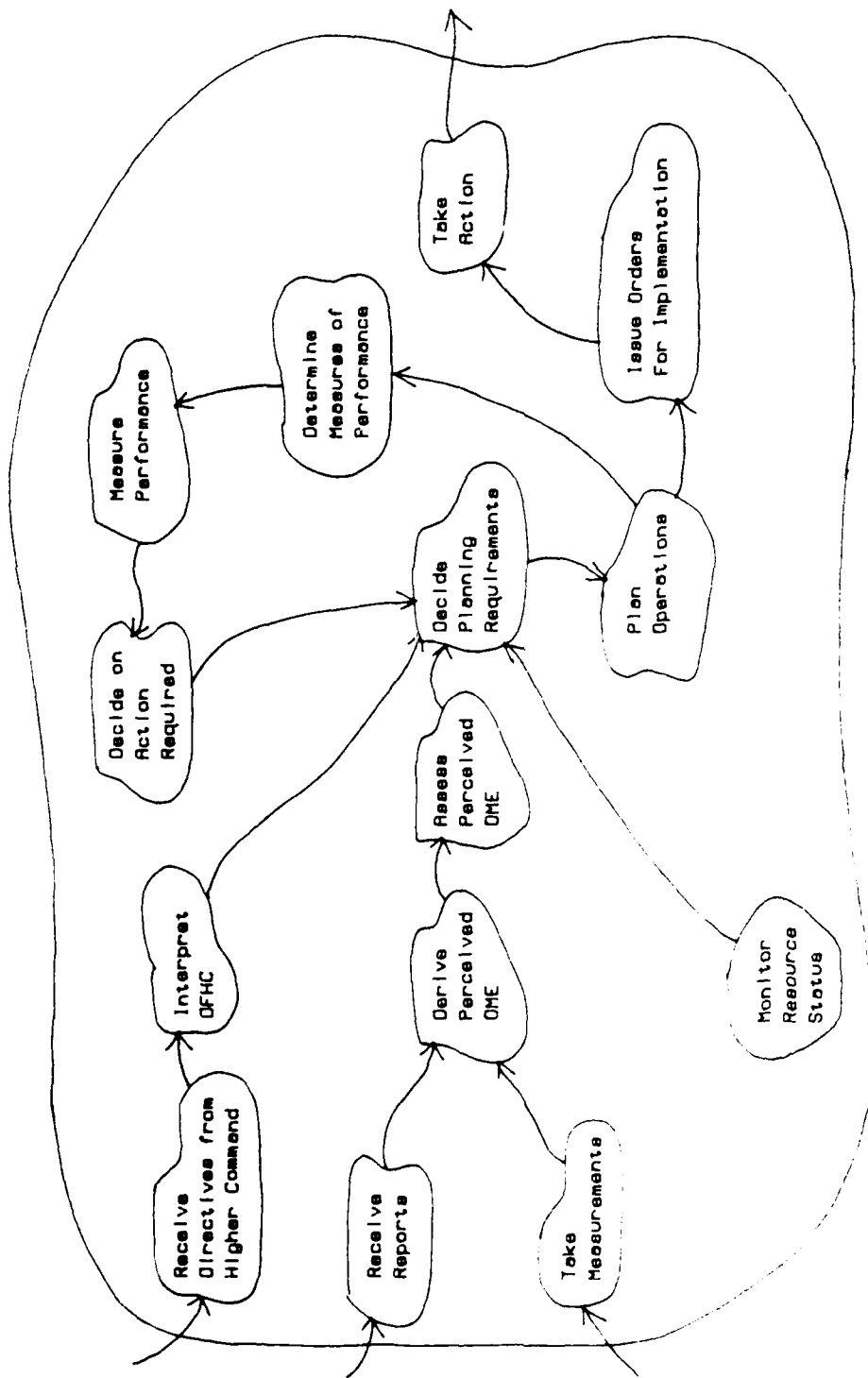


Figure 6: Primary Task Model of a Submarine Combat System

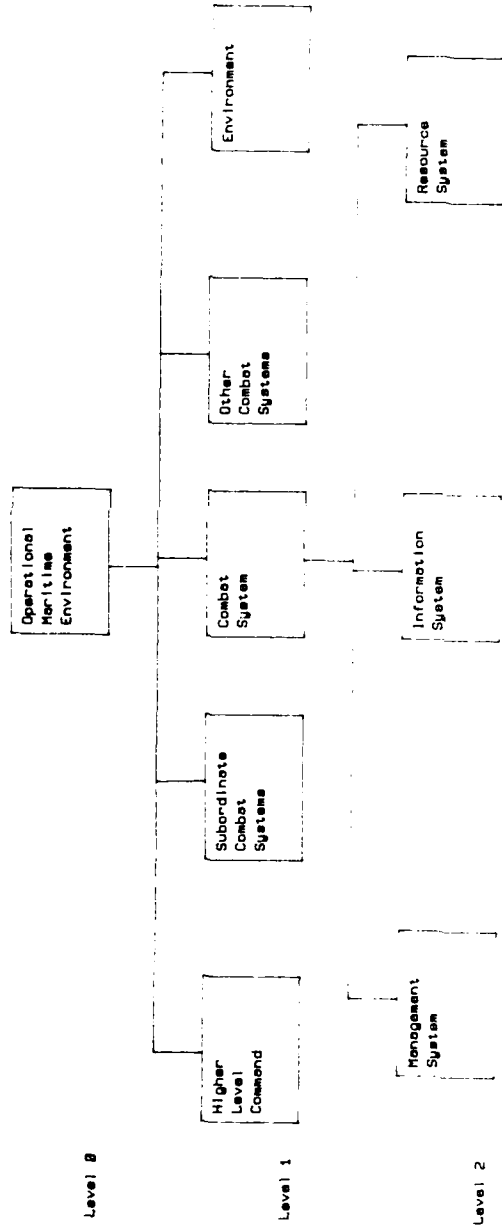


Figure 7: Original Viewpoint Diagram to Level 2

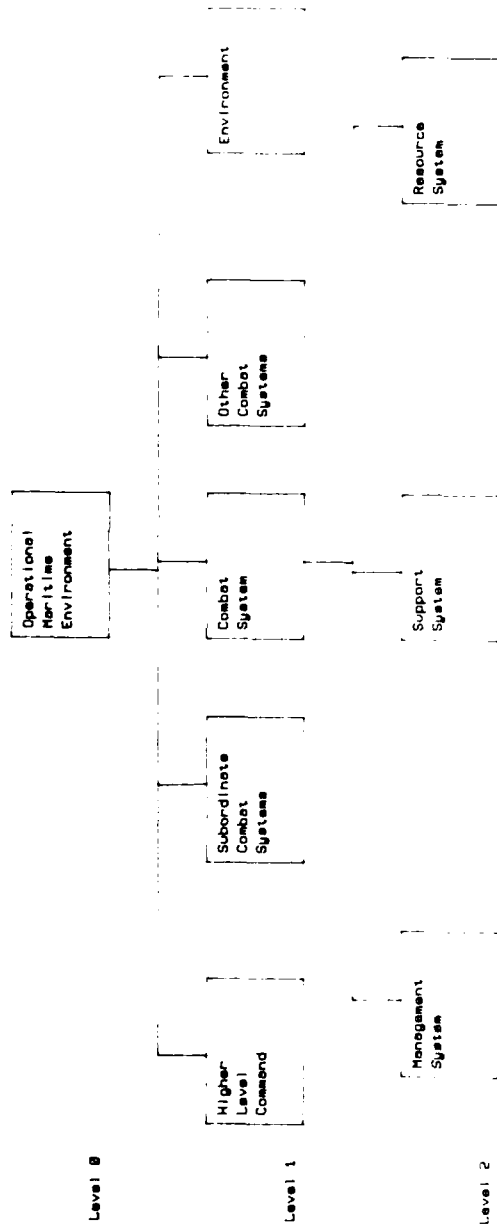


Figure 8: Modified Viewpoint Diagram to Level 2

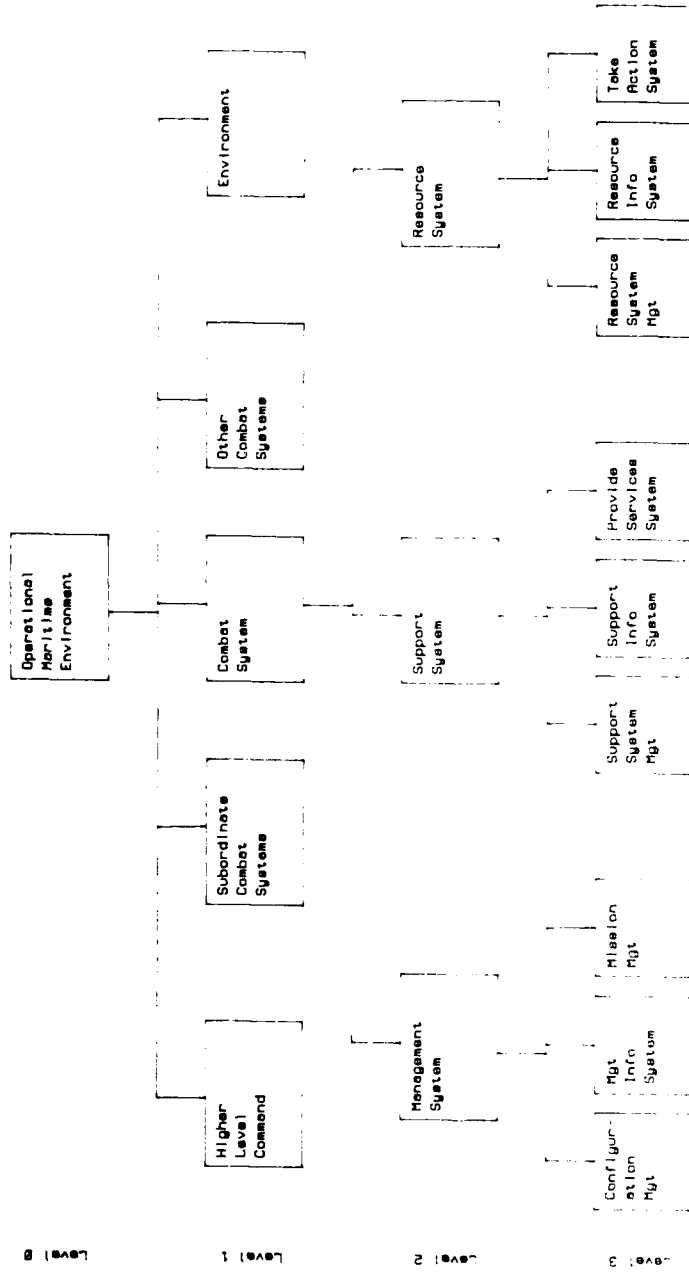


Figure 9: Original Viewpoint Diagram to Level 3

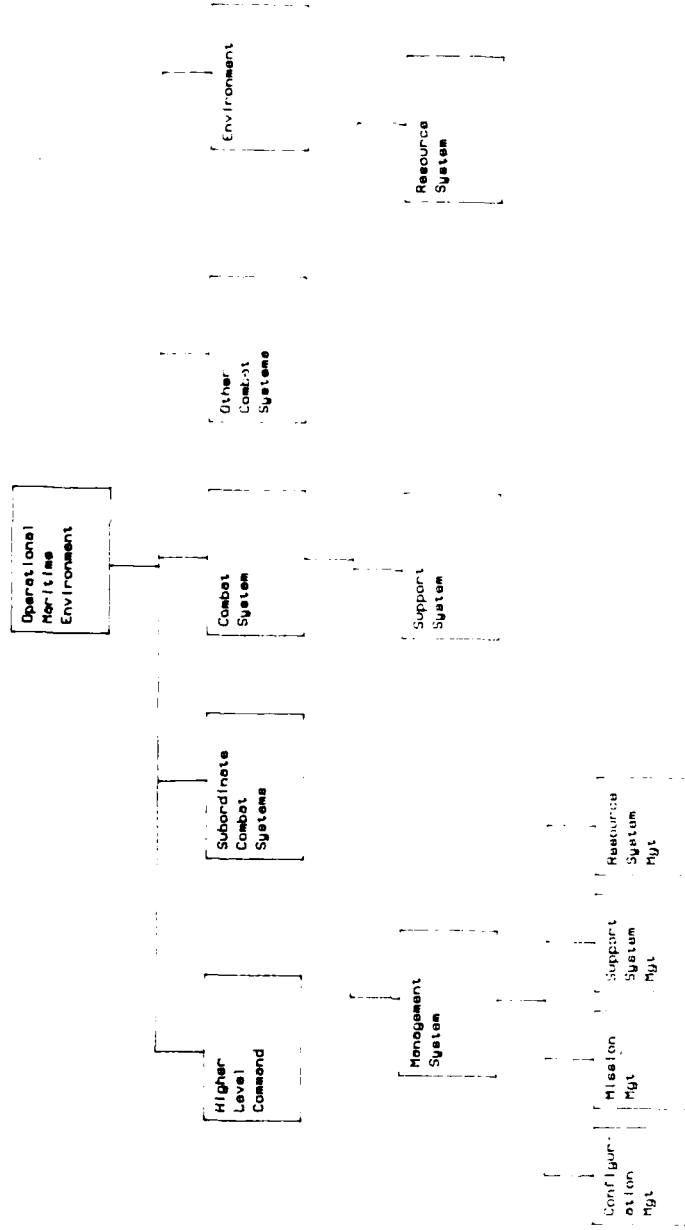


Figure 10: Modified Viewpoint Diagram to Level 3

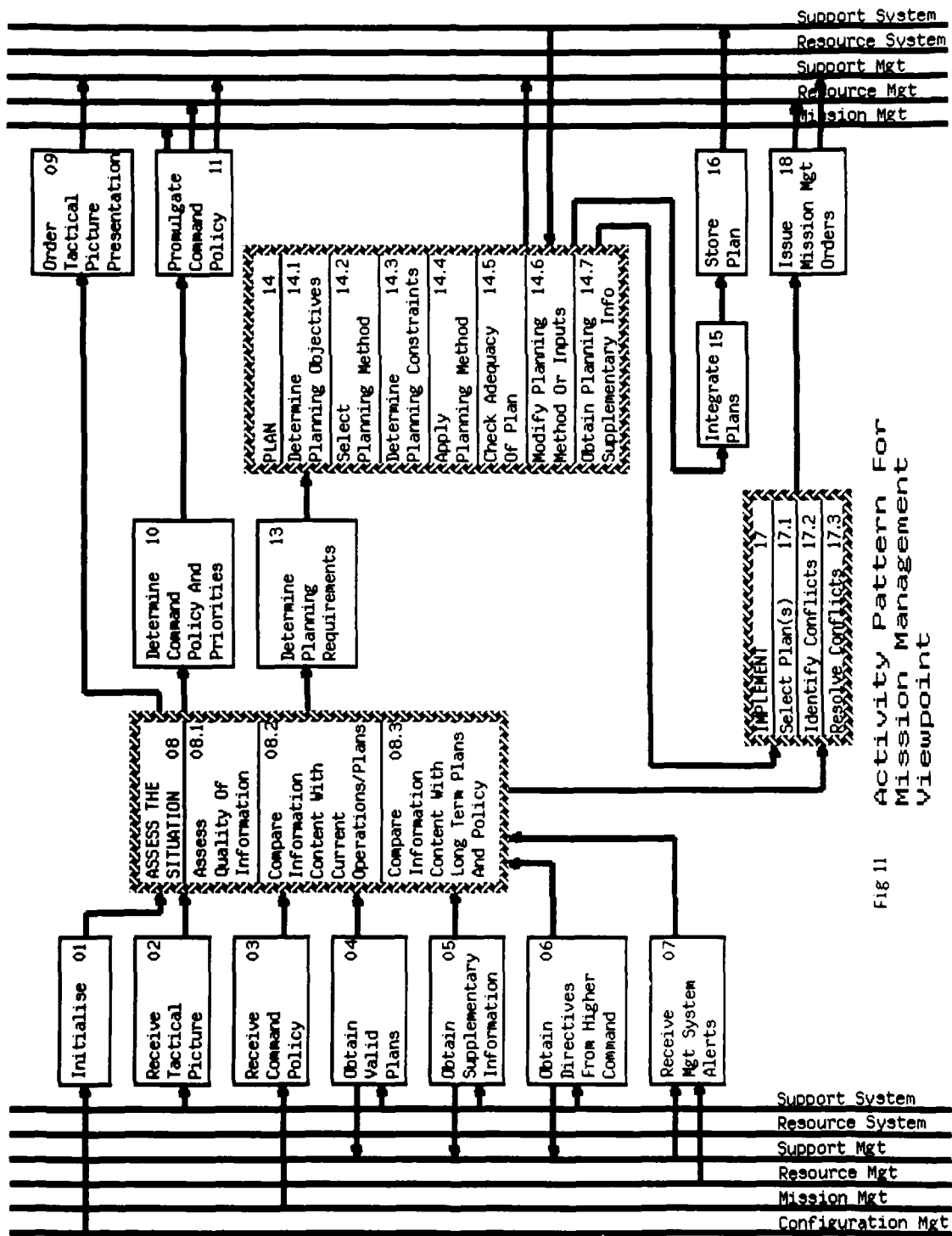
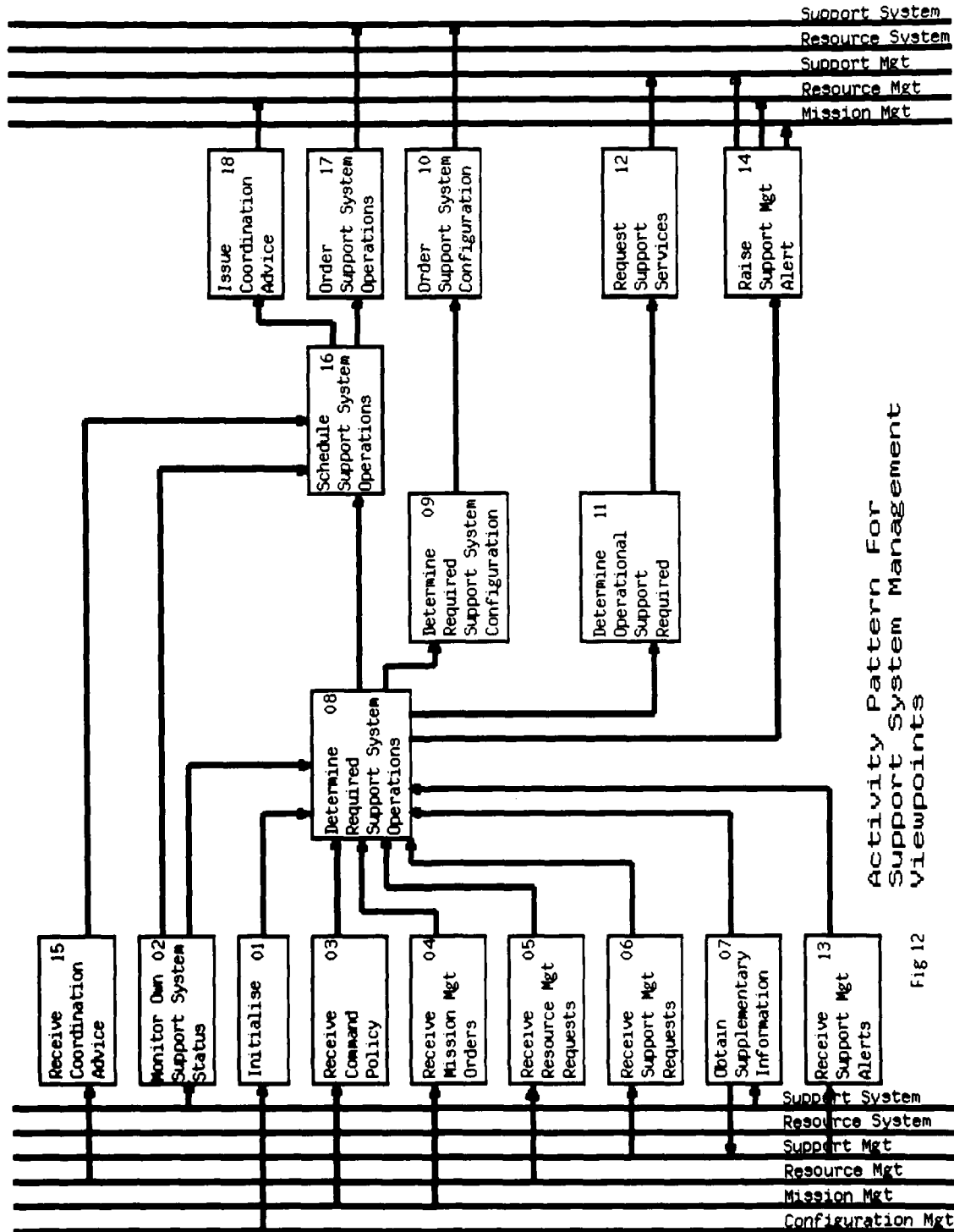
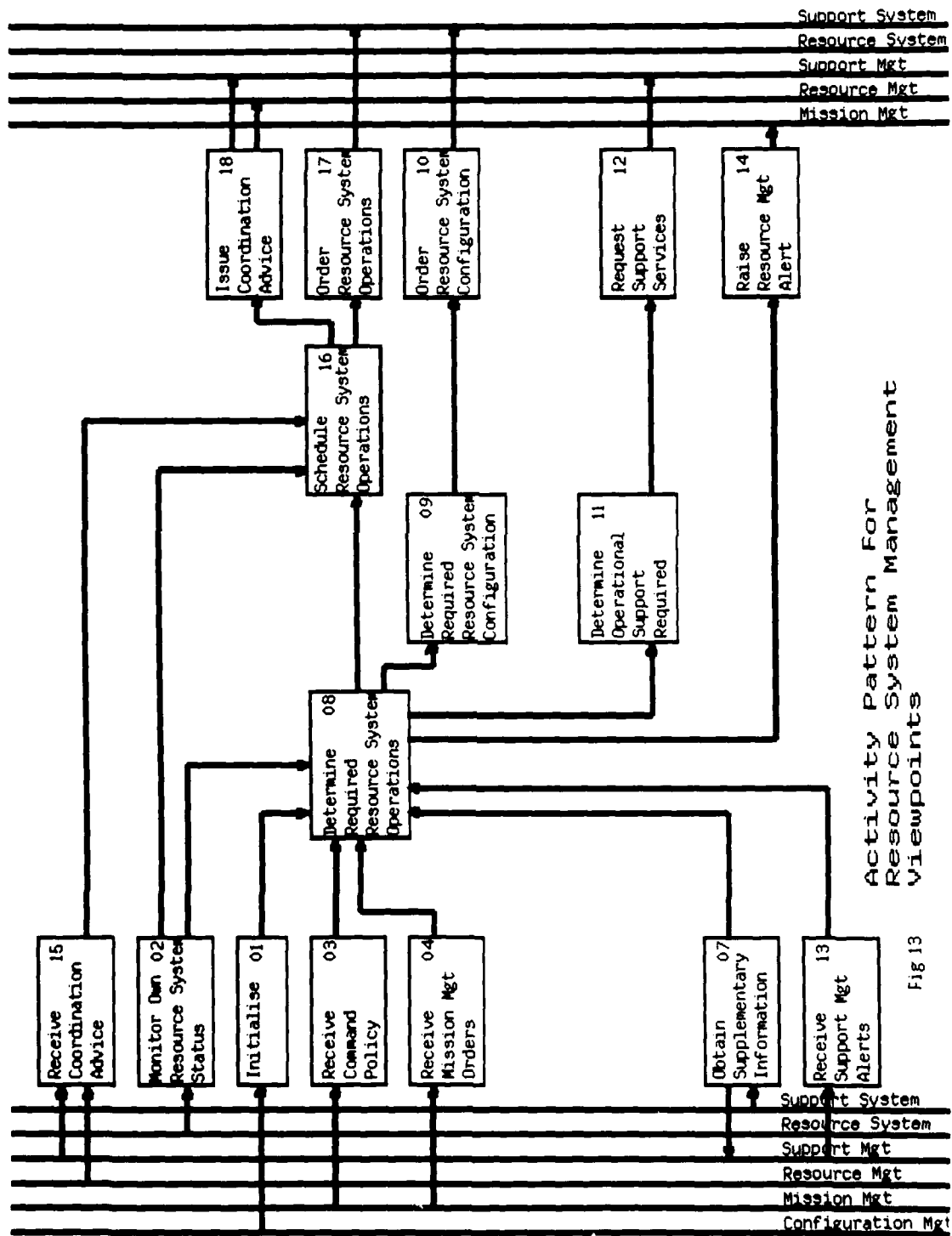


Fig 11 Activity Pattern For Mission Management Viewpoint



Activity Pattern For Support System Management Viewpoints

Fig 12



Activity Pattern For Resource System Management Viewpoints

Fig 13

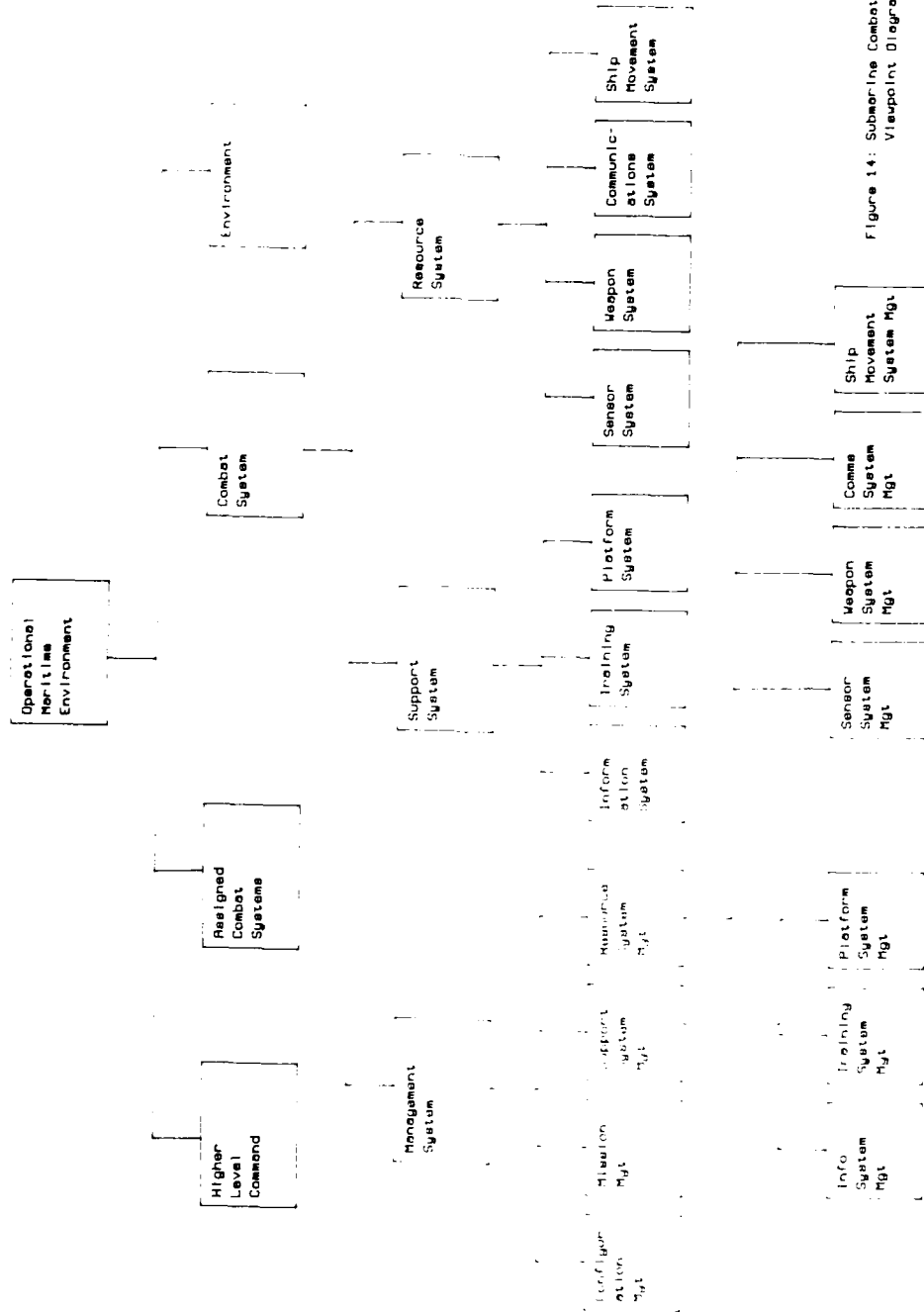


Figure 14: Submarine Combat System Viewpoint Diagram

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