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An organizational strategic intelligence mis : an interactive hierarchical delphi approach.

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AN ORGANIZATIONAL STRATEGIC INTELLIGENCE MIS:
AN INTERACTIVE HIERARCHICAL DELPHI APPROACH

A DISSERTATION PRESENTED

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AN ORGANIZATIONAL STRATEGIC INTELLIGENCE MIS:
AN INTERACTIVE HIERARCHICAL DELPHI APPROACH (July 1973)

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This dissertation can be viewed as one that outlines a theoretical argument and results in the development of a working model of a management information system designed on that theoretical basis.

The organization is viewed as an open system. As a result of the interactions occurring across its boundaries the organization is changed or modified in reaction to them and, in turn, changes or modifies elements within the environment. Drawing an analogy with the human body the organization is looked at as attempting to "homeostatically" adapt to its environment in a dynamic manner.

Information is analyzed as that which reduces alternative choices. Information is derived from data but, in general, cannot be inferred automatically. Data must be viewed within the context of a model; out of data within a context arises information. A sub-set of the organizational adaptive process is concerned with information.

Intelligence is looked at as an organizational function concerned with the reconciliation of information into a co-

herent whole or its definition of the alternative interpretations that can be reasonably inferred. Intelligence is viewed as always purposeful. Additionally the data under study must originate both internal to the organization and internal to the environment. Successful adaptation of the organization involves the utilization of data from both sources.

Strategic intelligence is that branch of intelligence concerned with the long range, with the very goals and objectives of the organization and with questions that affect a significant part of the total effort of the organization. It tends to take on a hierarchical aspect. The decomposition of a complex problem into simpler (and therefore more manageable) sub-problems appears to be both natural and effective.

Intelligence system pathologies can probably not be completely eliminated. Any system designed for strategic intelligence purposes must take into account their omnipresent threat and must attempt to minimize their effect.

The Delphi technique is a systematic method for soliciting data difficult to quantify. The structure of a Delphi exercise involves anonymity which may reduce the influence of some irrelevant variables.

A Hegelian or dialectical inquiry system is a philosophical approach that is appropriate to problems that are ill-defined, have opposing objectives, and require human experience or intuition. This system is a conflictual one. It is in the clash of ideas that the assumptions behind different positions will be exposed and subjected to rigorous challenge. Out of this dialectic will arise a more informed analysis and interpretation of the data.

Strategic intelligence does not fit the traditional mold of management science, which deals with well structured problems. Instead it closely fits the mold described as appropriate for a Hegelian form of inquiry.

A computer based management information system designed as a tool for organizational strategic intelligence applications is described. The MIS is based on a two tier design. The fundamental building block is an interactive Delphi based module designed within a dialectical context. The MIS described consists of interconnection of the basic modules into a hierarchical structure. A particular structure must be created for a particular application. Results from subordinate modules are made available to their immediately superior module. Except for this information flow capability all modules are designed so as to be independent of all other modules. It is suggested that systems of this type may serve as a valuable adjunct to more traditional management information systems.

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CHAPTER I

INTRODUCTION

This dissertation can be best described as one that outlines a theoretical approach to a broad organizational problem. On the basis of this theoretical approach the design of a working model of a management information system (MIS) is presented. This MIS model is offered as a tool for use by an organization attempting to effectively cope with this problem.

Military history is replete with examples of the general who through the application of his own genius overcame what appeared to be insuperable odds. In many cases it was shrewd intuition or the dominance of the personality of the commander that carried the day. In an ever increasingly complex world the individually brilliant tactician may still win battles; but strategic victories tend to be the result more of scientific management, the performance of a general staff and the consideration of factors not traditionally considered military in nature.

Organizations of many kinds today find themselves in a world analagous to that described above. Although intuition, personality and business "hunches" may still contribute to individual short range success organizational health in the long run now requires a considerably more sophisticated approach.

The organization, whether business, political, philanthropic or one of the many other types, finds itself surrounded by change. It must be clear to even a casual observer that this change involves that which ranges from the trivial to the very values upon which a society rests. This change is ubiquitous. As society is gaining in complexity change appears to be growing both in kind and in rate.

External to the organization factors critical to its health and even to its very survival change slowly or rapidly. These changes may occur in the intangible but critical area of goodwill or reputation. Generally such factors tend to change slowly although a relatively sudden shift may occur. Such changes may be difficult to reverse.

Technology expands and sometimes spurts forward as the result of a "breakthrough". It cannot be denied that the introduction of the automobile at the beginning of this century has had staggering repercussions throughout society. Computers have created new industries and eliminated old ones. The transistor and the newer integrated circuit are still making their impact felt in many areas.

The law changes and interpretations of the law change with time. Anti-trust action may be vigorous or moderate. The current interest in the environment and in consumerism has triggered new legislation which has had wide ranging effects.

"Acts of God" may affect an organization either directly or indirectly (e.g. the business organization may find its sources of supplies or its customer outlets disrupted). The relative position of competitors improves or slips. Fads come and go; tastes change. Population shifts into and out of geographic areas occur. Leisure time has increased and with it spurred entirely new organizations into being.

Economics clearly has a profound influence on organizational activity. Gross national product (GNP) influences and is a reflection of employment patterns, disposable income, savings, etc. which affect different organizations in different ways. There is also a clear influence on the passage of new laws or the modification of existing ones. Taxation, tarriffs and import quotas are only three exmples of this feedback.

Changes occur also within the organization. Personnel enter and leave the organization. The mix of skills changes. With new personnel come new attitudes, beliefs, knowledge, experience, interests, etc. The formal structure of the organization and the ever present informal relationships undergo modification. New technology is implemented and old technology is obsoleted.

The problem facing the organization is, however, compounded. First, there is uncertainty as to which variables are significant to the organization. It may be clear that some variables have been significant to the organization historically. Some of these will become insignificant while new variables will become all important. History provides innumerable examples of the devastating effect of the unexpected. Second, there is uncertainty as to the values of the variables that are considered relevant. This uncertainty may arise in the collection of data (e.g. Has a random sample truly been collected?), in the measurement itself (e.g. Does this measure what it is thought to measure?) or because the variables are difficult (if not impossible) to quantify or to operationalize. Additionally projection of the values of variables into the future is fraught with uncertainty by its nature.

The organization must try to understand what changes occurring both internal to and external to itself are of significance. It must try to adapt to them successfully if it is to thrive. This adaptation involves the collection of information originating both within and without the organization.

The reconciliation of that information needed for the successful adaptation of the organization is called organizational intelligence. When concerned with the long range, with the goals and objectives of the organization, or with functions vital to the organization's health it is termed organizational strategic intelligence.

OUTLINE OF THE DISSERTATION

Chapter II will look at the organization in terms of systems theory. Some of the basic terms will be defined. Such important concepts as open system and information will be emphasized. The idea of hierarchy in both a structural and a capability sense will be introduced. The organization will then be viewed as an open system acting upon and being acted upon by its environment. Drawing an analogy the organization will be looked upon as attempting to homeostatically adapt to its environment. This adaptation will be looked at as dynamic, i.e. not just striving to achieve equilibrium but possibly striving to change in some more favorable direction. Organizational functions of learning and goal changing will be viewed and the idea of organizational pathology will be discussed.

Chapter III will then review a sub-set of the interactions across the organizational boundary. This sub-set is information. Information will be viewed as being inferred from data. Data per se will be considered an inchoate mass. The application of a model to the data will be presented as the means of producing information. Intelligence will then be seen as the reconciliation of information into a coherent whole. In short the interrelationship between data, model, information and intelligence will be examined. Strategic intelligence as a particular form of intelligence for the organization will be introduced. In general it will be shown that the organizational strategic intelligence function will take on a hierarchical structure as a means of coping with complexity. The danger of intelligence system pathologies will also be considered.

Chapter IV will introduce the Delphi technique. Delphi will be shown to be a systematic method of collecting and interpreting data difficult to quantify through iterative feedback. It will be argued that a Hegelian, i.e. a dialectical, philosophical approach within a Delphi framework is a logical tool for an organizational strategic intelligence application. Because of the ill-structured nature and the policy considerations implied in an organizational strategic intelligence question it will be shown that traditional management science techniques are not applicable.

Chapter V will present a working model of a management information system that has been designed for an organizational strategic intelligence application. It will be argued that such an MIS must be flexibly structured. The working model described will be shown to be capable of flexible interconnections of Delphi based modules. Each module will be capable of autonomous operation but when placed within a hierarchical structure in the MIS will allow information flow to its immediately superior module. Thus the MIS will be described first at the system level and second at the module level.

Chapter VI will present a final summary of the argument built up and presented within the dissertation. Additionally it will attempt to outline some areas for further research. It will be shown that these areas may require significant groundwork before results can be drawn. It will be shown also that they may offer very significant potential increase in the power and the sophistication available to the user of an MIS of the type described.

CHAPTER II

THE ORGANIZATION AS SYSTEM

OVERVIEW

This chapter will attempt to draw a reasonably coherent picture (although, necessarily limited) of the current state of systems thinking and its application to organization theory. Necessarily, only those aspects of systems thinking that have been or may be utilized in organization theory will be viewed. This does not imply, of course, that any concepts, that have been ignored for the purposes of this study, may not in their own right possess a high level of insight or have potential for practical applications in some or many fields of knowledge. Their omission only implies that a subjective judgement has been made that they will not illuminate our study of organizations interacting with their environments.

The area of system theory is a broad one. It is broad in two senses: first, it is interdisciplinary and appears to be continuing to expand across the somewhat artificial boundaries of academic specialties; and second, the use of systems terminology has involved a continuum of definitions ranging from the very rigorously specialized to the very shallow and all-encompassing.

The first aspect, i.e. the interdisciplinary, contains a potential both for discovering new insights in established disciplines and for drawing false or meaningless conclusions from the creation of inappropriate analogues.

A model is a finite representation of a physical reality, which possesses an infinite amount of information. The necessity of abstracting a finite (and manageable) number of variables from this infinite collection always requires a judgement as to which variables are relevant for the model builder's purposes. Thus, a model is always a constrained view of reality. Applying a model built as a representation of one view of a phenomenon to another phenomenon carries risk - risk that some of the variables used are not relevant (or that some that are relevant are not included) in describing this new phenomenon, or that the model builder's purposes in describing the original phenomenon are not meaningful in describing the second phenomenon.

The systems viewpoint has been primarily formulated and advanced in the study of thermodynamics and later in the study of biology. Recently, i.e. within the last fifteen to twenty years, systems concepts have been extended to other areas. One of these areas now being affected is organization theory.

The second aspect, i.e. the use of systems terminology, is perhaps the more abused and, yet, the more easily corrected factor. Obviously, the broader the interpretation of systems (and systems is broad by definition) used the broader the results when applied to the considerable body of knowledge already existing in organization theory. The use of concepts, however, that deal in vague generalities will culminate in only the most nebulous results. As the concepts become more concrete, though, it becomes more urgent that they not be "force fitted" to new phenomena.

As Buckley,[1] Simon,[2] Friedman[3] (implicitly) and others would argue, the ultimate test of a model is in its usefulness. Of course, different models may be equally useful but differ in the efficiency with which resources (time, effort, etc.) are employed. Two models may also differ in the degree of insight or understanding provided to the user. Since all models are simplifications the range over which a model is useful or the degree of flexibility or possible updating of the model may make one model superior to another. Usefulness cannot be judged in isolation. Nevertheless, a systems theory view of organizations has proven to be not only useful but a source of insight for the design of management information systems.

SYSTEMS

The concept of system is a general but a powerful one. Hall and Fagen[4] say:

> "A system is a set of objects together with relationships between the objects and between their attributes....The decision as to which relationships are important and which trivial is up to the person dealing with the problem, i.e. the question of triviality turns out to be relative to one's interest."

and Faires,[5] writing in a thermodynamics context, indicates that:

> "A system is that portion of the universe, an atom or a galaxy, or some certain quantity of matter, which we specifically wish to study. It is a region enclosed by specified boundaries or by imaginary but definite mental boundaries."

Ludwig von Bertalanffy,[6] considered the father of General System Theory, says that a system is simply a "complex of interacting elements" and Beer[7] points out that a system is not something that is natural but it is a human invention.

Thus we can conclude that a system is a collection of elements involving relationships between certain attributes of these elements. The relationships involved are those which tie the system together. They are the associations between interdependent parts. Which relationships are relevant depend on the problem at hand. Implicit in the definition is the assumption that it can be determined for any given element whether or not that element is a member of the given collection and, therefore, whether or not it is a part of the system. In other words, a boundary may be drawn around the system; this boundary will enclose those elements which are a part of the system and exclude those which are not a part.

Open and closed systems. The next differentiation that must be made is that between open systems and closed systems. Bertalanffy[8] says:

> "A system is closed if no material enters or leaves it; it is open if there is import and export and, therefore, change of the components....Living systems are open systems maintaining themselves in exchange of materials with environment, and in continuous building up and breaking down of their components."

and Ackermann,[9] employing a more general definition, points out:

> "A closed system is by definition a system subject to the influence of no forces, bodies, or whatever outside the system....In theory, a completely closed system must be isolated thermally, gravitationally, electrodynamically, and so on from every other system. In practice, clearly, there are no completely closed systems...."

Bertalanffy,[10] in a most succinct manner, says that closed systems are those isolated from their environments. He clearly implies in this that open systems are those not isolated from their environment.

Since the boundary between a system and its environment is defined in terms of its utility to the scientist, a system may be considered closed with respect to the relationships between the attributes of some elements of the system and its environment and open with respect to others. For example, a theoretical system might be closed with respect to material of all kinds but open with respect to information. (Information is here meant in the sense of Shannon and Weaver.[11])

The concept of open system is not a triviality. Although it is true, as Ackermann suggests above, that systems may be closed in only very limited senses to their environment the degree to which such systems are open can be critical. (Clearly the total physical universe forming a completely closed system is a limiting and a trivial case.)

Adaptation to the environment. Cannon[12] in 1939 stated that "The ability of living beings to maintain their own constancy has long impressed biologists." Quoting the French physiologist, Charles Richet writing in 1900, Cannon[13] adds:

> "The living being is stable....It must be so in order not to be destroyed, dissolved or disintigrated by the colossal forces, often adverse, which surround it. By an apparent contradiction it maintains its stability only if it is excitable and capable of modifying itself according to external stimuli and adjusting its response to the stimulation. In a sense it is stable because it is modifiable - the slight instability is the necessary condition for the true stability of the organism."

Cannon[14] then contributed a new term to the language:

> "The coordinated physiological processes which maintain most of the steady states in the organism are so complex and so peculiar to living beings... that I have suggested a special designation for these states, homeostasis."

The concept of homeostasis of an organism has been considerably extended. Hall[15] says: "A system is stable with respect to certain of its variables if these variables tend to remain within defined limits." The more dynamic nature of this concept should be evident. The system, in a sense, is not necessarily "locked" into a stable point or points but may seek to maintain itself within limits. Hall[16] elaborates this point:

> "Many natural systems, especially living ones, show a quality usually called adaptation. That is, they possess the ability to react to their environments in a way that is favorable, in some sense, to the continued operation of the systems....evolutionary theory is based heavily on the notion of adaptation to the environment."

Hall includes both living and non-living systems in his description of this adaptation to the environment. Indeed, many electrical and/or mechanical devices have been built utilizing this principle. Cybernetics, or the science of control and communication, involves the utilization of feedback from a system's environment to reduce an "error" or, in other words, to seek an objective. Rosenblueth, Wiener, and Bigelow,[17] as original cyberneticians, divide active behavior into purposeless and purposeful. Purposeless behavior is random, whereas purposeful appears to be directed to a goal. Rosenblueth and Wiener[18] say elsewhere:

> "....we wish to stress that in some modes of behavior an acting object is closely coupled to certain features or objects in its environment. The analysis of the behavior is then quite incomplete if the object is considered in isolation, for it is only a part of a larger system."

Emerson[19] suggests:

> "....in part homeostasis can be interpreted as controlling optimal competition. In other words competitive systems themselves are regulated in the direction of more optimal conditions of competition, because if competition is too weak, homeostasis, and therefore survival, is threatened. If competition is too strong, certain destructive events also happen. Consequently competition is not necessarily bad, nor is it necessarily all good; there is an optimal level of competition that has survival value."

Whitehead[20] summarizes this idea by saying:

> "The essence of life is the teleological introduction of novelty, with some conformation of objectives. Thus novelty of circumstances is met with novelty of functioning adapted to steadiness of purpose."

As an aside this idea of an optimal level of competition bears a remarkable resemblance to Toynbee's[21] theory of the rise and fall of civilizations. To Toynbee a civilization must have a challenge to respond to and to overcome. If the challenge is too weak, response will be weak and the society will weaken and either stagnate or perish; if the challenge is too strong, the society will be overwhelmed and fall.

All of these thoughts imply open systems - to adapt to an environment a system must be affected by the environment. By definition this is an open system.

Ackermann[22] adds a word of caution, however:

> "Successful adaptation to the environment is a property we can notice only over a sufficiently great period of time, and it is a process which we see most clearly by examination of gross features."

Entropy. There are additional differences between open and closed systems. The second law of thermodynamics, sometimes referred to as the law of degradation of energy, applies only to closed systems. The second law has been stated in a number of different ways. Faires[23] says: "All spontaneous processes result in a more probable state." Bertalanffy[24] says:

> "....the general course of physical events (in closed systems) is toward increasing entropy, leveling down of differences and states of maximum disorder. In open systems, however, with transfer of matter import of 'negative entropy' is possible. Hence, such systems can maintain themselves at a high level, and even evolve toward an increase of order and complexity - as is indeed one of the most important characteristics of life processes."

and in paraphrasing the second law, Bertalanffy[25] says that "entropy must increase in all irreversible processes. Therefore the change in entropy in a closed system must always be positive." And, perhaps, more powerfully, Bertalanffy[26] again says:

> "Thermodynamics expressly declares that its laws only apply to closed systems. In particular, the second principle of thermodynamics states that in a closed system, a certain quantity, called entropy, must increase to a maximum, and eventually the process comes to a stop at a state of equilibrium."

What is entropy? Again Bertalanffy[27] speaking: ".... entropy is a measure of probability, and so a closed system temds to be a state of most probable distribution." In short, it has achieved the "least common denominator" or has approached randomness.

In contrast to the closed system, the open system can offset this inevitability. It does this by importing negative entropy. One non-physical example of negative entropy is simply information. Thus, the second law (or the dismal law as it is often called) is defeated in the open system by an import of whatever the system requires (men, machines, materials, information, etc.).

To summarize Bertalanffy[28] says: "Entropy may decrease in open systems. Therefore such systems may spontaneously develop toward states of greater heterogeneity and complexity."

Equifinality. Another important attribute of open systems is equifinality. Bertalanffy[29] explains about open systems:

> "....the final state may be reached from different initial conditions and in different ways. Such behavior we call equifinal....Analysis shows that closed systems cannot behave equifinally."

Thus, the closed system progresses inevitably to a state of maximum entropy (minimum information) while the open system may progress via different paths to a state of less than maximum entropy; and this final state may be independent of the paths taken by the system.

Bertalanffy[30] expands this idea in the following excerpt:

> "....an open system will attain a steady state in which its composition remains constant, but in contrast to conventional equilibria, this constancy is maintained in a continuous exchange and flow of component material....the open system may attain a time-independent state independent of initial conditions and determined only by the system parameters."

Information theory. At this point a divergence may be most appropriate. On two occassions above reference has been made to 'information'. As Raisbeck[31] points out:

> "When a new technical concept is named with a common word, the word acquires a new meaning. It is impossible to use the word in a technical context until that new meaning has been defined.... There is no reason to expect anyone to know what the word information means to an information theorist unless he has been told."

Let us consider the often used "black box". The contents of the box are, as usual, inaccessible to us. An experiment is being carried on inside that box and its results will be reported to the outside world via n light bulbs on the box's exterior. Let us further assume that there are n equally likely outcomes possible from this experiment. Figure 2-1 illustrates this.

Now let us assume a different "black box" - this one contains two independent experiments. The results of the first experiment may be one of n_1 equally likely outcomes and the results of the second experiment may be one of n_2 equally likely outcomes. The results of the two experiments taken together may be one of $n = n_1 \cdot n_2$ possible equally likely outcomes. Figure 2-2 illustrates this.

There are, at least, two desireable properties for information: (1) it should be positive, i.e. negative information (in a mathematical sense) is disallowed and (2) it should be additive, i.e. in Figure 2-2 if f(n) is a measure of information and is a function of n, then $f(n)=f(n_1)+f(n_2)$. There are a number of relationships which satisfy these requirements. Since Shannon's pioneering work this relationship has been standardized as $f(n) = c \log n$ and, specifically, for the case of n equally likely outcomes $f(n) = \log_2 n$. Information, as defined here, is frequently denoted as H and is expressed in bits.

To illustrate this idea: Will the sun rise tomorrow? There is only one possible outcome - yes; therefore, $n = 1$ and $H = \log_2 1 = 0$ bits of information. Thus the answer to this question provides no information - the outcome is a certainty.

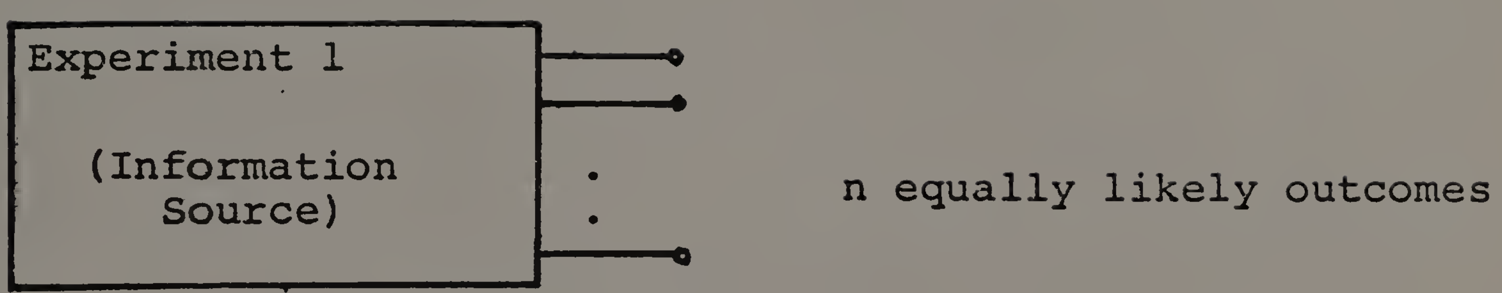

Figure 2-1 - Information Source

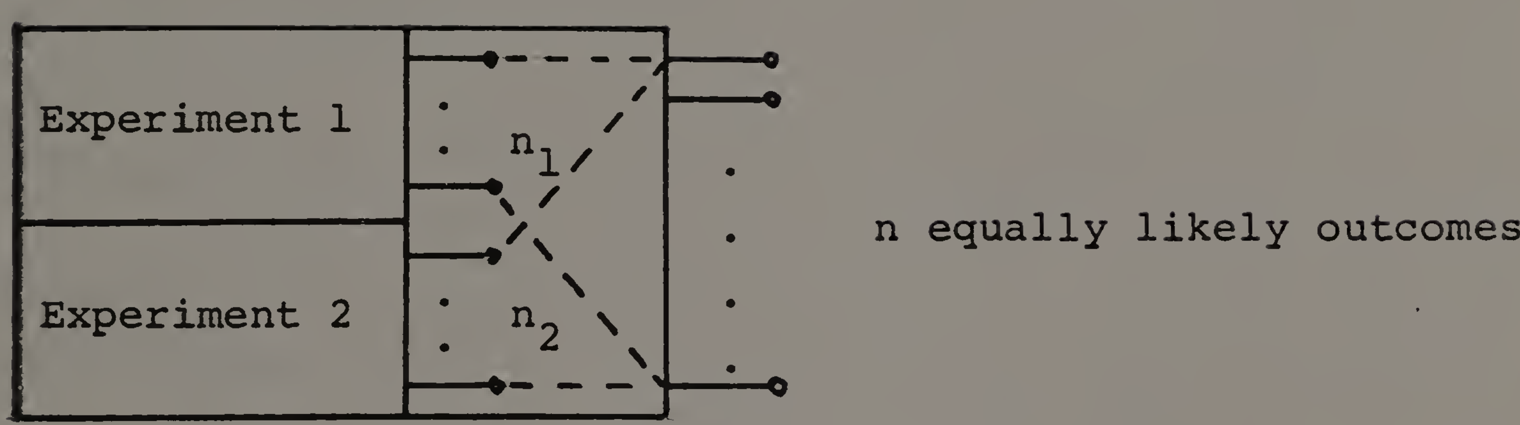

Figure 2-2 - Two Independent Information Sources

Now suppose the possible outcomes are not equally likely. Thus, the observer only asks if the outcome is in n_1 or n_2 where $n_1 \neq n_2$. Figure 2-3 illustrates this.

The outcomes, then have probabilities:

$p_1 = \frac{n_1}{n_1+n_2}$ and $p_2 = \frac{n_2}{n_1+n_2}$. The information associated with one message can be shown to be:

$$H = \sum_{i=1}^{2} - p_i \log_2 p_i$$

subject to $\sum_{i=1}^{n} p_i = 1$

when n outcomes are equally probable:

$$p_i = 1/n$$

$$H = \sum_{i=1}^{n} - 1/n \log_2 (1/n) = \log_2 n$$

It can be shown that maximum information is obtained when each outcome is equally probable (e.g. maximize the general definition of H using Lagrangian multipliers).

There is an unexpected conclusion that necessarily follows from this work. As Ashby[32] says: "The information conveyed is not an intrinsic property of the individual message." It is only a property of the probabilities of the outcomes.

<u>Systems hierarchy</u>. A hierarchy of systems is an idea that, though critical to either the analysis of an existing system or to the design of a new system, is not discussed in

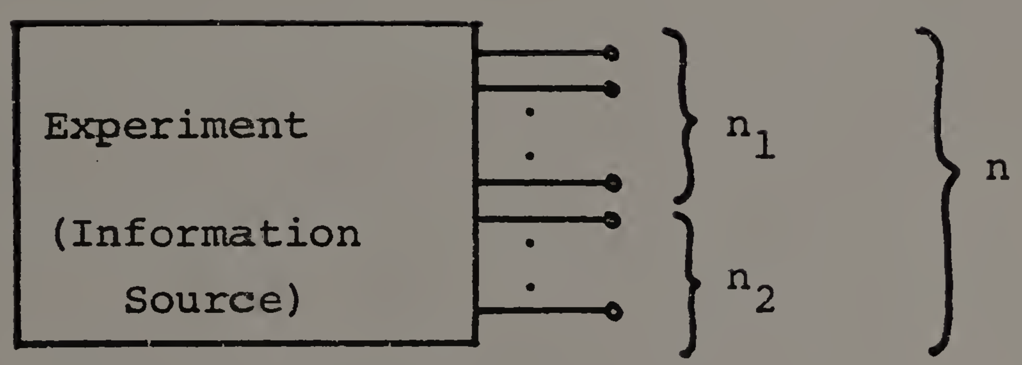

Figure 2-3 - Information Source with Unequally Probable Outcomes the literature to a very great extent. This may be due to a simple assumption that all systems involving the human element are of the most sophisticated type. It may be easier and even useful, at times, to so simplify. It must be kept in mind, however, that gains in one area are usually paid for by costs in another. So, by definition, simplification involves the giving up of some facts.

Another danger exists in categorization. Any systems hierarchy is meant to be descriptive of reality. Categorization tends to result in seeing "hard and fast" breaks between systems levels when, in fact, a continuum exists. Nevertheless, valuable insights may be gained by looking at systems as a hierarchy.

Boulding,[33] for example, suggests a "system of systems" involving nine levels. Litterer[34] has taken the Boulding hierarchy and modified it into a more generally useful tool for the study of organizations. In his hierarchy there are four levels:

(1) the level of frameworks,

(2) the level of clockworks,

(3) the level of closed systems,

(4) the level of open systems.

Hare,[35] in looking at systems, suggests five levels:

(1) the simple machine or transformation,

(2) the simple machine with feedback,

(3) the system with conditional selection of plans and predictive behavior,

(4) the system that learns,

(5) the goal changing system.

Deutsch,[36] although less explicit, appears to parallel Hare to a considerable extent. Clearly the hierarchical level of a system may determine whether a particular operation of the system is pathological or normal. For example, using Hare's terminology, the simple transforming system that "tracks" is pathological whereas it is the distinguishing characteristic of the simple system with feedback and is normal in all higher levels of systems.

Another aspect of systems hierarchy has to do not with systems capabilities as above, but with structural concepts. Simon,[37] for example, points out that more complex systems will generally evolve from simpler systems through stable intermediately complex forms.

He illustrates this point with his new classic example of the watchmakers Tempus and Hora and concludes:

> "One path to the construction of a nontrivial theory of complex systems is by way of a theory of hierarchy....We could expect complex systems to be hierarchies in a world in which complexity had to evolve from simplicity. In their dynamics, hierarchies have a property, near decomposability, that greatly simplifies their behavior. Near decomposability also simplifies the description of a complex system."

Thus, Simon argues that the concept of structural hierarchy is valuable not only because it appears to reflect reality but also that it is useful to the investigator.

A completely decomposable system is probably only a theoretical concept, i.e. such a system would really be a set of independent systems. In terms of interactions near decomposability (a relative term) implies that the interactions within a sub-system are "stronger" than those between sub-systems. In a hierarchical system sub-systems can be created on the basis of near decomposability; in turn these sub-systems may be further decomposed on the same basis, etc. In the short run behavior of sub-systems within a nearly decomposable system will be approximately independent of each other.

Whyte, Wilson, and Wilson,[38] reporting on an interdisciplinary symposium on "Hierarchical Structure in Nature and Artifact," clearly show its ubiquity. Alfred North Whitehead[39] emphasizes this very point as follows:

> "The universe achieves its values by reason of its coordination into societies of societies, and in societies of societies of societies."

Organizations as Systems

In the preceding section an introduction to systems concepts and terminology was provided. A broad view of the general field of systems was taken. This section will attempt to tie these systems viewpoints and analogs of reality specifically into the area of organization theory. It will attempt to look at organizations as systems and, from this perspective, see what insights have been gained and what conclusions have been drawn.

A point made in the Overview should be reiterated here. Ashby[40] has pointed out that all models of reality fall short of complete description. His argument is that since reality (or any part of it) possesses an infinite amount of information then any representation (i.e. model) of it must be finite and therefore incomplete. It must, by definition, "sin" by omission. This idea is not new. Whitehead,[41] in discussing Plato's Seventh Epistle, says:

> "The moral of his writings is that all points of view, reasonably coherent and in some sense with an application, have something to contribute to our understanding of the universe, and also involve omissions whereby they fail to include the totality of evident fact."

It is argued that an open systems view of organizations is a useful one for the design of the subject management information system.

Arrow[42] emphasizes the importance of organization as follows:

> "Among man's innovations the use of organization to accomplish his end is among both his greatest and his earliest....If we had no other evidence, we would know that complex organizations were necessary to the accomplishment of great construction tasks - planned cities like Nara or Kyoto, or monuments like Pyramids....For less material ends we know of organizations of the Inca empire of Peru where a complex and far-flung state was administered in a highly systematic manner with a technology so poor as to include neither writing nor the wheel."

Classical organization theory was fathered in the late nineteenth and early twentieth centuries by names like Max Weber and Frederick W. Taylor. It was conceived with a rather static view of the organization, although it allowed for growth. The important concepts of structure and specialization were formulated within this school.

Neoclassical organization theory involved the introduction of the behavioral sciences and attempted to integrate them into the classical framework.

Modern organization theory is the name given to the most recent branch. Scott[43] argues that modern organization theory and general systems theory are similar and have much to offer each other. The limitations of the classical and neoclassical models are obvious. For example, Rice[44] points out that for the most part they are based on closed systems. Katz and Kahn[45] say that such closed system thinking results in "surprises" from the environment.

It should not be thought, however, that the introduction of a general systems approach has been universally acclaimed. Littrell[46] doubts the usefulness of such theories. He attributes this to a tendency to overeagerness of explanation and a questionable sense of unity.

Perhaps an intermediate view is presented by Longenecker[47] who indicates that the systems viewpoint may be both a new and useful concept and a matter of semantics at the same time.

Scott[48] warns of the danger from poorly founded analogies and illustrates it by saying that superficial similarities between ant and human societies are not particularly instructive. Littrell[49] emphasizes that the ultimate test of any model is grounded in reality:

> "Theoretical models are never constructed in the sense that a scale model of an airplane might be constructed. Rather, they are described by one's language; they seek to construct secondary systems of thought by which original sets of facts may be examined.'

Blegen[50] counters Scott with the argument that the systems approach looks upon analogies as suggestive only. Studies of biological systems may in fact suggest questions to be asked of human organizations. As the "father" of general systems theory, Bertalanffy's writings are permeated with similar thoughts warning against the misuse of system concepts.

As an aside, Gross[51] illustrates the application of systems in a very generalized manner - so general, it would appear not very useful to the organizational theory researcher.

It is not the purpose of this chapter to attempt to review the definitions in the literature of organization or to outline criteria to determine if a group is organized to any given degree. This would call for a complete study in itself. On the contrary, systems theory says that a precise definition of organizational boundaries is less important, since it is in interactions (whether within or across boundaries) that we must seek understanding of the organization as a system. Ackoff,[52] who clearly has been influenced by systems thinking, suggests a general concept of organization.

Littrell,[53] though a doubter of systems theory, is clearly not incompatible with it when he says: "The structure of the organization in question is the pattern of interactions which persist." Katz and Kahn[54] speak of an organization in terms of an energic input-output system between the organization and its environment.

In summary, a quote from Rapoport and Horvath[55] seems appropriate:

> "In totality, then, we have today a variety of approaches to the study of organization (as an abstract principle) and a variety of approaches to the study of organizations (i.e., human aggregates with certain specified relations of interdependence among the members)....Occasionally, a connecting path will be discerned along which ideas can trickle from one stream to the other."

Interaction with the environment. The organization can be looked upon as a system. The classical organizational theorist effectively looked upon this system as closed. This terminology was, of course, not employed; but the critical variables under study were internal to the organization itself. The systems theorist has not denied the importance of variables internal to the organization but has simply pointed out their incompleteness. The organization is viewed as an open system and, therefore, by definition affected by its environment.

Reinermann[56] points out the sometimes overwhelming effect of the environment on an organization with a quote from sixty years ago during a meeting of the American Association of Horsedrawn Carriages in New York. The subject was the possible effect of the then new automobile on horsedrawn carriages.

> "Who forecasts a reduction in the number of cars is a fool. Who denies the advantages of a car and its many uses is even a greater fool. And who forecasts the complete disappearance of horse and carriage is the greatest of all fools."

Roberts[57] emphasizes this idea when he says:

> "The key to effective control often lies outside the boundaries of conventional operational control systems; in fact, it is sometimes outside the formal boundaries of the company organization."

What he is saying is that the environment of the organization must be taken into account. Cadwallader[58] presents the same idea more bluntly: "An open system, whether social or biological, in a changing environment either changes or perishes."

Rice[59] introduces the practical aspect of this idea when he points out that business success is largely determined by organizational ability to control the interactions across its boundaries. Katz and Kahn,[60] discussing when social systems are regarded as closed rather than open, say:

> "The major misconception is the failure to recognize fully that the organization is continually dependent upon inputs from the environment and that the inflow of materials and human energy is not a constant."

What is inherent in these ideas is that the organization does not have complete control of its own destiny. It is constrained by the environment, if it wishes to continue to thrive (or even to continue to exist). Thompson and McEwen[61] make this same point:

> "A continuing situation of necessary interaction between an organization and its environment introduces an element of environmental control into the organization."

Galbraith[62] suggests that the function of the "technostructure" is to maintain independence from external interference.

Thompson and McEwen[63] stress that this idea of independence of or control over the environment is not dichotomous, i.e. this control is really a gradation, and that few organizations approach either total control over or total control by the environment.

McWhinney,[64] in discussing Haire's[65] work, says that Haire drew analogies between organizations and bodily and growth patterns found in biology. He also drew a parallel between the relation between the surface area and the enclosed volume of a solid and measures of the surface and the interior of an organization. There has been evidence to the contrary, however. Levy and Donhow[66] and Draper and Strother[67] conclude that Haire is in error.

Thus, interaction between the organization and its environment is a fact of life. It is only the degrees of interaction and the specific subsystems within both the organization and the environment that is variable. But, is the organization the same after interaction? Does the environment remain unchanged? In general the question must be answered in the negative. Changes in both may and do occur.

Thompson[68] hints at this in the following in his use of the word "adjustment":

> "The crucial problem for boundary spanning units of an organization, therefore, is not coordination (of variables under control) but adjustment to constraints and contingencies not controlled by the organization."

Miller[69] makes a more general comment by pointing out that any exchange across a boundary results in alteration or change. But the interaction may result in even more significant changes than that of behavior alteration and adjustment. Inputs from the environment change and, according to Thompson,[70] "for a given organization, the nature of environmental constraints may change over time." Katz and Kahn[71] say:

> "The very efforts of the organization to maintain a constant external environment produce changes in organizational structure. The reaction to changed inputs to mute their possible revolutionary implications also results in changes."

and Morris[72] in discussing Chandler[73] argues that changing environments result in changing strategy which results in changes in organizational structure. March and Simon[74] say that specialization will be carried furthest in organizations with stable environments.

Changes within the organization, induced by interaction with the environment, will in turn induce additional changes within the organization. For example, Chapple[75] indicates that the cultural and structural patterns of the organization set up constraints on what interactions will take place. In turn, these changes may induce changes in the environment. Thus the organization receives feedback from the environment over many channels and the environment can also receive feedback (to a greater or lesser degree) from the organization.

Thompson[76] goes on to say:

> "When the range of task-environment variations is large or unpredictable, the responsible organization component must achieve the necessary adaptation by monitoring that environment and planning responses, and this calls for localized units."

He divides the organization into core and periphery units. The core will contain the technology upon which the organization's functioning depends. Under "norms of rationality" the organization seeks to seal off its core from the environment, i.e. to transform the core into a relatively closed system. The periphery, then, interacts with the environment and buffers the core.

McFeely[77] very concisely says in discussing the business form of organization:

"In a business environment in which dynamics, change, and results are trigger terms, organization becomes a strategy - rather than a structure - to accomplish goals. Managing change is the goal.... organization is a system of response."

Interaction between sub-units of an organization is also affected by the hierarchical structure. For example, locating sub-units that are closely related near to each other in the structure will reduce the interactions. Coordination between sub-units can also be reduced by the introduction of "decoupling" devices, e.g. the establishment of ranges or thresholds on interface variables, the deliberate maintenance of slack, buffers, etc.

This study has so far talked of the interactions between organization and environment and of the interactions within the organization resulting from environmental influences. Emery and Trist[78] say that this is inadequate. They would add to the above interactions within the environment. Various parts of the environment are related to other parts - changes in one part may eventually through a chain totally within the environment induce an interaction across the organizational boundary. These authors use the term "turbulent" to describe an environment in which continuous interaction under uncertainty is occurring between the organization and its environment while the organization is striving to maintain a steady state. Terreberry[79] says: "Turbulence is characterized by complexity as well as rapidity of change in causal interconnections in the environment." And Lynton[80] states: "The spontaneous response to a turbulent environment is to reduce the turbulence." Terreberry[81] goes on to say: "Organizational change is largely externally induced." And Ackoff[82] brings us full circle with his comment: "....a homeostatic system is one that retains its state in a changing environment by internal adjustments."

In summary, an organization is an open system - being acted upon and acting on its environment. These interactions are compounded by interactions internal to the organization and by others internal to the environment. The organization attempts to maintain a steady state and homeostatically adapts to incoming perturbations from the environment. This adaptation may result in structural change (possibly, including new specialization) within the organization. The organization, in turn, may seek to favorably modify the inputs from the environment either through buffering or by inducing changes in the environment itself.

Learning and higher functions. Blegen[83] discusses the idea that open systems may move toward increased order and organization. (This is, of course, impossible in closed systems.) He sketches this in terms of information theory:

> "Entropy as well as information may be defined in mathematical relations as the logarithm of the possible events or states of the system....entropy may be seen as a measure of disorder. Consequently, negative entropy may be seen as a measure of order or degree of organization. A quantitative measure of information may further be defined by the corresponding increase in negative entropy. (Information represents a negative contribution to entropy;

> that is, a new information brought into a system is increasing the negative entropy of the system.)
> There is here a parallel between information theory and the theory of open systems, since such systems can reach states of higher order and organization (show negative entropy)."

Ackoff[84] says:

> "....adaptiveness is the ability of a system to modify itself or its environment when either has changed to the system's disadvantage so as to regain at least some of its lost efficiency."

The system may change internally in pursuit of its goals, but there is a danger here. Thus, Katz and Kahn[85] warn:

> "Moves toward tighter integration and coordination are made to insure stability, when flexibility may be the most important requirement."

The system adapts to its environment but it can also, in a sense, adapt to its adaptations, i.e. it can learn. A system responds in some manner to a stimulus; with experience its response to that same stimulus changes. If the change results in a response that is "better" in some sense (e.g. optimizing or to use Simon's phrase, "satisficing" in its pursuit of some goal or goals), then it can be said that the system is learning. The goals sought may be static (classical homeostasis) or dynamic. Cadwallader[86] says: "....some classes of open systems adapt to a fluctuating environment through processes of learning and innovation," Terreberry[87] says: "System adaptability (e.g. organizational) is a function of ability to learn and to perform according to changing environmental contingencies" and Ackoff[88] points out: "To learn is to increase one's efficiency in the pursuit of a goal under unchanging conditions" (somewhat a more narrow definition than the other authors cited).

Deutsch,[89] who has specialized in the study of political organizations as systems, writes:

> "If different experiences are consistently fed into similar systems of communication and learning, the information stored in each such system, and then the system's output which that stored information helps to shape will become different."

Writing elsewhere Deutsch[90] also says: "Seen from the outside, learning may be called the acquisition of new repetitive patterns of behavior."

As Leighten[91] so brilliantly indicates: "To the blind, all things are sudden," so too Deutsch[92] explains that learning of new patterns of behavior and memory of old patterns are complementary:

> "An organization is autonomous insofar as it remembers and is thus guided by its past, provided that this information recalled from memory is confronted or balanced with incoming information from the present state of the outside world and from the organization's own position within it."

This chapter has talked about the pursuit of the system's goals. How do these goals arise? Thompson and McEwen[93] indicate that they grow out of the interaction between the organization and its environment. These same two authors[94] also point out that change either in the organization or in the environment may require change in the organization's goals.

Haberstroh[95] introduces a common practical aspect of this problem:

> "Meaningful decentralization is probably impossible without a resolution of the goals into non-conflicting, operative sub-goals so that these can be placed under independent control."

In other words, internal change in an organization, e.g. in structure, demands re-evaluation of goals.

Summary

This chapter has reviewed some of the basic concepts of systems theory and then has looked at these concepts as they have been applied to organization theory. Both systems theory and organization theory cover a broad spectrum of thought; the intersection of these two fields although narrower is still impressively, if not overwhelmingly, large. Hence, necessarily only a cursory view was possible.

The term "systems" is one that is used extensively in the literature. Unfortunately, it is not always rigorously defined. The use of the term "systems" to indicate that all relevant variables should be included in a model that is to be used to predict or to explain some phenomenon is almost a tautology. Although the objective investigator cannot quarrel with this philosophy and, indeed, the scientist has been attempting to use this approach since, at least, the seventeenth century, declaring this "systems" approach to be new is misleading, yet common.

The concept of open system is one that seems so descriptive of organizations that an investigator is almost forced to the conclusion that its non-use would result in only sterile results. Yet insights were, and are being, provided by its predecessor theories. Its "obviousness" is only a credit to its many successful applications.

Beyond open system the cybernetic concept of feedback is invaluable. For, as it has been shown in the literature reviewed, feedback occurs from the environment to the organization and from the organization to the environment. This feedback, which is a form of interaction, results, in part, in the organization's adaptive movements.

The organization strives homeostatically to achieve a steady state (as systems thoery would predict for any open system) by adjusting to both interactions from within itself and from the environment. Applying systems theory a little further, one could suggest that since the organization is an open system then it must also possess equifinality. There are, thus, different paths to the same goal. It cannot be concluded, however, that all such paths are equally efficient.

As the organization becomes more closed, entropy may increase (negative entropy or information decreases). This means that the most probable state will be approached. Its learning and adaptation to the environment will slow and it will become less oriented or less sensitive to its environment (or reality). This could be considered a case of organizational "sickness". The "healthy" organization finds a delicate balance between data in its memory and new information from the environment.

Thus, the systems model is a potentially rich one. It has been abused. Shallow comparisons or conclusions have been drawn. Its greatest supporters, though, have warned against these dangers. As a tool, systems theory has proven to be a very useful model. As with any model it is limited by definition.

The next chapter will view the nature of strategic intelligence. The meaning of strategy will be discussed. The necessity of reconciling information from the environment that is relevant to a strategic question with information from within the organization that is also relevant will be shown. This reconciliation results (perhaps iteratively) in a coherent or consistent conclusion or in the formulation of internally consistent alternatives.

References

1. Buckley, W., "Society as a Complex Adaptive System" in "Modern Systems Research," W. Buckley (ed.), Chicago: Aldine, 1968.

2. Simon, H.A., "The Architecture of Complexity," Proceedings of the American Philosophical Society, 1962, 106, p. 467-482.

3. Friedman, M., "Essays in Positive Economics," Chicago: University of Chicago, 1953.

4. Hall, A.D. and R.E. Fagen, "Definition of Systems," General Systems, 1956, I, p. 18.

5. Faires, V.M., "Elementary Thermodynamics," New York: MacMillan, 1957, p. 2.

6. Bertalanffy, L. von, "General System Theory," New York: George Braziller, 1968, p. 55-56.

7. Beer, S., "Decision and Control," London: Wiley, 1966, p. 241-242.

8. Bertalanffy, L. von, "The Theory of Open Systems in Physics and Biology," Science, 1950, 2872, p. 23.

9. Ackermann, R., "The Philosophy of Science," New York: Pegasus, 1970, p. 105.

10. Bertalanffy, L. von, "General Systems Theory," General Systems, 1956, I, p. 3.

11. Shannon, C.E. and W. Weaver, "The Mathematical Theory of Communication," Evansville, Ill.: University of Illinois, 1949.

12. Cannon, W.B., "Self Regulation of the Body," in "Modern Systems Research for the Behavioral Scientist," W. Buckley (ed.), Chicago: Aldine, 1968, p. 256 (originally published in Cannon, W.B., "The Wisdom of the Body," New York: Norton, 1939).

13. <u>Ibid</u>., p. 257.

14. <u>Ibid</u>., p. 258.

15. Hall, A.D., "A Methodology for Systems Engineering," Princeton, N.J.: Van Nostrand, 1962, p. 70.

16. _Ibid_., p. 70.

17. Rosenblueth, A., N. Wiener and N. Bigelow, "Behavior, Purpose, and Teleology," Philosophy of Science, 1943, 10, p. 18.

18. Rosenblueth, A. and N. Wiener, "Purposeful and Non-Purposeful Behavior," Philosophy of Science, 1950, 17, p. 326.

19. Emerson, A.E., "Homeostasis and Comparison of Systems" in "Toward a Unified Theory of Human Behavior," R.R. Grinker (ed.), New York: Basic Books, 1950, p. 149.

20. Whitehead, A.N., "Adventures of Ideas," New York: The Free Press, 1967, (originally published New York: MacMillan, 1933), p. 207.

21. Toynbee, A.J., "A Study of History," London: Oxford University, 1946.

22. Ackermann, R., _op_. _cit_., p. 64.

23. Faires, V.M., _op_. _cit_., p. 110.

24. Bertalanffy, L. von, "General Systems Theory - A Critical Review," General Systems, 1962, VII, p. 7.

25. Bertalanffy, L. von, "The Theory of Open Systems in Physics and Biology," Science, 1950, 2872, p. 26.

26. Bertalanffy, L. von, "General Systems Theory," General Systems, 1955, I, p. 3.

27. _Ibid_., p. 3.

28. Bertalanffy, L. von, "The Theory of Open Systems in Physics and Biology," Science, 1950, 2872, p. 26.

29. _Ibid_., p. 25.

30. Bertalanffy, L. von, "General Systems Theory - A Critical Review," General Systems, 1962, VII, p. 7.

31. Raisbeck, G., "Information Theory," Cambridge, Mass.: MIT, 1963, p. 2.

32. Ashby, W.R., "An Introduction to Cybernetics," London: Chapman and Hall, 1956, p. 124.

33. Boulding, K.E., "General System Theory - The Skeleton of a Science," Management Science, 1956, April, p. 197-208.

34. Litterer, J.A. (ed.), "Organizations," 2nd ed., New York: Wiley, 1969.

35. Hare, V.C. Jr., "Systems Analysis: A Diagnostic Approach," New York: Harcourt, Brace and World, 1967, p. 127-128.

36. Deutsch, K.W., "The Nerves of Government: Models of Political Communication and Control," New York: The Free Press, 1966, Chapter 5.

37. Simon, H.A., "The Architecture of Complexity" in "Organizations," J.A. Litterer (ed.), 2nd ed., New York: Wiley, 1969, p. 105.

38. Whyte, L.L., A.G. Wilson and D. Wilson, "Hierarchical Structures," New York: American Elsevier, 1969.

39. Whitehead, A.N., op. cit., p. 206.

40. Ashby, W.R., "Analysis of the System to be Modelled" in "The Process of Model Building in the Behavioral Sciences," R.M. Stogdill (ed.), Columbus: Ohio State University, 1963.

41. Whitehead, A.N., op. cit., p. 52.

42. Arrow, K.J., "Control in Large Organizations," Management Science, 1964, 10, p. 397-398.

43. Scott, W.G., "Organization Theory: An Overview and an Appraisal" in "Organizations," J.A. Litterer (ed.), 2nd ed., New York: Wiley, 1969, p. 23.

44. Rice, A.K., "The Enterprise and Its Environment," London: Tavistock, 1963, p. 183.

45. Katz, D. and R.L. Kahn, "The Social Psychology of Organizations," New York: Wiley, 1966, p. 27.

46. Littrell, W.B., "Complex Organizations: Models and Reality," Rocky Mountain Social Science Journal, 1969, October, p. 160.

47. Longenecker, J.G., "Systems: Semantics and Significance," Advanced Management Journal, 1970, April, p. 63.

48. Scott, W.G., op. cit., p. 23.

49. Littrell, W.B., op. cit., p. 156.

50. Blegen, H.M., "The System Approach to the Study of Organizations," Acta Sociologica, 1968, 11, p. 14.

51. Gross, B.M., "What Are Your Organization's Objectives? A General Systems Approach to Planning," Human Relations, 1965, 3, p. 196.

52. Ackoff, R.L., "Systems, Organizations, and Interdisciplinary Research," General Systems, 1960, 5, p. 2.

53. Littrell, W.B., op. cit., p. 160.

54. Katz, D. and R.L. Kahn, op. cit., p. 16.

55. Rapoport, A. and W.J. Horwath, "Thoughts on Organization Theory and a Review of Two Conferences," General Systems, 1959, IV, p. 91.

56. Reinermann, H., "Business Systems and Biological Systems - A Contribution to Interdisciplinary Systems Analysis and to Organizational Research," Kommunikation, 1970, 2, p. 85.

57. Roberts, E.B., "Industrial Dynamics and the Design of Management Control Systems" in "Organizations," J.A. Litterer (ed.), 2nd ed., New York: Wiley, 1969, p. 302.

58. Cadwallader, M.L., "The Cybernetic Analysis of Change in Complex Social Organizations" in "Organizations," J.A. Litterer (ed.), 2nd ed., New York: Wiley, 1969, p. 305.

59. Rice, A.K., "The Enterprise and Its Environment," London: Tavistock, 1963, p. 183.

60. Katz, D. and R.L. Kahn, op. cit., p. 26.

61. Thompson, J.D. and W.J. McEwen, "Organizational Goals and Environment" in "Complex Organizations: A Sociological Reader," A. Etzione (ed.), New York: Holt, 1961, p. 179.

62. Galbraith, J.K., "The New Industrial State," Boston: Houghton-Mifflin, 1967.

63. Thompson, J.D. and W.J. McEwen, op. cit., p. 180.

64. McWhinney, W.H., "On the Geometry of Organizations," Administrative Science Quarterly, 1965, December, p. 348.

65. Haire, M. (ed.), "Modern Organization Theory," New York: Wiley, 1959.

66. Levy, S. and G. Donhowe, "Explorations of a Biological Model of Industrial Organization," Journal of Business, 1963, October, p. 335-342.

67. Draper, J. and G. Strother, "Testing a Model of Organizational Growth," Human Organization, 1963, 22, p. 180-194.

68. Thompson, J.D., "Organizations in Action," New York: McGraw-Hill, 1967, p. 66.

69. Miller, J.G., "Toward a General Theory for the Behavioral Sciences," American Psychologist, 1955, 10, p. 514.

70. Thompson, J.D. op. cit., p. 67.

71. Katz, D. and R.L. Kahn, op. cit., p. 26.

72. Morris, W.T., "Decentralization in Management Systems," Columbus: Ohio State University, 1968, p. 12.

73. Chandler, A.D. Jr., "Strategy and Structure: Chapters in the History of the Industrial Enterprise," Cambridge, Mass.: MIT, 1963.

74. March, J.G. and H.A. Simon, "Organizations," New York: Wiley, 1958, p. 159.

75. Chapple, E.D., "Quantitative Analysis of Complex Organizational Systems," Human Organizations, 1962, 21, p. 69.

76. Thompson, J.D., op. cit., p. 72.

77. McFeely, W.M., "Organization as a System of Response," Conference Board Recrod, 1970, April, p. 44.

78. Emery, F.E. and E.L. Trist, "The Causal Texture of Organizational Environments," Human Relations, 1965, 18, p. 22.

79. Terreberry, S., "The Evolution of Organizational Environments," Administrative Science Quarterly, 1968, March, p. 593.

80. Lynton, R.P., "Linking an Innovative Subsystem into the System," Administrative Science Quarterly, 1969, September, p. 399.

81. Terreberry, S., op. cit., p. 610.

82. Ackoff, R.L., "Towards a System of Systems Concepts," Management Science, 1971, 17, p. 664.

83. Blegen, H.M., op. cit., p. 17.

84. Ackoff, R.L., op. cit., p. 668.

85. Katz, D. and R.L. Kahn, op. cit., p. 26.

86. Cadwallader, M.L., op. cit., p. 305.

87. Terreberry, S., op. cit., p. 611-612.

88. Ackoff, R.L., op. cit., p. 669.

89. Deutsch, K.W., "Nationalism and Social Communication," New York: Wiley, 1953, p. 94.

90. Deutsch, K.W., "Innovation, Entrepreneurship, and the Learning Process" in "Change and the Entrepreneur: Postulates and Patterns for Entrepreneurial History," A.H. Cole (ed.), Cambridge, Mass.: Harvard University, 1949, p. 27.

91. Leighton, A.H., "The Governing of Men: General Principles and Recommendations Based on Experience at a Japanese Relocation Camp," Princeton, N.J.: Princeton University, 1946, p. 258.

92. Deutsch, K.W., "On Communication Models in the Social Sciences," Public Opinion Quarterly, 1952, 16, p. 369.

93. Thompson, J.D. and W.J. McEwen, op. cit., p. 186.

94. Ibid., p. 177.

95. Haberstroh, C.J., "Control as an Organizational Process," Management Science, 1960, January, p. 170.

CHAPTER III

ORGANIZATIONAL STRATEGIC INTELLIGENCE

Overview

In the last chapter the organization was viewed as being in constant interaction with its environment, both acting upon and being acted upon by it. The degree of "openness" of the organization as system was a measure of the degree of filtering of inputs from the environment. Because of time and energy constraints all organizations must filter in order to avoid an overload condition. At the other extreme over-filtering results in over-rigidity. The organization attempts to homeostatically adapt to its environment. It must balance itself between rigidity and overload. Additionally, the successful adaptation involves an adjustment not only to its external environment but involves the obtaining of a dynamic balance between the inputs originating internal and to those originating external to the organization.

This chapter will attempt to focus down on a narrower area of interest from the relatively broad one presented in the last chapter. It will be concerned with a specific subset of the organizational adaptive process.

Intelligence is looked at as a process of gaining knowledge useful to the organization in the light of a particular objective. This knowledge may be a more or less certain reflection of the "current" situation facing the organization or it may be a basis for a plan or for a forecast oriented towards the future.

Data may be viewed as originating from within the organization or from within the environment. Data are the elemental units of intelligence. Information is viewed as data within a context or evaluated within a model. Intelligence is looked at as the obtaining of the best interpretation or interpretations of the information from all sources utilized.

Although an introduction to organizational intelligence will be provided the main emphasis and concern will be with only that form of intelligence that can be termed strategic. Failures in organizational intelligence are not uncommon and, therefore, a look at some of the sources of such failures will also be presented.

In the sixteenth century Machiavelli[1] wrote:

> "....fortune is the ruler of half our actions, but....she allows the other half or thereabouts to be governed by us....So it is with fortune, which shows her power where no measures have been taken to resist her, and directs her fury where she knows that no dykes or barriers have been made to hold her."

This observation is a concise and still valid statement of the need for effective intelligence on the part of the modern organization.

Organizational Intelligence

As a concept intelligence has had a long history. Indeed, it is probable that from the earliest times of the species man as a group has been vitally concerned with the relationship of the group to its environment. Successful adaptation was necessary to evade enemies and predators and to find the animal game necessary for food and clothing. The context, though, in which the term intelligence has been traditionally used has been in the political and military spheres of human endeavor. Ransom,[2] for example, says:

> "The need for knowledge of the external environment for planning and decision has been recognized since the beginnings of explicit political systems; indeed, it has always been a condition of rational political survival."

An early example of the quest for intelligence of a political-military nature is provided in the Old Testament. The Book of Numbers records Moses as seeking this type of intelligence upon arriving in the area of Canaan. He instructs a reconnaissance party as follows:

> "Go up here in the Negeb, up into the highlands, and see what kind of land it is. Are the people living there strong or weak, few or many? Is the country in which they live good or bad? Are the towns in which they dwell open or fortified? Is the soil fertile or barren, wooded or clear?"[3]

Aguilar,[4] speaking in a modern business context, explains:

> "Top management can no longer simple cope with conditions. The art of learning and the attitudes of adaptiveness and flexibility have assumed major importance for top management."

Thus, although not new as a concept, intelligence has expanded. It is now considered as an approach necessary for organizational survival, in many cases. In other words, organizations of all kinds, operating in an environment that is increasingly complex and, as Toffler[5] would suggest, undergoing change at an increasing rate, must take a more organized and scientific approach to intelligence.

What is intelligence? Intelligence has been defined as "the information - questions, insights, hypotheses, evidence - relevant to policy."[6] In the 1950s the Hoover Commission[7] indicated: "Intelligence deals with all the things which should be known in advance of initiating a course of action." Wilensky[8] writes: "To gather, process, interpret and communicate the technical and political information needed in decision making is to fulfill the intelligence function." It is that information that the organization needs to successfully adapt to its environment.

At this point, a clarification of the relationship existing between data, information and intelligence is appropriate. Figure 3-1 illustrates graphically a simple intelligence model.

Data or "facts" are meaningless outside of a model or of a context. A fallacious argument that has been presented many times in the management information systems (MIS) and in the intelligence literature is that "facts" speak for themselves. The implication of this thinking is that larger

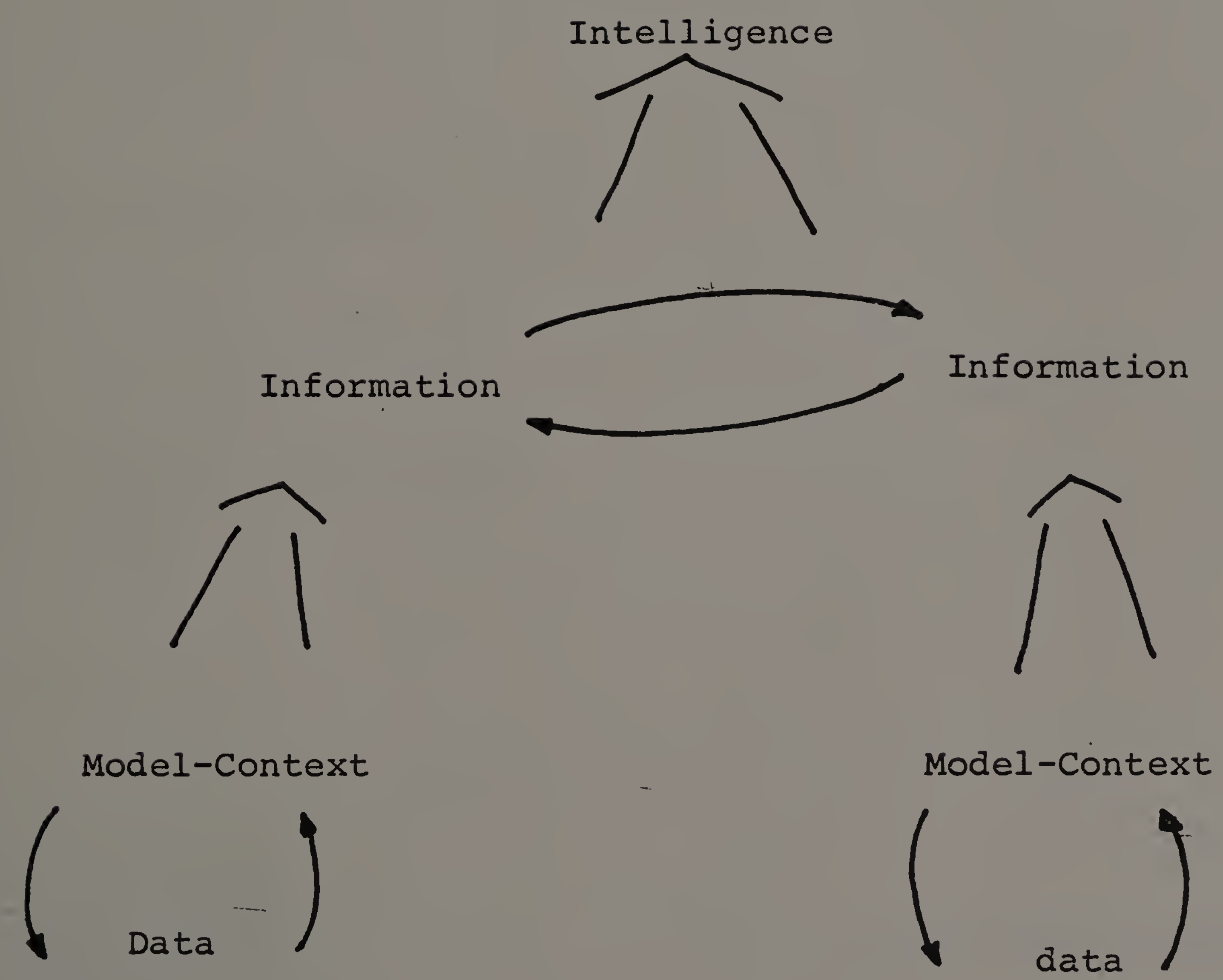

Figure 3-1 - Simple Intelligence Model

and larger data bases are the answer to MIS problems and that more collected data is the answer to organizational intelligence problems.

A point made in Chapter II is relevant here. A model is a finite representation of a physical reality, which possesses an infinite amount of data. There is always a necessity to abstract a finite (and manageable) number of variables from this infinite collection. Braybrooke and Lindblom[9] say this is another way: "....our minds determine what is relevant and irrelevant, by imposing a structure upon the problem situation." Martin and Norman[10] express the same idea: "Information has to be organized into patterns relevant to its ultimate use." Hellmer[11] says: "Except in rare instances, the facts do not 'speak for themselves.' They must be correlated in such a manner as to provide the basis for valid inferences."

Thus, 'facts' or data do not contain an obvious correct "answer". The facts do not implicitly contain only one inference or interpretation. The information-seeker must nevertheless use some method of selecting the data to be studied. "It is....theories,....hypotheses, expectations, propositions, generalizations or assumptions that help a problem-solver select from the mass of facts surrounding him those that he hopes are relevant."[12]

Information obtained from facts in one context may not be relevant within another context. The source of information "known" must be closely examined before it can be accepted. This requires that data must be re-examined within a new context if it is to be used a second time.

The information-seeker uses, at least, an implicit model to collect data. These data then serve as a guide in the selection of additional data. But, at the same time, these data may modify the model. Thus, there is a feedback between data and model and between model and data. The result is information. As shown in Chapter II information is that which reduces uncertainty, i.e. reduces the number of decision alternatives. It is the inference drawn from that data collected from within the context of the information-seeker's model.

Intelligence is the collation and reconciliation, if necessary, of a collection of information-carrying inferences. It is the summation and the result of the information gathering efforts described above. The intelligence process may be conceived of as encompassing the efforts ranging from the collection of data within the context of the original models through the final intelligence statement.

The term intelligence has during recent years accrued a number of connotations. In a popular vein it brings to mind thoughts of espionage, spying and the use of unethical or illegal acts against the property or information possessed by another. As used within this dissertation the word possesses none of these implications. Intelligence is limited only to that meaning presented in this chapter.

In the creation of a model, the abstraction of a finite number of variables always requires a judgement as to which variables are relevant for the model-builder's purposes. There are a wide range of situations in which a unique model does not exist. It may not exist for a number of reasons: there may not exist sufficient data to formulate such a model, the number of relevant variables required for a useful model may be too great, the model-builders may not agree on a model, etc. Intelligence can be described in just this manner.

Kent,[13] writing in a political-governmental context, would argue that intelligence is always for the practical purpose of making decisions and taking action; and, therefore, the intelligence function must mesh closely with and be an integral part of policy. Hilsman[14] supports this point of view as follows:

> "The agrument here is that the job of sifting, evaluating and giving weight to information cannot be meaningfully done except in the process of analyzing a problem."

The same argument can be made with respect to organizational strategic intelligence in general.

A policy maker is someone who, once convinced about the desireability of an action, can and will effect the committment of an organization to this action. The desireability of an action is influenced by the effects of this action on its "clients". These clients may be organizational members or be external to the organization. The successful implementation of an action may require the approval of or, at least, the acceptance of some (or, in some cases, all) of its clients. The clients may, however, possess differing models of the relevant environment - the models suggesting different and, even, conflicting actions.

Thus, the ultimate decision maker, i.e. the policy maker, is faced with a paradox. In order to make a good (in some sense) decision he must gather inputs from many sources but these sources may be in conflict with respect to their models of reality. It is here in his (i.e. the policy maker's) attempt to balance these conflicting and centrifugal forces that the policy maker faces an increased probability of intelligence system pathologies.

Wilensky[15] says that "the chronic condition is a surfeit of information, useless, poorly integrated, or lost somewhere in the system." Facts per se do not provide the basis for the "best" decision. In line with Ashby's[16] thinking an infinity of facts is available to describe any given aspect of reality. The facts speak only when they are placed in context, i.e. superimposed with a model of reality. Thus, differing models of reality allow the facts to speak differently.

For the purposes of this study intelligence may be oriented towards the present or towards the future.[17] It is clear that intelligence concerning the present will have a strong impact on intelligence concerning the future. The present is the jumping-off point for explorations of the future. These two viewpoints are analagous to Kent's[18] "current reportorial" and "speculative-evaluative" types respectively. Future-oriented intelligence may involve forecasting or planning or both.

Strategic intelligence. The work "strategy" extends back to ancient Greece. It is derived from the ancient Greek word "strategos" which was the word for a general. Strategy, thus, was the art of a general. Steiner[19] explains that a generalization of the word occurred in the late eighteenth century:

> "Before Napoleon's time strategy referred to the art and science of directing military forces to defeat an enemy or to mitigate the results of defeat. In Napoleon's day, strategy was extended to include political and economic moves to improve the chances for military victory."

In a present day organizational context Aguilar[20] says:

> "....strategic information is information useful for making decisions about strategy and long-range plans. External strategic information....is strategic information about events or relationships in the firm's outside environment."

and Anthony[21] describes the first of his three classes of planning and control systems as follows:

> "Strategic planning is the process of deciding on objectives of the organization, on changes in these objectives, on the resources used to attain these objectives, and on the policies that are to govern the acquisition, use, and disposition of these resources."

Mottley[22] says that planning is concerned with future situations, needs and capabilities and that strategic forecasting is concerned with anticipating future needs. Mason[23] summarizes by saying that planning is concerned with the future and attempts to select a preferred future from two or more options. Of course, one of the alternatives facing the strategic planner in Mason's summary may be that of doing nothing.

Implicit in strategic intelligence is uncertainty, i.e. it involves decision making in a probabilistic environment. It is generally ill-structured and the variables that are most relevant are difficult not only to quantify but even to operationalize.

Strategic intelligence, at its most sophisticated, may be concerned with organizational goal changing or modification. Within this context it falls within the realm of the most complex systems level, e.g. Hare[24] and Deutsch's[25] "goal changing system". As goal changing has reverberating implications within the lower system hierarchical levels,[26] so too strategic intelligence has implications outside the strategic area. For example, Anthony's[27] taxonomy includes strategic planning, management control, and operational planning. These types are categorized on a dimension ranging from almost pure planning to almost pure control. A change in strategic planning will have effects on management control and operational planning. Similarly, in a military context, strategy influences tactics which in turn influences operations.

Although implicit in the above, it should be made explicit at this point that strategic intelligence subsumes planning and forecasting. Most of the literature discusses either planning or forecasting. The distinction, seldom made clear, is one only of emphasis. Forecasting per se regards the future in a passive sense, i.e. it attempts to "predict" the values of some relevant variable or variables at some time in the future. Planning per se regards the future in a more active manner, i.e. it attempts to "affect" the value of some variable or variables at some time in the future. Each interacts with the other. For example, it is frequently the purpose of a plan to affect a forecast. A forecast, in turn, may be either self-fulfilling or self-defeating.

Drucker[28] points out that planning involves deliberately accepting new risk but that this risk is less in the long run than the risk associated with accepting future surprises.

It should be noted that the near future will tend, in general, to be more fixed, i.e. more difficult to change. Yet, it is the near future that is seen clearest. The more distant future is capable of the most change but, at the same time, is seen with the greatest uncertainty.

But strategic intelligence, as shown above, is not only future-oriented - it is also present-oriented. The distinction, though clear in theory, is less clear in practice.

Today influences tomorrow. To use a statistical analogy strategic intelligence is saturated by autocorrelation. Thus future-oriented strategic intelligence must use as a base strategic intelligence concerning the relevant present. Similarly it is the future unknown that helps to create the models on which data of the present must be collected and formed into information.

Anthony[29] says that most companies do not successfully foresee changes in their environment but only react after these changes have already occurred. Ackoff[39] emphasizes this point with:

> "Those who benefit most from the future are those who have helped create it. One may be able to survive and even prosper without making the future but one cannot pull away from the pack without doing so."

In essence this is the function of strategic intelligence.

Hierarchical nature of intelligence. In this section the term hierarchical will be construed, not in a systems capability sense but, in a structural sense. Traditionally those activities requiring a hierarchical approach such as planning have assumed a hierarchy isomophic to the organizational structure. In intelligence in general and in strategic intelligence in particular this isomorphism is not the only possible basis.

It appears that hierarchy is ubiquitous both in nature and in human endeavor. Simon,[31] for example, says that "hierarchical subdivision is common to virtually all complex systems of which we have knowledge." Hormann[32] argues that planning is hierarchical by nature because (1) plans evolve from the general to the concrete and (2) the necessity of subdividing the task.

If strategic intelligence is concerned with application then it is clear that there must be a movement from the general to the more particular and, therefore, the more applicable. A complex task, i.e. one that contains many aspects, may overwhelm the intelligence seeker. The phenomenon of information overload is well known. (For example, Kahn and Wolfe.)[33] "Hierarchy is the adaptive form for finite intelligence to assume in the face of complexity."[34]

Thus, in order to cope with an environment that contains an infinite amount of data, a filtering process based on an, at least implicit, model is utilized. Additionally condensation or the forming of data into patterns occurs. Intelligence may be viewed as a search for order amongst a data filled disorder.

> "The value of decomposing a complex problem by subdividing it into a number of parts, each of which can be attacked by a smaller search (or divided still further), should not be underestimated."[35]

Specialization appears to be a natural approach to the problem of complexity.

With specialization, however, arises the problem of coordination and integration. A hierarchical organization of the intelligence effort is an effective approach. More than effectiveness, hierarchy may also represent efficiency. Hierarchy is the path of nature in the face of complexity. Simon,[36] for example, writes:

> "The effect of the existence of stable intermediate forms exercises a powerful effect on the evolution of complex forms....A little reflection reveals that cues signaling progress play the same role in the problem-solving process that stable intermediate forms play in the biological evolutionary process."

Intelligence Pathology

The sources of intelligence failure are many and varied. Data is collected within the context of a model. As stated above "facts" do not speak of themselves. The questions asked are thus of critical importance. In answer to the wrong questions interesting but irrelevant data at best will be collected. At worst the inferences drawn from this data will be counter-productive for the purposes of the investigation.

"No decisions would ever be made if we did not limit the number of uncertain factors to be taken into consideration."[37] Yet, as Taviss[38] says: "There is a suspicion that those elements of a decision which cannot be readily quantified will not be given due attention." Management science techniques may give an illusion of rigor and comprehensiveness. Those factors which cannot be conveniently fitted into such a model may be "assumed" away; but, frequently, it is the non-quantifiable or the intangible that spells the difference between success and failure. It is in these areas and in the areas of complex "pattern recognition" that human experience and expertise becomes crucial.

Deutsch[39] says in discussing human organizations:

> "Autonomy is impossible without openness to communication from the outside world; but at the same time autonomy is impossible unless the incoming flow of external information is overriden to a significant extent by internal memories and preferences."

He goes on to caution against the organizational tendency to over-discount the future and "to imprison themselves in an invisible rut of their own making."[40] DeJouvenel[41] emphasizes this latter point:

> "....we think certain aspects of the future are known, because we rely on 'dikes' built to contain its uncertainty. But the more we trust these 'dikes', the less they provoke our curiosity. And when people speak about knowledge of the future they are not usually concerned with the aspects they believe to be trustworthy: what they would like to guess is the novelty ahead."

Both of these tendencies are pathological reflections of the normal and generally wise heavier weighting of the immediate future over the distant future and of the tried and true channels of information both from within and without the organization. "Francis Bacon's warning that man converts his words into idols that darken his understanding is as pertinent today as it was three centuries ago....facts, arguments, and propaganda directed at friends and enemies alike in and out of an organization can be self convincing."[42] Information that does not fit the expectations of the receiver may be filtered out or distorted. It is human to cling to the familiar.

It is not only over-confidence in the familiar that leads to intelligence failure. He who has made an intellectual committment to an idea will frequently reject that which refutes it. Wilensky[43] states that:

> "....men use a variety of ingenious defenses to protect cherished convictions under the onslaught of devastating attack....In fact, when confronted with undeniable disconfirmation men do not merely defend their convictions; under some conditions - when their belief is strong, when they have committed themselves with some important act which is difficult to disavow, and when they have social support in their denial of reality - they do so with reborn fervor, seeking new converts."

Palz[44] and Festinger and Aronson[45] provide examples of research in this area.

The manner of organizing an intelligence inquiry influences the questions asked, the data collected, and the inferences drawn. In an attempt to formulate strategic intelligence under conditions of complexity[46] no one approach will prove to be optimum. Hilsman[47] describes the difficulty of reconciling geographical and functional lines of organization within an intelligence organization.

"Intelligence failures are rooted in structural problems that cannot be fully solved; they express universal dilemmas of organizational life that can be resolved in various ways at varying costs."[48] Wilensky, then, goes on to attribute most such failures to sources of distortion inherent in hierarchy, specialization and centralization.

> "Insofar as the problem of organizational control is solved by rewards of status, power, and promotion ....hierarchy is conducive to concealment and misrepresentation."[49]
> "The main cost of specialization in intelligence is parochialism, or the production of misleading or irrelevant information."[50]
> "Centralized intelligence....keeps the collection of data too far from their true use in policy; it encourages agreed-on estimates that may conceal strong disagreement and that in any case do not reveal the weights of diverse opinions....and it completes with its own subsidiaries for scarce personnel and documentation facilities....(and) the acquisition of unnecessary responsibility."[51]

These "modes of failure present every self-governing organization....with a serious danger of self-induced stagnation or of partial or total self-destruction."[52]

Summary

This chapter has reviewed the field of organizational intelligence. It has attempted to view intelligence in the light of a fairly simple model. In this model data interacts with model and vice versa. Out of this interaction information arises. Intelligence is the reconciliation of various pieces of information into a coherent whole.

Intelligence is always purposeful, i.e. it must be judged in terms of some organizational question or questions. Thus, theoretically it is not a continuous process. It is an intermittent function that is triggered only in response to a specific organizational objective. Of course, in practice more than one intelligence effort may exist at the same time or several may overlap in time. As one effort is completed another may begin.

Strategic intelligence is that form of intelligence concerned with the long range, with the more distant future, with the very goals of the organization, or with questions involving all or significant functions of the organization in a major way. The very survival of the organization may be affected by the meaningfulness of its strategic intelligence effort.

By its very nature, intelligence, and especially that type termed strategic, is subject to failure. The roots of failure may be in the nature of the effort, i.e. by definition strategic intelligence deals in areas of significant uncertainty, in human nature, or in a pathological condition of the organization itself. It does not appear possible to eliminate all sources of failure; but, it is important to recognize what possible sources exist and to employ those methodologies and techniques which will minimize or, at least, control to the extent possible the deleterious effects of these sources.

The next chapter will review the Delphi technique and will demonstrate its implications for strategic intelligence. The technique was developed and has been utilized in situations that can be described by characteristics also contained in strategic intelligence. It will be argued that the Delphi technique possesses a clear potential for application to an organizational strategic intelligence system.

References

1. Machiavelli, N., "The Prince," (trans. by L. Ricci), New York: Mentor, 1952, p. 120.

2. Ransom, H.H., "Intelligence, Political and Military," International Encyclopedia of the Social Sciences, Vol. 7, New York: Macmillan and The Free Press, 1968, p. 415-416.

3. "The Holy Bible," Book of Numbers, Chapt. 13, Vol. 1, Paterson, N.J.: St. Anthony Guild Press, p. 343-344.

4. Aguilar, F.J., "Scanning the Business Environment," New York: Macmillan, 1967, p. 12.

5. Toffler, A., "Future Shock," New York: Random House, 1970.

6. Wilensky, H.L., "Organizational Intelligence," New York: Basic Books, 1967, p. viii.

7. Commission on Organization of the Executive Branch of the Government, Hon. Herbert Hoover (chrmn.), "Intelligence Activities," Report to Congress, June 1955, p. 26.

8. Wilensky, H.L., "Organizations: Organizational Intelligence," International Encyclopedia of the Social Sciences, Vol. 11, New York: Macmillan and The Free Press, 1968, p. 319.

9. Braybrooke, D. and C.E. Lindblom, "A Strategy of Decision," New York: The Free Press, 1970, p. 43.

10. Martin, J. and A.R.D. Norman, "The Computerized Society," Englewood Cliffs, N.J.: Prentice-Hall, 1970, p. 506.

11. Hellmer, M.H., "Evidence and Inference in Foreign Intelligence," in "Information System Science and Technology," D.E. Walker (ed.), Washington, D.C.: Thompson, 1967, p. 295.

12. Hilsman, R., "Strategic Intelligence and National Decision," Glencoe, Ill.: The Free Press, 1956, p. 72.

13. Kent, S., "Strategic Intelligence for American World Policy," Princeton, N.J.: Princeton University Press, 1949.

14. Hilsman, R., op. cit., p. 177.

15. Wilensky, H.L., "Organizational Intelligence," p. vii.

16. Ashby, W.R., "Analysis of the System to be Modelled" in "The Process of Model Building in the Behavioral Sciences," R.M. Stogdill (ed.), Columbus: Ohio State University, 1962.

17. An orientation towards the past more properly falls into the area of historical research.

18. Kent, S., op. cit., p. 8.

19. Steiner, G.A., "Top Management Planning," London: Macmillan, 1969, p. 237.

20. Aguilar, F.J., op. cit., p. 5-6.

21. Anthony, R.N., "Planning and Control Systems: A Framework for Analysis," Boston: Harvard Business School, 1965, p. 16.

22. Mottley, C.M., "The Application of Strategic Forecasting to the Coal Industry," in "Technological Forecasting for Industry and Government," J.R. Bright (ed.), Englewood Cliffs, N.J.: Prentice-Hall, 1968, p. 375.

23. Mason, R.O., "A Dialectical Approach to Strategic Planning," Management Science, 15, No. 8, 1969, p. B403.

24. Hare, V.C. Jr., "Systems Analysis: A Diagnostic Approach," New York: Harcourt, Brace and World, 1967.

25. Deutsch, K.W., "The Nerves of Government: Models of Political Communication and Control," New York: The Free Press, 1966.

26. Systems levels here refer to capability levels rather than structural levels.

27. Anthony, R.N., op. cit., p. 21.

28. Drucker, P.F., "The Big Power of Little Ideas," Harvard Business Review, 42, May, 1964, p. 6-19, 180-182.

29. Anthony, R.N., op. cit., p. 38-39.

30. Ackoff, R.L., "A Concept of Corporate Planning," New York: Wiley-Interscience, 1969, p. 56.

31. Simon, H.A., "Management and Decision Making" in "The Computer Impact," I. Taviss (ed.), Englewood Cliffs, N.J.: Prentice-Hall, 1970, p. 63.

32. Hormann, A.N., "Planning for Man-Machine Synergism" in "On-Line Planning: Towards Creative Problem-Solving," H. Sackman and R.L. Citrenbaum (eds.), Englewood Cliffs, N.J.: Prentice-Hall, 1972, p. 91-92.

33. Kahn, R.L. and D.M. Wolfe, "Role Conflict in an Organization" in "Power and Conflict in Organizations," R.L. Kahn and E. Boulding (eds.), New York: Basic Books, 1964, p. 115-126.

34. Simon, H.A., _op_. _cit_., p. 65.

35. Citrenbaum, R.L., "Planning and Artificial Intelligence" in "On-Line Planning: Towards Creative Problem-Solving," H. Sackman and R.L. Citrenbaum (eds.), Englewood Cliffs, N.J.: Prentice-Hall, 1972, p. 148.

36. Simon, H.A., "The Sciences of the Artificial," Cambridge, Mass.: MIT Press, 1969, p. 95-96.

37. DeJouvenel, B., "The Art of Conjecture," New York: Basic Books, 1967, p. 35.

38. Taviss, I., "The Computer Impact," Englewood Cliffs, N.J.: Prentice-Hall, 1970, p. 14.

39. Deutsch, K.W., _op_. _cit_., p. 219.

40. _Ibid_., p. 224.

41. DeJouvenel, B., _op_. _cit_., p. 47.

42. Wilensky, H.L., "Organizational Intelligence," p. 22-23.

43. _Ibid_., p. 78-79.

44. Pelz, E.B., "Some Factors in Group Decision" in "Basic Studies in Social Psychology," H. Proshansky and B. Seidenberg (eds.), New York: Holt, Rinehart and Winston, 1965, p. 437-444.

45. Festinger, L. and E. Aronson, "Arousal and Reduction of Dissonance in Social Contexts" in "Group Dynamics," D. Cartwright and A. Zander (eds.), New York: Harper and Row, 1968, p. 125-136.

46. It is almost redundant to refer to strategic intelligence and conditions of complexity - at least, in any realistic framework.

47. Hilsman, R., _op. cit._

48. Wilensky, H.L., "Organizations: Organizational Intelligence," p. 323.

49. _Ibid._, p. 323.

50. _Ibid._, p. 325.

51. _Ibid._, p, 325.

52. Deutsch, K.W., _op. cit._, p. 228.

CHAPTER IV

THE DELPHI TECHNIQUE

Overview

In the last chapter organizational intelligence was looked at in the light of a simple intelligence model. Intelligence was viewed as a function of the organization concerned with its adaptation to the environment. In order to efficiently adapt, the organization (1) had to recognize its current position within its environment, i.e. it had to be oriented towards the present and (2) had to anticipate its relationship to the environment, i.e. it had to be oriented towards the future.

Organizational strategic intelligence is that form of intelligence concerned with the most critical and most general relations of the organization with its environment. As such it operates in an atmosphere of uncertainty and is concerned with variables that tend to be more qualitative than quantitative. If this were all, then current decision theoretic approaches to the problem would be applicable. The problem is, however, compounded. These traditional approaches imply a unique model. In organizational strategic intelligence differing models may result in differing and even contradictory conclusions. Yet, the prime function of organizational intelligence is to provide the policy maker with "the most deeply and objectively based and carefully considered estimate"[1] or estimates.

In this chapter an introduction to the Delphi[2] technique will be provided. The technique is a means of obtaining a collective judgement on a particular question or questions through feedback. It will be argued that the Delphi technique can be used as the basic building block of a strategic intelligence management information system (MIS). As a tool for the policy maker such an MIS should provide a statement of the alternatives (possibly only one) deemed most reasonable by the strategic intelligence process. These alternatives will have been defined only after a most rigorous analysis.

Description of the Technique

The Delphi technique, formally identified as such, is of relatively recent origin. It was developed within the Rand Corporation. Quade[3] reports that its earliest use was in an experiment to predict horse race outcomes in 1948. The first documented application of the Delphi technique to prediction of future events was reported by Kaplan et al.[4] The study found that predictions made by a group were more likely to be correct than predictions made by the same individuals alone. Dalkey and Helmer[5] applied the technique to a study involving estimates of nuclear attack results. A conclusion of this study was that individual estimates showed a tendency to converge as the experiment continued.

Of course, a goal of this particular experiment was to obtain a consensus of a group of experts.

Gordon and Helmer[6] reported on the first attempt to forecast technological achievements through the application of Delphi in 1964. Helmer and Quade[7] used gaming techniques in conjunction with Delphi methodology to study a developing economy.

In 1966 Helmer[8] described a fairly extensive exercise run in a university setting and oriented towards the future. The exercise was in the form of a simulation. Helmer[9] also in the same year reported on a pilot study involving an application of the Delphi technique to the educational field.

Business Week[10] reported in 1970 a developing interest in Delphi by various corporations. The best known study reported on in this article was that conducted by the McDonnell Douglas Corporation to forecast the future of commercial air transportation. In fact, the technique is being applied in an ever increasing number of areas. Turoff[11] provides a fairly comprehensive bibliography which includes reports on a broad range of applications.

In the same article Turoff[12] defines the technique as "a method for the systematic solicitation and collation of informed judgements on a particular topic." Helmer[13] says that Delphi "attempts to make effective use of informed intuitive judgement." The technique is a method of controlled feedback. Jantsch[14] in describing Delphi says that:

> "....it can be regarded as a succession of iterative brainstorming rounds in which an attempt is made to avoid the interference of psychological factors that tend to reduce the value of brainstorming sessions."

Delphi seeks to formulate information on a particular topic or topics by obtaining responses to relevant questions from "experts". The term "expert" is one used frequently in the Delphi literature. Its common usage may, however, indicate too narrow a range of choice for the selection of the participants in a Delphi exercise. In general, it is true that an expert is one who has specialized knowledge applicable to the problem at hand. For an exercise that is dominated by forecasting the participation will generally be dominated by this class of expert. For an exercise that is dominated by planning participation will in many cases be heavily influenced by those most affected by the proposed plans.

In a policy process reality may be viewed differently by those who must concur or, at least, tolerate some decision. Further it cannot be argued that the usefulness of an individual model will be tested in the crucible of reality. The value systemsof the clients may differ, i.e. the results of a decision may be an overwhelming success for one and a catastrophic failure for another. This situation is not uncommon; it describes reasonably well decisions taken in any organization that involve the approval of its members or it describes the political process in a democratic society.

Thus, an expert must be construed in a broad sense. He may be a possessor of specialized knowledge or he may be someone intimately involved in the results of the exercise, i.e. a client. Dependent on the purpose of the exercise experts may include only one of these types or a mix of the two types.

The selection of experts is not an easy task. It involves first the determination of what forms of expertise are required and second the determination of which individuals possess the requisite expertise and are available for the exercise. Helmer and Rescher[15] differentiate in theory between two cases in the use of experts; although they indicate that in practice the two will overlap:

> "One is a situation in which the opinions of several experts on the same question or questions are solicited; the other is one in which experts with separate specialties are asked to comment on distinct aspects of a problem."

Another feature of Delphi is anonymity, i.e. the source of a response remains unknown to all other participants. The argument for this feature is that the anonymity of responses promotes independent viewpoints. Turoff,[16] for example, suggests that Delphi overcomes some of the problems encountered in committees:

> "The domineering personality, or outspoken individual that takes over the committee process.
> The unwillingness of individuals to take a position on an issue before all the facts are in or before it is known which way the majority is headed.
> The difficulty of publicly contradicting individuals in higher positions.

The unwillingness to abandon a position once it is publicly taken."

Anonymity may be an, at least, partially effective preventive of intelligence pathologies induced by organizational hierarchic relationships and by individual public intellectual committments. Delphi contrasts opposite points of view and provides channels for communication that are relatively free of such emotional and hierarchical noise factors. As Dalkey and Helmer[17] suggest:

> "Direct confrontation....all too often induces the hasty formulation of preconceived notions, an inclination to close one's mind to novel ideas, a tendency to defend a stand once taken or,....a predisposition to be swayed by persuasively stated opinions of others."

In Delphi the participants are asked for an initial response to the question or questions under study. In addition to the basic response they are encouraged to provide their reasons for making that particular response. Thus, the participant gives his best answer to the question and then "presents his case". After all participants have responded, feedback is provided to all of them. The feedback is usually constrained. Most frequently statistical information on the responses is calculated, e.g. the median or mode, upper and lower quartiles or deciles, etc. This statistical information is then presented along with a summary of the supporting arguments. The sumamry may include the most extreme opinions, a sample of typical opinions or even, in the limit, all opinions expressed. Constrained feedback facilitates the recording and synthesis of a large number of responses. The administrative workload associated with a Delphi exercise should not be underestimated.

Another round is initiated after the participants have been given an opportunity to reflect on the responses and their supporting arguments. This cycle is repeated until either a specified number of rounds has been completed or until some form of response stability has been attained.

Although "the individual estimates will show a tendency to converge as the experiment continues"[18] the Delphi technique does not ensure consensus but due to the interaction, a clearer statement of the possible alternatives available as an outcome of the study may be achieved. For example, Helmer[19] writes concerning cases of failure to gain consensus:

> "....the Delphi technique would have served the purpose of crystallizing the reasoning process that led to the positions which were taken and thus would have helped to clarify the issues even in the absence of a group consensus."

Additionally, due to the interaction, insights may be gained that would otherwise be ignored.

It is also interesting to note that the Delphi technique may have, at least, one analog in nature. Kilmer, McCulloch and Blum[20] in describing a model of the reticular formation in vertebrates use twelve coupled modules stacked in a columnar array. Each module appears to act as a small Delphi processing unit.

Delphi pathology. Delphi is, of course, not without some weaknesses. It is possible for a participant to deliberately introduce responses known to be false so as to mislead the group or to take positions more extreme than he actually advocates so as to increase the probability of a compromise position closer to his true one. Although this may also happen in a face-to-face committee meeting the essential anonymity factor may mask its influence more. This may be especially true when statistics summarize round responses.

All of the problems implicit in scaling still exist in a Delphi exercise. For example, in most realistic situations the achievement of an interval scale is very difficult.

Unless the participants have had very similar backgrounds the same question may be interpreted quite differently by different participants. Similarly comments made may not be interpreted alike by all. Thus any response pattern could become meaningless.

The emotional content of response comments will be greatly reduced. This may not always be the best approach. The strength with which a participant holds an opinion may be important.

An awareness of these possible weaknesses should lead to careful structuring of the exercise and careful monitoring of its progress by the moderator.

Hegelian inquiry. Churchman[21] describes five philosophical approaches in the search for "truth". These are the Leibnizian, Lockean, Kantian, Hegelian and Singerian inquiring systems. Each approach has its own strengths and weaknesses. One may, however, be more appropriate under a particular set of circumstances. Mitroff and Turoff[22] argue that the Hegelian (also termed a "dialectical" system) is best suited for a problem that is ill-defined, has opposing objects, and requires intuitive or synthetic reasoning.

Mason,[23] in a study of a company in the throes of a two faction intra-organizational conflict, used such a dialectical inquiry system. He states:

> "A system may be said to be dialectical if it examines a situation completely and logically from two different points of view....The vehicle for inducing ....reflection is a structured debate."

This approach, rooted in the philosophy of Hegel,[24] is a conflictual system. A thesis is contrasted with an antithesis, both of which are supported by the same data. The essence of the system is to maximally challenge the thesis under investigation. Mitroff and Turoff[25] write:

> "The plan and the counterplan represent strongly divergent and opposing conceptions of the whole system. Their function is to engage each other in an unremitting debate over the 'true' nature of the whole system, in order to draw forth a new plan that will hopefully reconcile (synthesize, encompass) the plan and the counterplan."

In this clash of ideas the underlying assumptions may be exposed and subjected to rigorous cross-examination. As a result of this exposure and close examination the decision maker may make a more informed interpretation of the data. "Bertrand Russell warned us that, 'Even when the experts all agree, they may well be mistaken.'"[26] A dialectical inquiry system is a philosophical approach that attempts to minimize this possibility in an environment difficult or impossible to adequately model in any unique manner.

A dialectical inquiry approach is one that can easily be incorporated into a Delphi exercise. This is not the only philosophical system that is compatible with Delphi. Delphi may serve as a framework or a "shell" within which a dialectical exercise is organized. In order to clarify this Lockean, Kantian and Hegelian systems can be contrasted.

A Lockean approach is basically empirical and inductive in nature and is best applied to well-defined problems. The outcome of a Lockean based exercise must be judged by its degree of consensus. Thus its application in a Delphi framework demands a strong attempt to achieve consensus.

A Kantian approach seeks truth in the interaction between theory and empiricism. It is best suited to ill-structured problems and seeks alternate paths to truth. Its application into a Delphi framework does not demand consensus but seeks the formulation of alternatives.

A Hegelian approach, as discussed above, seeks truth in the exposing of models and assumptions to dialectical challenge. Under those conditions in which men interpret the same data through different models, under conditions of high uncertainty and involving problems difficult to structure, and in situations requiring a significant amount of human insight, judgement and "pattern recognition" a dialectically based Delphi may be a significantly effective tool.

Delphi and Strategic Intelligence

In general strategic intelligence takes on a hierarchic nature. Sub-decisions or defined alternatives are made and organized into higher level decisions or alternatives, which in turn are used as inputs to even higher level intelligence production. This is illustrated in Figure 4-1. "Experts" relevant to the formulation of one specific sub-decision may be the same, differ or overlap with those who are expert in the areas relevant to another sub-decision.

Management science has been concerned with "well structured" problems. Given the assumptions the management scientist applies rigorous mathematical and logical rules to achieve an optimal solution, if one exists. The area of strategic intelligence does not fit this traditional approach. The problem is ill-structured to an extremely high degree. This function requires a significant, if not totally dominant, amount of human intuition, expertise and experience - just those characteristics that are difficult to quantify. Thus, human judgement and problem solving is

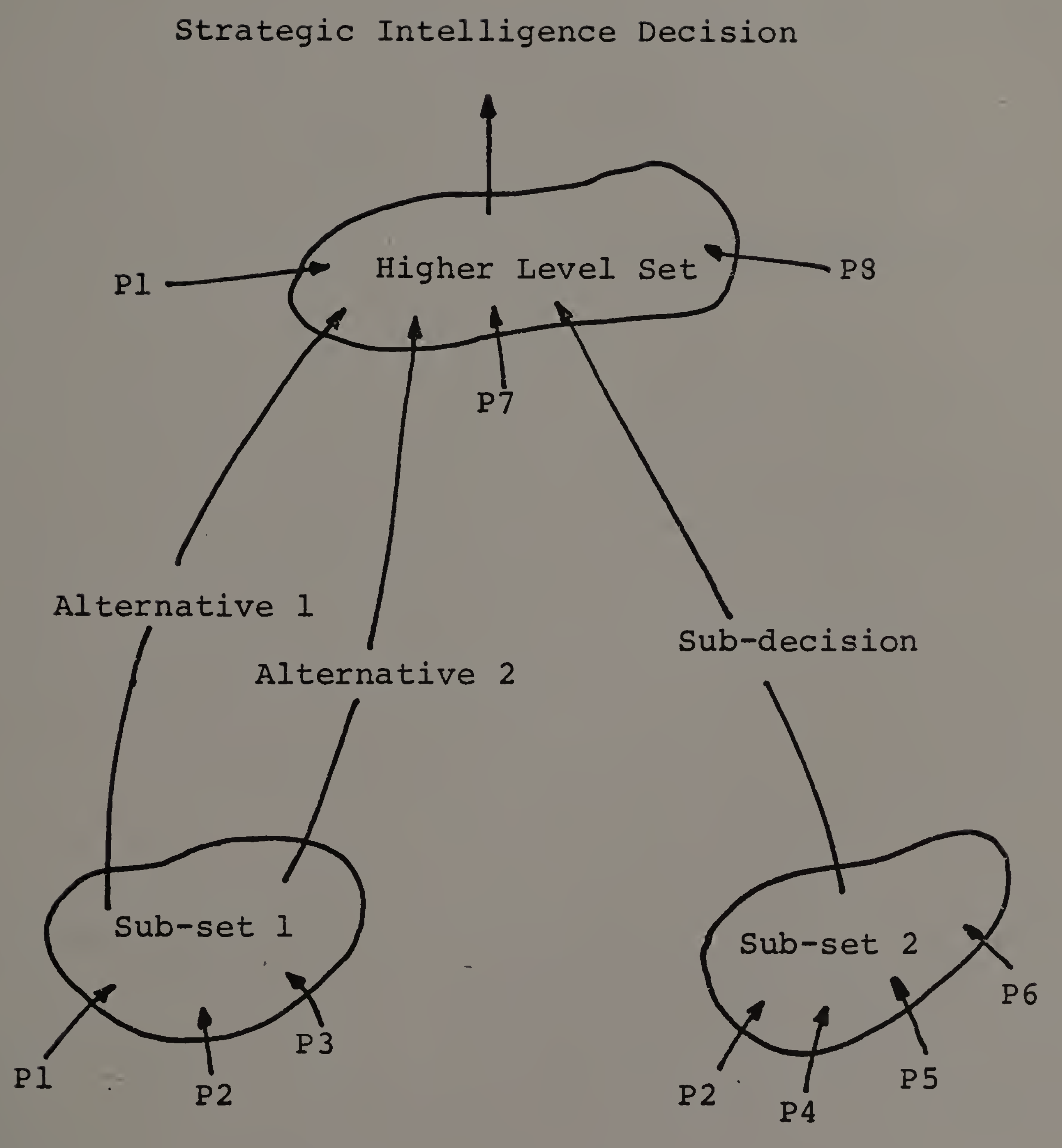

Figure 4-1 - General Hierarchic Intelligence Structure necessary; yet it, too, must be handled with caution. Mason[27] warns:

> "Through his experience the manager develops habitual ways of viewing his organization and coping with its problems. Life in most modern organizations only serves to reinforce those stereotyped responses to organizational problems...The collection of these habitual ways of viewing the business....forms the underlying assumptions (or world view) of a plan. This world view becomes so implicit that management is normally unaware of the full import of its influence....
> Sophisticated techniques and complicated technologies tend to obscure the assumptions which underlie their use."

Delphi "recognizes that in non-exact disciplines, expert opinion and subjective judgement must, of necessity, substitute for the exact laws of causality found in the physical sciences."[28] But opinion and subjective judgement imply that the expert is utilizing a model to organize the available data into a coherent whole. As indicated above different models operating on the same data may result in different inferences.

In the general hierarchic intelligence structure illustrated in Figure 4-1 one of the sub-sets represents a particular hierarchically decomposed portion of the total strategic intelligence "question". Data originating both internal to and external to the organization are studied and information is drawn from this study. The participating experts may be expert in the specialized knowledge sense or in the client sense. In most cases it would be expected that few participants would be other than a mix of specialist and advocate.

Additionally, although some participants might provide data completely external to the organization and others might provide data completely internal, it would be expected that in general most participants would provide data mixed as to its origin.

An organizational member is exposed to data in his daily organizational life from many sources (both internal and external). Figure 4-2 illustrates some of these possible sources. All of these inputs are affected by such factors as inertia, attention, interest, etc. Some members who normally operate on the periphery of the organization, i.e. interact more frequently with the environment, such as salesmen, lawyers, purchasing agents, etc., may have a greater awareness of certain aspects of the environment. Other members, such as accountants, administrators, etc., may be more heavily oriented towards the organization itself. Some, such as scientists, engineers, etc., may be both strongly oriented to the organization and the environment (especially through professional societies, journals, etc.).

An additional group of persons, such as management consultants, lobbyists, auditors, etc., though not organizational members may have very significant data to contribute to the organization's strategic intelligence function.

Thus, a mix of experts, probably differing in the models applied, participates in an organized effort to either reach a rational decision or to define what alternative interpretations are available. It is here that a dialectical approach

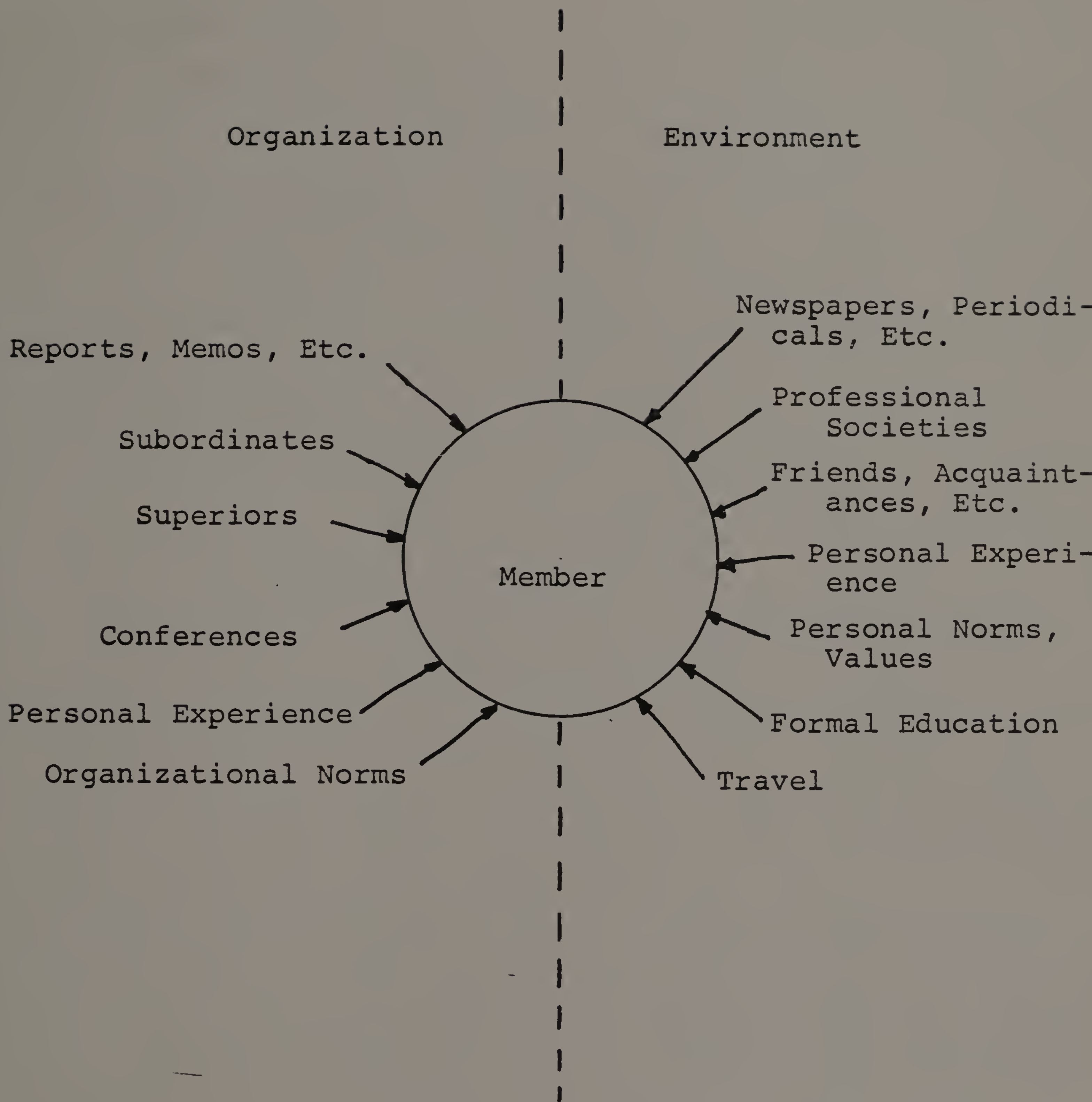

Figure 4-2 - A Sample of Data Sources for an Organizational Member can be especially valuable. Both assumptions and inferences can be maximally challenged. To the true Hegelian thesis and anti-thesis, i.e. two alternatives, are contrasted. To the practical dialectician more than two alternatives may be critically viewed. Robert Kennedy,[29] for example, in discussing the Cuban missile crisis wrote:

> "....if we had to make a decision in twenty-four hours, I believe the course we would have taken would have been quite different and filled with far greater risks. The fact that we were able to talk, debate, argue, disagree, and then debate some more was essential in choosing our ultimate course."

When all sub-set studies have been concluded the results may then serve as inputs to the next higher level set. Here again a Hegelian approach, utilizing both inputs from the sub-sets and new inputs at this level, may be employed. The cycle repeats to any arbitrary number of levels until the final strategic intelligence estimate or alternative estimates are available to the policy maker.

The Delphi technique is a method that can be utilized as the basic building block for such an organizational strategic intelligence system. A basic Delphi module may be utilized as a framework within which a strategic intelligence sub-set may operate. The output of several modules may serve as, at least, partial input to another module higher in the intelligence hierarchic structure.

The lack of a requirement to achieve consensus in any given module will tend to minimize the tendency to gloss over deep rooted differences between participating experts in achieving an intelligence interpretation. A not uncommon organizational flaw is to achieve agreement on a subject by taking a "least common denominator" approach. This approach tends to mask that which may be critical to a successful policy decision.

It should be emphasized that the hierarchic structure of the described strategic intelligence MIS is not necessarily isomorphic to the organizational hierarchic structure. The intelligence structure is based on an analysis of the components of the "question" currently under study. Thus experts from different levels of the organizational hierarchy may participate in the same Delphi module. It is the relevance of their expertise that is the determining factor in including or excluding particular individuals.

Summary

This chapter has reviewed the Delphi technique and its potential application to the area of organizational strategic intelligence.

Delphi is an organized approach to the collection and attempted reconciliation of the interpretations placed on data by its participants. It makes use of controlled feedback. On the basis of this feedback participants are allowed to modify their original responses. Through a series of iterations (rounds) theoretically offering more data or inferences to each participant the probability of a better (in some sense) interpretation is increased.

Anonymity reduces many of the flaws inherent in a committee structure, e.g. organizational hierarchy, emotional, and cognitive dissonance factors. In a Delphi exercise research shows a tendency towards consensus, but this is not necessary. It is possible that two or more incompatible positions will be defined.

A Hegelian or dialectical inquiry system is a philosophical approach based on the concept that out of the conflict of ideas rises what may be termed truth. What can be called true is only that which has been subjected to maximal challenge and has survived (perhaps in a modified form).

A Delphi exercise may be designed based on a dialectical system. This approach is particularly appropriate when the subject is ill-structured, can be analyzed in terms of different models giving different interpretations, and requires a significant amount of human judgement, experience, and intuition. Organizational strategic intelligence is such an area.

Intelligence forms a hierarchy. Inferences are iteratively drawn from data interpreted through models; these are then combined into broader interpretations. Information is combined with modification to form intelligence. A dialectically oriented Delphi module can be used as a basic building block of an organizational strategic intelligence MIS. This approach results not only in the advantages of the Delphi technique and the dialectical inquiry system but also adds great flexibility and introduces an element of rigor to such a management information system.

The next chapter will describe a working model of a computer based MIS utilizing the approach outlined in this chapter. It will describe the working of the programs written for the system and their inter-relationships. The flexibility of the system will be described along with the options available to the user.

References

1. Kent, S., "Strategic Intelligence for American World Policy," Princeton, N.J.: Princeton University Press, 1949, p. 58-59.

2. The technique was named after the oracle at Delphi because of its early applications to forecasting.

3. Quade, E.S., "Cost-Effectiveness: Some Trends in Analysis," Santa Monica, California: Rand Corp., P-3529, 1967.

4. Kaplan, A., A.L. Skogstad and M.A. Girshick, "The Prediction of Social and Technological Events," Public Opinion Quarterly, Vol. 14, 1950, Spring, p. 93-110.

5. Dalkey, N.C. and O. Helmer, "An Experimental Application of the Delphi Method to the Use of Experts," Management Science, Vol. 9, 1963, p. 458-467.

6. Gordon, T.J. and O. Helmer, "Report on a Long Range Forecasting Study," Santa Monica, California: Rand Corp., P-2982, 1964.

7. Helmer, O. and E.S. Quade, "An Approach to the Study of a Developing Economy by Operational Gaming," Santa Monica, California: Rand Corp., P-2718, 1963.

8. Helmer, O., "A Use of Simulation for the Study of Future Values," Santa Monica, California: Rand Corp., P-3443, 1966.

9. Helmer, O., "The Use of the Delphi Technique in Problems of Educational Innovators," Santa Monica, California: Rand Corp., P-3499, 1966.

10. "Forecasters Turn to Group Guesswork," Business Week, March 14, 1970, p. 130-134.

11. Turoff, M., "The Design of a Policy Delphi," Technological Forecasting and Social Change, Vol. 2, 1970, p. 149-171.

12. Ibid., p. 149.

13. Helmer, O., "Analysis of the Future: The Delphi Method" in "Technological Forecasting for Industry and Government," Bright, J.R. (ed.), Englewood Cliffs, N.J.: Prentice-Hall, 1968, p. 118.

14. Jantsch, E., "Technological Forecasting in Perspective," Paris: OECD, 1967, p. 137.

15. Helmer, O. and N. Rescher, "On the Epistimology of the Inexact Sciences," Management Science, Vol. 6, 1959, p. 47.

16. Turoff, M., op. cit., p. 152.

17. Dalkey, N. and O. Helmer, op. cit., p. 459.

18. Ibid., p. 459.

19. Helmer, O., "Analysis of the Future: The Delphi Method," op. cit., p. 121.

20. Kilmer, W.L., W.S. McCulloch and J. Blum, "An Embodiment of Some Vertebrate Command and Control Principles," Unpublished Manuscript, MIT Instrumentation Laboratory.

21. Churchman, C.W., "The Design of Inquiring Systems," New York: Basic Books, 1971.

22. Mitroff, I.I. and M. Turoff, "Technological Forecasting and Assessment," IEEE Spectrum, Vol. 10, March, 1973, p. 62-71.

23. Mason, R.O., "A Dialectical Approach to Strategic Planning," Management Science, Vol. 15, April, 1969, p. B-408.

24. Hegel, G.W.F., "The Phenomenonology of Mind," 2nd ed., (trans. by J.B. Barillie), London: George Allen and Unwin Ltd., 1964.

25. Mitroff, I.I. and M. Turoff, op. cit., p. 68.

26. Mitroff, I.I., "A Communications Model of Dialectical Inquiring Systems - A Strategy for Strategic Planning," Management Science, Vol. 17, June, 1971, p. B-647.

27. Mason, R.O., op. cit., p. B-406 - B-407.

28. Gordon, T.J., "New Approaches to Delphi" in "Technological Forecasting for Industry and Government," Bright, J.R. (ed.), Englewood Cliffs, N.J.: Prentice-Hall, 1968, p. 134.

29. Kennedy, R.F., "Thirteen Days," New York: Norton, 1969, p. 111.

CHAPTER V

AN INTERACTIVE HIERARCHICAL MIS

Overview

In the last chapter an outline of an organizational strategic intelligence MIS was presented. This MIS was based on a hierarchical Delphi structure. A dialectically oriented Delphi module was recommended as the basic building block of the system. The system would be organized on a hierarchical arrangement of the basic Delphi modules.

This chapter will describe a working model of the theoretical system described above. This model has been developed as a computer based interactive system.

The computer can be utilized as a highly efficient tool for a Delphi based study. It can accomplish all that a non-computer Delphi exercise can and it contributes its efficiency in calculation and symbol manipulation. Storage of data on long-term memory devices (e.g. disk) can result in rapid response to requests for such data and to relatively easy re-combination of data through careful file structuring.

This approach has been implemented and has resulted in the development of an interactive hierarchical Delphi system as a basis for an organizational strategic intelligence MIS on the University of Massachusetts timesharing system (UMASS). UMASS operates on a CDC 3600 computer system. Because of the ease of manipulation of string variables, i.e. alphanumeric variables containing up to 80 characters on UMASS, BASICX (Extended BASIC) was chosen as the programming language.

The programs were written and the system was organized with two points of view in mind. First, it was felt necessary that it be possible for all programs to be "run" by inexperienced users with relatively little or no assistance. This implied a highly conversational mode of operation. All directions had to be given clearly and simply to the user when they were required. Additionally, extensive error checking was deemed necessary on all inputs by the user. Second, the programs had to be flexible enough to be used as a tool for a wide variety of strategic intelligence applications.

The approach utilizes programs on two levels: the system level and the module level. Figure 5-1 illustrates the overall concept.

On the module level, a separate "access" area is required on disk for each Delphi module and its associated files. Three standardized module programs control and report on the activity for each module within the system.

On the system level, one module is designated the master module and controls the hierarchical relationships between the various modules within the MIS. One program is used at this level.

Identification of variables is made in Appendix A, identification of files is made in Appendix B, and listings

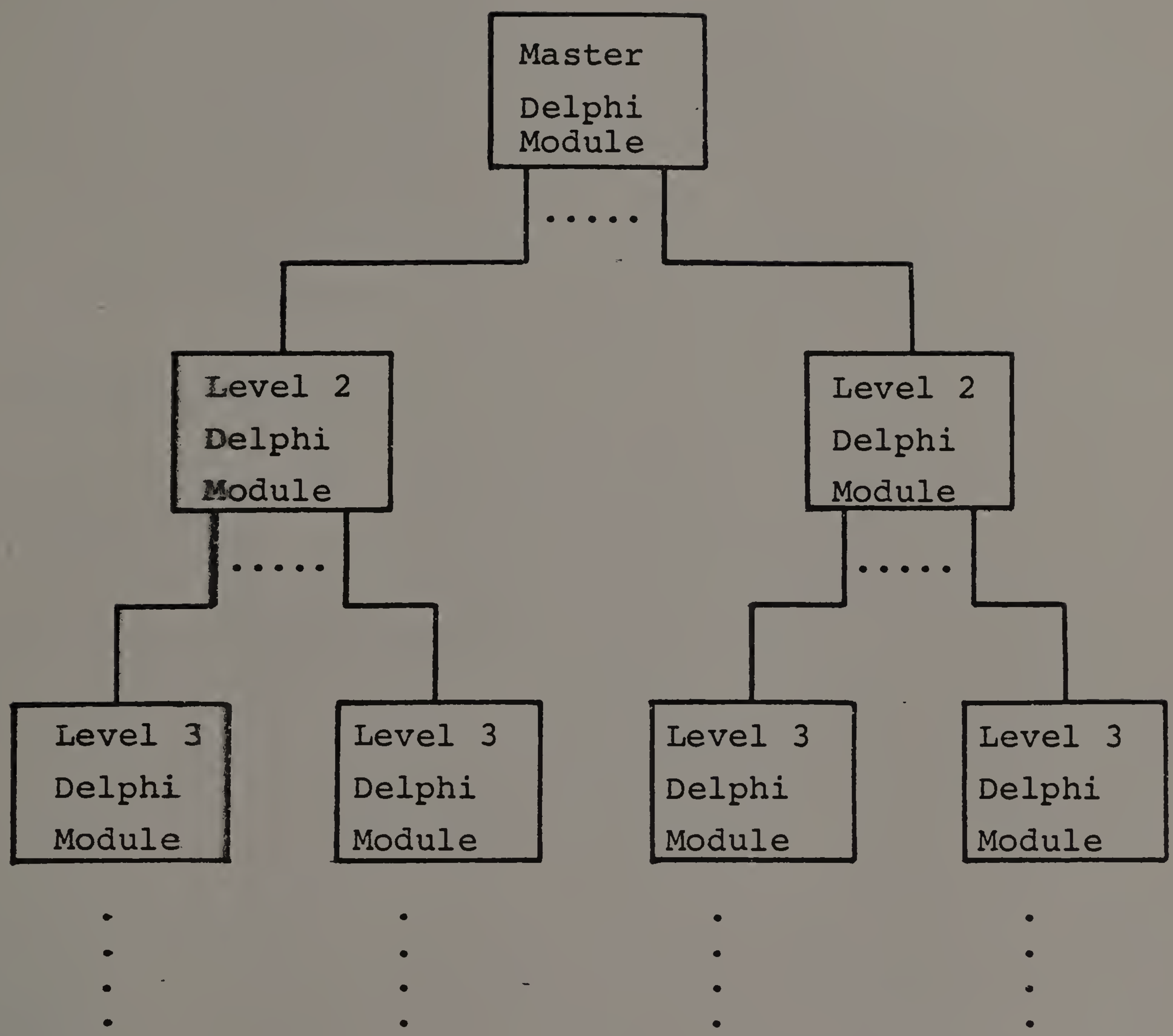

Figure 5-1 - System Overview of the MIS

of all programs are contained in Appendix C.

The System

As stated above, the system to be described is organized in accordance with Figure 5-1. Although the same programs are used within each module, files created within one module are isolated from files created within any other module. Additionally operating parameters in one module are independent from those in any other module. Any module has access to the results obtained within any subordinate module at its conclusion.

For a given investigation an individualized hierarchical structure is created. A maximum of five modules may be made subordinate to any one module; a maximum of five levels may be used within the hierarchy. Thus a maximum of 781 Delphi modules may be used at one time.[1]

If an individual, i.e. a one module, Delphi exercise is to be used, then the system capability described in this section may be excluded. For an exercise utilizing two or more modules that are related to each other, the system level program must be exercised.

The system level program's function is to establish the hierarchical relationship between the modules within the MIS. This stated relationship is then used to allow data flow only from a subordinate module to its immediately superior module in the hierarchy. The program used for this purpose is named STINT. Figure 5-2 illustrates a generalized MIS

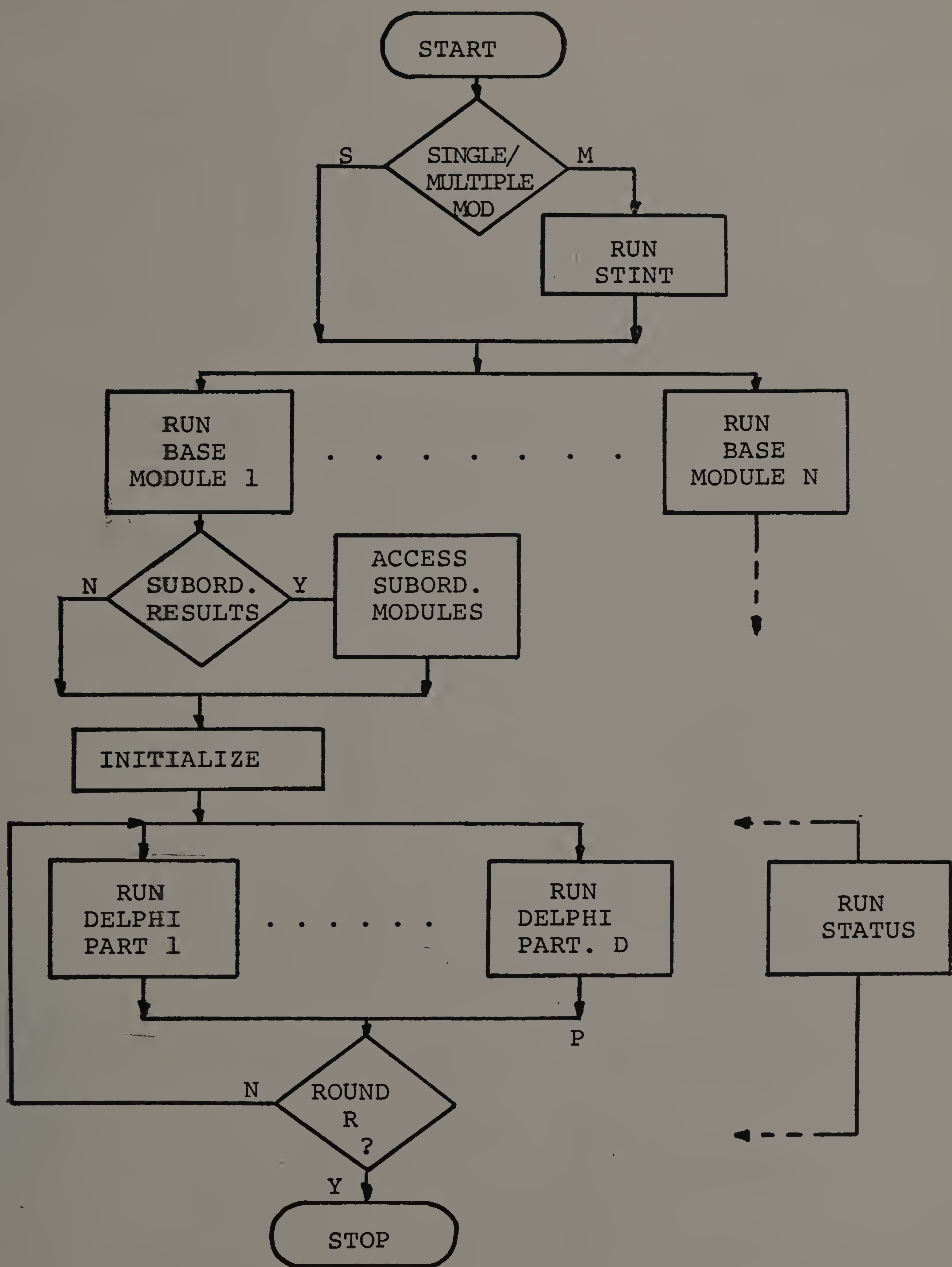

Figure 5-2 - Generalized MIS Flowchart

flowchart.

Program STINT. The program, which requires a minimum of 8K of core, offers two options as follows:

```
THE FOLLOWING OPTIONS ARE AVAILABLE:
   1. INITIAL SET-UP OF SYSTEM ORGANIZATION
   2.  PRINT OUT OF SYSTEM ORGANIZATION
WHICH OPTION DO YOU WISH? ENTER NUMBER.
?
```

Option 1 is the selection of the hierarchical organization for a new investigation, i.e. the hierarchical relationships between modules are to be established as a starting point. Option 2 is a report on the hierarchical structure of an MIS that was previously established. Thus option 2 cannot be requested unless option 1 has been exercised some time previously.

If neither a 1 nor a 2 are input then an error message is output:

```
INPUT MUST BE EITHER 1 OR 2. PLEAST TRY AGAIN.
?
```

and another input is requested.

If a 1 is input option 1 is indicated and the following output results:

```
HOW MANY LEVELS IN THE SYSTEM?
```

The input is restricted to an integer between 1 and 5. If the input does not meet this restriction an error message is printed out:

```
THE NUMBER OF LEVELS MUST BE AN INTEGER BETWEEN 1 AND 5.
PLEASE TRY AGAIN.
?
```

If the input is accepted, the number is placed in variable L and the following is requested:

FOR LEVEL 1 :
WHAT IS THE ACCESS NUMBER FOR MODULE 1 ?

WHAT IS THE ACCESS CODE FOR MODULE 1 ?

The access number is placed into variable A and the access code is placed into variable C. Both of these variables are simple alphanumeric variables.[2]

The system now requests:

HOW MANY MODULES ARE DIRECTLY SUBORDINATE TO THIS MODULE?

and places the response into variable S.

These inputs are placed into file HIER. The file structure of HIER is illustrated in Figure 5-3. Matrix M in this figure is a 1 by 5 matrix. The pointer locations for data on subsidiary modules is placed in the first S cells (M(1,1) thru M(1,S)). All remaining cells (M(1,S+1) thru M(1,5)) are filled with a dummy number: 9999.

The pointer location for each subsidiary module record in the file is calculated by adding 8 (per Figure 5-3 there are 8 words per record) to the last assigned location.

Based on the number of subsidiary modules input at level 1, the program requests the same information on that number of modules at level 2. The procedure repeats for all L levels.

It should be noted that there is no requirement for symmetry in the hierarchical tree. Branches of the tree may also terminate at different levels.

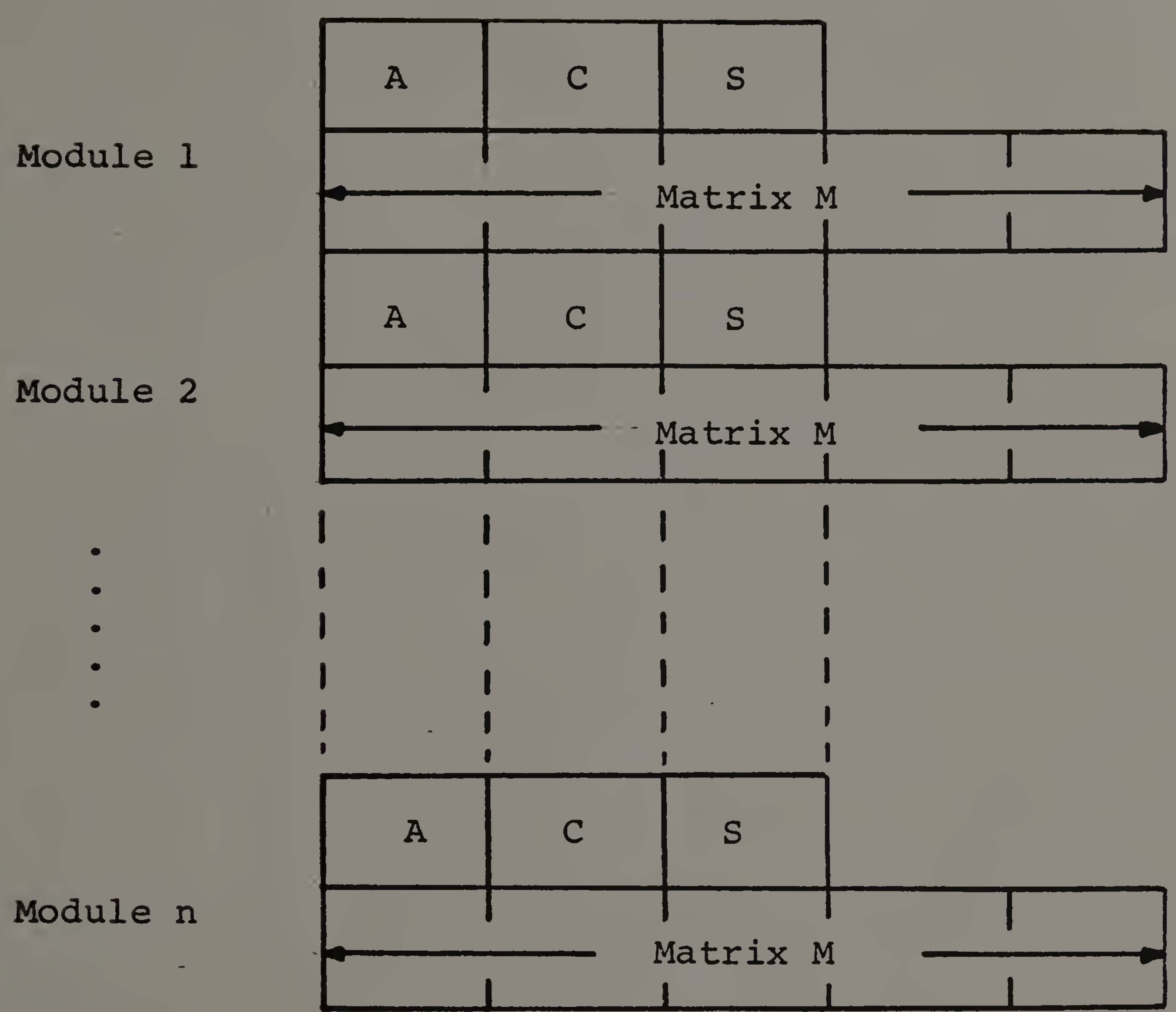

Figure 5-3 - File Structure of HIER

If in the original selection of options a 2 is input, option 2 is selected. This option prints out a chart of the hierarchical structure of the MIS that was previously entered. This information is obtained by reading file HIER. Such an MIS structure is printed out in the form of the following example:

```
LEVEL 1   LEVEL 2   LEVEL 3   LEVEL 4   LEVEL 5
RØØ1
          RØØ2
                    RØØ5
                    RØØ6
                              RØ1Ø
                              RØ11
          RØØ3
                    RØØ7
          RØØ4
                    RØØ8
                    RØØ9
```

The characters, e.g. RØØ1, contained in the chart are the module access numbers originally placed in the file. Access codes are not printed out in order to maintain privacy. Module numbers RØ1Ø and RØ11 are subordinate to module RØØ6 as are RØØ6 and RØØ5 to RØØ2 in this example.

The program begins this option by reading the first record, which contains information on the sole level 1 module. The pointer locations for the records on the level 2 modules are contained here. Each level 2 record is read; each contains information on its level 3 modules, if any. Each level 3 module contains the information on its level 4 modules, etc.

Thus, in summary, this program enters into file HIER the hierarchical relationships between the modules in the MIS and the access numbers and codes required for entry into any module. It also provides the ability for the user to obtain a summary of the relationships between the modules presented in chart form.

The Module

The module within the MIS is supported by three programs. It has been designed as a self-contained Delphi package and as a highly interactive module. Users of a module are of two types: (1) a moderator who is required to initialize the exercise and to intervene at the end of each round and (2) participants in the Delphi exercise who provide the responses to and receive feedback from the system. The three module programs are: program BASE, program DELPHI, and Program STATUS. Each will be discussed in turn.

Program BASE. This program requires a minimum of 16K of core. It is required to be used first within the module. It is operated by the moderator and possesses two capabilities: (1) it can provide the results obtained in subordinate modules and (2) it can set up the files required to initialize this particular module.

The first output when this program is executed is:

```
DO YOU WISH ACCESS TO SUBORDINATE MODULE RESULTS? ANSWER
EITHER YES OR NO.
?
```

If either a YES or a NO is not given an error message is printed out:

YOUR RESPONSE MUST BE EITHER YES OR NO. PLEASE TRY AGAIN.
?

If the user enters YES the response is:

FOR THE MASTER MODULE PLEASE SUPPLY THE FOLLOWING:
   ACCESS NUMBER?

   CODE?

The master module is defined as the sole level 1 module. This module contains the file HIER that was created by the STINT program described above. After this information is entered the program requests:

FOR THIS MODULE PLEASE SUPPLY THE FOLLOWING:
    ACCESS NUMBER?

    CODE?

If the access number entered here matches the master module access number then this particular module is the master module and the HIER file is opened directly. If the two numbers do not match the program ACCESSes into the master module and opens the HIER file there.

Using the GETPTR command the length of the file in computer words is obtained. Since each record contains 8 words, the number of records is easily calculated. The file is read seeking a match on the initiating module access number. If no such match occurs, the response is:

ACCESS NUMBER DOES NOT MATCH MASTER FILE. PLEASE TRY AGAIN.

and the user is asked for the initiating module access number and access code again.

If a match occurs the pointer locations for the subsidiary modules are obtained. For each subsidiary module (a minimum of 0 and a maximum of 5) the appropriate disk area is ACCESSed and a check is made to determine if that module has been completed. This is accomplished by comparing the contents of two variables contained in the PARAS file. (This file will be discussed below under program DELPHI.)

If the Delphi based exercise in the module under consideration has not been completed the following is an example of the print-out (identifying the particular module by access number):

MODULE R1234 HAS NOT BEEN COMPLETED YET. PLEASE TRY AGAIN LATER.

If the exercise in the module has been completed the final results are presented as follows. The module is identified, for example:

RESULTS FROM MODULE R1234 :

The questions used in this module are presented in turn. For each a bar graph of the final results are presented similar to the following example:

THE RESULTS FOR QUESTION 1 WERE AS FOLLOWS:

```
  1Ø  I
      I
   8  I
      I
   6  I
      I
   4  I                          x
      I                          x
   2  I                      x   x   x
      I______________x_______x___x___x___x__________
         1   2   3   4   5   6   7   8   9   1Ø
                 RESPONSE
```

Additionally a summary of the final arguments made in the exercise are presented:

FINAL SIGNIFICANT COMMENTS ON THIS QUESTION WERE:

Details of the file structures, formats, etc. on these data will be discussed below under program DELPHI.

The above data are presented for each completed subsidiary module. This completes this section of the BASE program.

If the user enters a NO to the original question, i.e.:

```
DO YOU WISH ACCESS TO SUBORDINATE MODULE RESULTS? ANSWER
EITHER YES OR NO.
?
```

or at the completion of the above section the following is asked:

```
DO YOU WISH TO INITIALIZE THIS MODULE? ANSWER EITHER
YES OR NO.
?
```

If either a YES or a NO is not given an error message is produced:

```
YOUR RESPONSE MUST BE EITHER YES OR NO.  PLEASE TRY AGAIN.
?
```

If the response is NO the program terminates. If the response is YES entry into this section of the program is begun.

There are three basic parameters of the module which are used to dimension all matrices and as standards for various comparisons within all three programs of the module. These parameters are first requested.

The first input required is:

```
FOR THE EXPERIMENT PLEASE ANSWER THE FOLLOWING QUESTIONS.

   WHAT IS THE NUMBER OF PARTICIPANTS? (A MAXIMUM OF 15
   IS ALLOWED.)
?
```

The input here is placed into variable P. Error checking insures that it is an integer between 1 and 15.

The second input required is:

```
WHAT IS THE NUMBER OF QUESTIONS? (A MAXIMUM OF 1Ø
IS ALLOWED.)
?
```

The input here is placed into variable Q. Error checking insures that it is an integer between 1 and 10.

The third input required is:

```
WHAT IS THE NUMBER OF ROUNDS?  (A MAXIMUM OF 5
IS ALLOWED.)
?
```

The input here is placed into variable R. Error checking insures that it is an integer between 1 and 5.

Counters S and T, switches W and Y, and variable K7 are initialized at zero. The values of these plus the contents of variables P, Q, and R are filed on disk as PARAS. Figure 5-4 shows the file structure of this relatively simple file.

The module is organized around a series of questions. In a particular application these questions would be centered around a central theme. With each question is a set of additional information clarifying or explaining the question in more detail. These questions and the additional information are next entered. Each question is handled internally as three string variables and each set of additional information

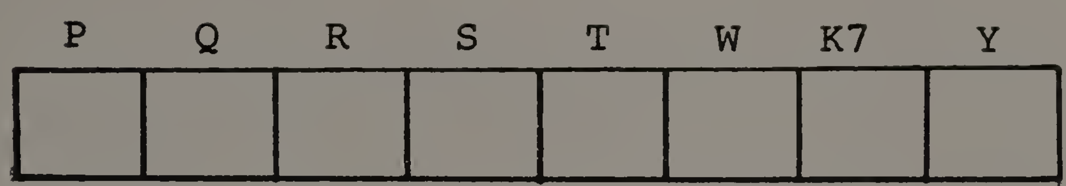

Figure 5-4 - File Structure of PARAS

as five string variables. For convenience, inputs for each string variable are limited to a maximum and a minimum of one teletype line.

ALL QUESTIONS ARE ALLOWED THREE TELETYPE LINES. ADDITIONAL INFORMATION ON EACH QUESTION IS ALLOWED FIVE TELETYPE LINES. IF A LINE IS NOT USED, ENTER A BLANK (SPACE), A COMMA, AND CARRIAGE RETURN. DO NOT USE COMMAS OTHERWISE.

The user is requested to supply the basic entries for the questions (and for the additional information) numbered consecutively from 1 to Q (entered above).

WHAT IS QUESTION 1 ?

WHAT ADDITIONAL INFORMATION DO YOU HAVE ON QUESTION 1 ?

The data entered in this set of 8 string variables is filed on disk as QUESTS. Figure 5-5 shows the file structure for this file.

No other data is required from the user in this program. The program automatically creates and dimensions all other necessary files.

A matrix N of dimensions 1 by P+1 is set to zero and filed on disk as NUM. Cell N(1,1) will be used as a counter. Cells N(1,2) through N(1,P+1) will be used as a set of P (entered above) switches.

Two alphanumeric variables, U and V (these will be used to contain the names of the participants), are filled with blanks and entered on file P times. This file is placed on disk under the name NAMES.

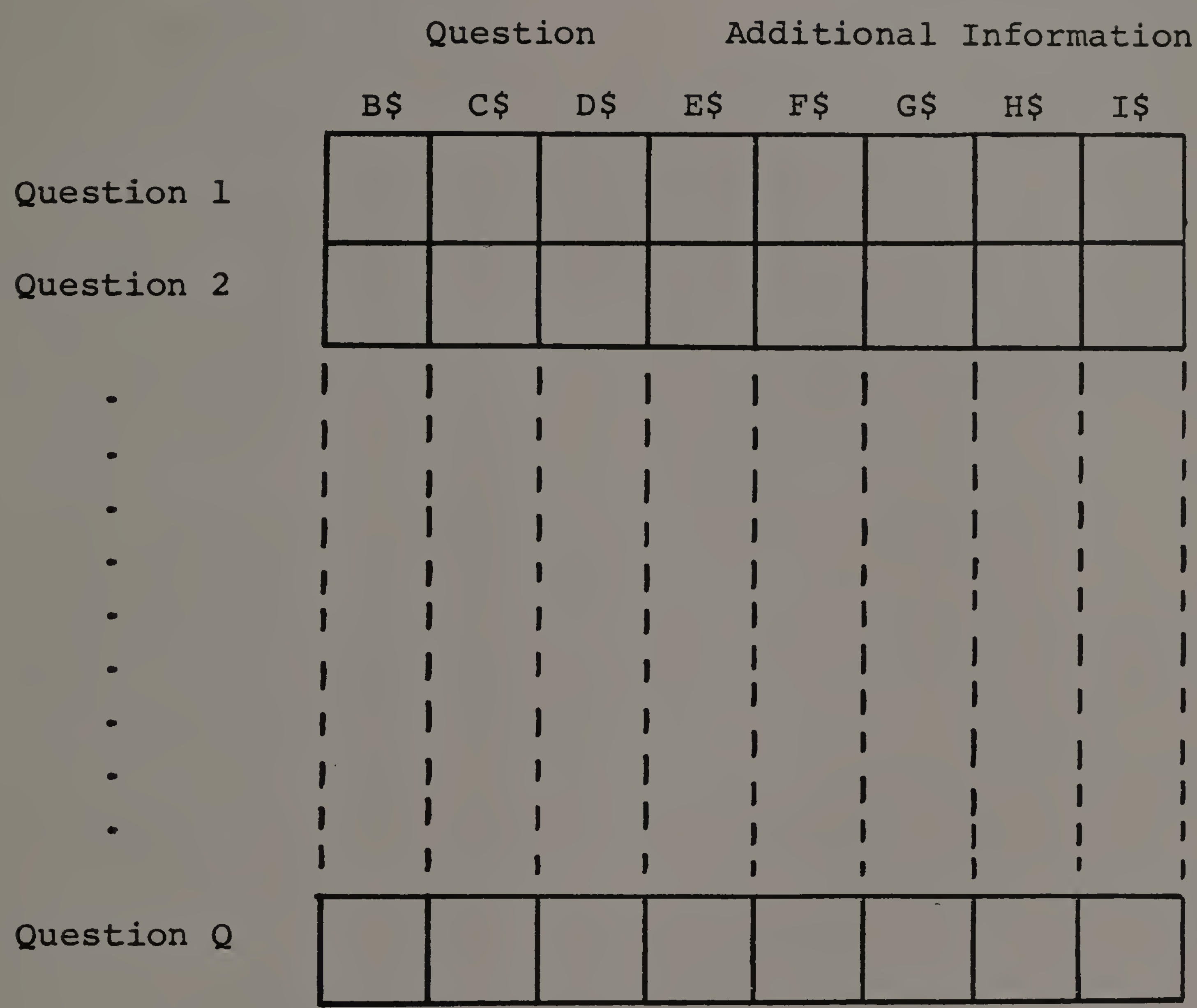

Figure 5-5 - File Structure of QUESTS

A matrix G is initialized at zero. This matrix will contain Q (entered above) by 10 cells. The matrix will be used later to create bar graph outputs. It is filed on disk under the name GRAPH.

A matrix A of dimensions Q x R and P is set to zero and is filed as ROUNDS. This matrix will contain the numerical responses entered by the participants during the exercise.

A matrix P of dimensions Q x P and R is set to zero and is filed as POINTER. This matrix will store pointer locations for entry into the comments files. These files will be discussed under program DELPHI.

In summary the following files have been created on disk after the initialization option of program BASE has been exercised:

File	Contents	Dimensions, Etc.
PARAS	8 numeric variables	
QUESTS	8 string variables/record	Q records
NUM	Matrix set to zero	1 by P+1
NAMES	2 alphanumeric variables/ record	P records
GRAPH	Matrix set to zero	Q by 10
ROUNDS	Matrix set to zero	QxR by P
POINTER	Matrix set to zero	QxP by R

Program DELPHI. This program is the basic program used by the participants in the exercise. It is the heart of the interactive system. The program requires 16K of core. Participants may interact with this program in any order. Each participant is uniquely identified by an identification number.

File PARAS is first read by the program. Variable Y (the eighth variable) is used to prevent more than one participant from accessing the files on disk at the same time. If two accesses were attempted into the same file confusion and/or destruction of some of the data in that file could result. The switch Y acts as a gate to prevent this. If Y contains a "1" the program responds with:

THE SYSTEM IS CURRENTLY BEING USED. PLEASE TRY AGAIN
AT A LATER TIME.

and a normal exit is made. If Y contains a "0" the program continues, switches Y to "1", and re-writes the PARAS file on disk. At the end of the program before exiting this switch is reset to "0".

Variable W (the sixth entry) is used to signify that a round has been completed and whether or not selection of comments (discussed below) has occurred. If such selection has not occurred W will contain a "1". It is reset to "0" after selection. If W does contain a "1" the program responds with:

Figure 5-6 - File Structure of NUM

```
ROUND 1 IS NOT COMPLETED YET.  PLEASE TRY AGAIN
AT A LATER TIME.
```

and a normal exit is made. If W contains a "0" the program continues.

File NUM is next read into matrix N. N is dimensioned on the basis of the parameters read previously from file PARAS. Figure 5-6 shows the file structure of NUM.

N(1,1) is a counter used only during the first round of the exercise. It is used as a device to issue consecutive identification numbers to the participants.[3] After reading this cell is incremented by 1. (Note: program BASE initialized all elements of this matrix to zero.)

Variable S is a counter specifying the number of rounds completed. If S contains a "0" then the following output is provided:

```
IS THIS YOUR FIRST ROUND FOR THIS EXPERIMENT
ANSWER EITHER YES OR NO.
?
```

If a response other than YES or NO is given an error message is printed:

```
YOUR RESPONSE MUST BE EITHER YES OR NO.
PLEASE TRY AGAIN.
?
```

and an opportunity to respond again is given.

If the response is NO (and S contains a "0") then the user is attempting to participate for the second time in round 1 and the following is printed out:

```
ROUND 1 IS NOT COMPLETED YET. PLEASE TRY AGAIN
AT A LATER TIME.
```

and the program terminates.

If the response is YES then the following output is provided:

```
WHAT IS YOUR NAME? (IT WILL BE KEPT CONFIDENTIAL.)
YOUR NAME MUST BE FROM 9 to 16 CHARACTERS LONG
INCLUSIVE.  USE BLANKS, IF NECESSARY.
?
```

Theinput in response to this question is placed into variables U and V and is written on disk in file NAMES. Figure 5-7 shows the file structure of NAMES. An identification number obtained from the incremented N(1,1) is issued as in the following example:

```
YOUR IDENTIFICATION NUMBER FOR THIS EXPERIMENT IS 4
PLEASE REMEMBER IT FOR FUTURE ROUNDS.
```

The number in N(1,1) is placed in N and cell N(1,N+1) is set equal to "1".[4]

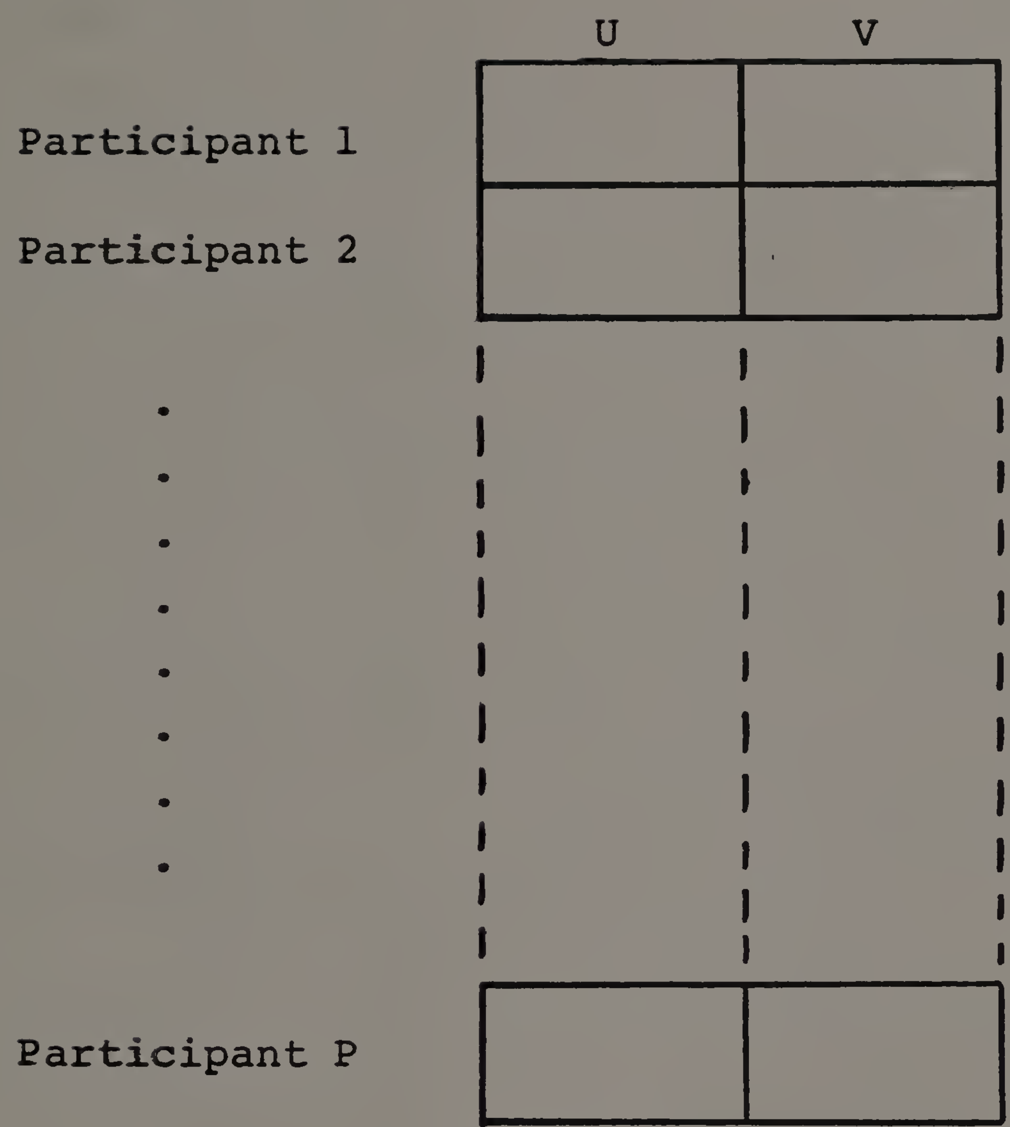

Figure 5-7 - File Structure of NAMES

If S contains a number other than "0", i.e. if one or more rounds have been completed, the following output is produced:

WHAT IS YOUR ID NUMBER?

and the identification number issued in round 1 is inputted and placed into variable N.

The value in element N(1,N+1) is checked. If this cell contains a "1" then the following output, as an example, results:

ROUND 2 IS NOT COMPLETED YET. PLEASE TRY AGAIN
AT A LATER TIME.

Thus, in a given round, the identification number is used to ensure that each participant signs on and interacts only once.

Files QUESTS is read as 8 string variables in an array of dimension Q. Next, the appropriate comments files are opened. The total possible set of such files is five: COMRND1, COMRND2, COMRND3, COMRND4, and COMRND5. The exact number will be determined by the number of rounds specified in BASE. COMRND1 contains the comments entered (discussed below) by each participant in round 1, COMRND2 refers to round 2, etc. Based on the value of S (the number of rounds completed), at most, two files of this family are opened and read - one containing the comments of the previous round and one to contain the comments of the present round. The exception to this rule occurs when only one file, COMRND1, is opened and written in round 1.

In all rounds (excluding the final summary available to all participants after completion of all rounds) the following instructions are provided:

```
ALL QUESTIONS SHOULD BE ANSWERED ON A SCALE RANGING
FROM A LOW OF 1 TO A HIGH OF 1Ø.
IF YOU WISH ADDITIONAL INFORMATION ON ANY QUESTION
ANSWER 99.
```

File ROUNDS is read for matrix A - A is used to enter the numerical responses from the participants. Each question (consisting of the first three string variables read from QUESTS) is then printed out in sequence, for example:

```
QUESTION 1 - LINE 1 OF 3
QUESTION 1 - LINE 2 of 3
QUESTION 1 - LINE 3 of 3
```

For all rounds, but the first, a bar graph of the responses made by the participants in the previous round is printed out as in the following example:

```
THE RESULTS OF ROUND 1 FOR QUESTION 1 WERE AS FOLLOWS:

1Ø  I
    I
 8  I
    I
 6  I
    I
 4  I                    X
    I                    X
 2  I                 X  X  X
    I__________X______X__X__X__X________
       1  2  3  4  5  6  7  8  9  1Ø
               RESPONSE
```

This information is obtained from reading file GRAPH. Figure 5-8 shows the file structure of GRAPH. The updating of this

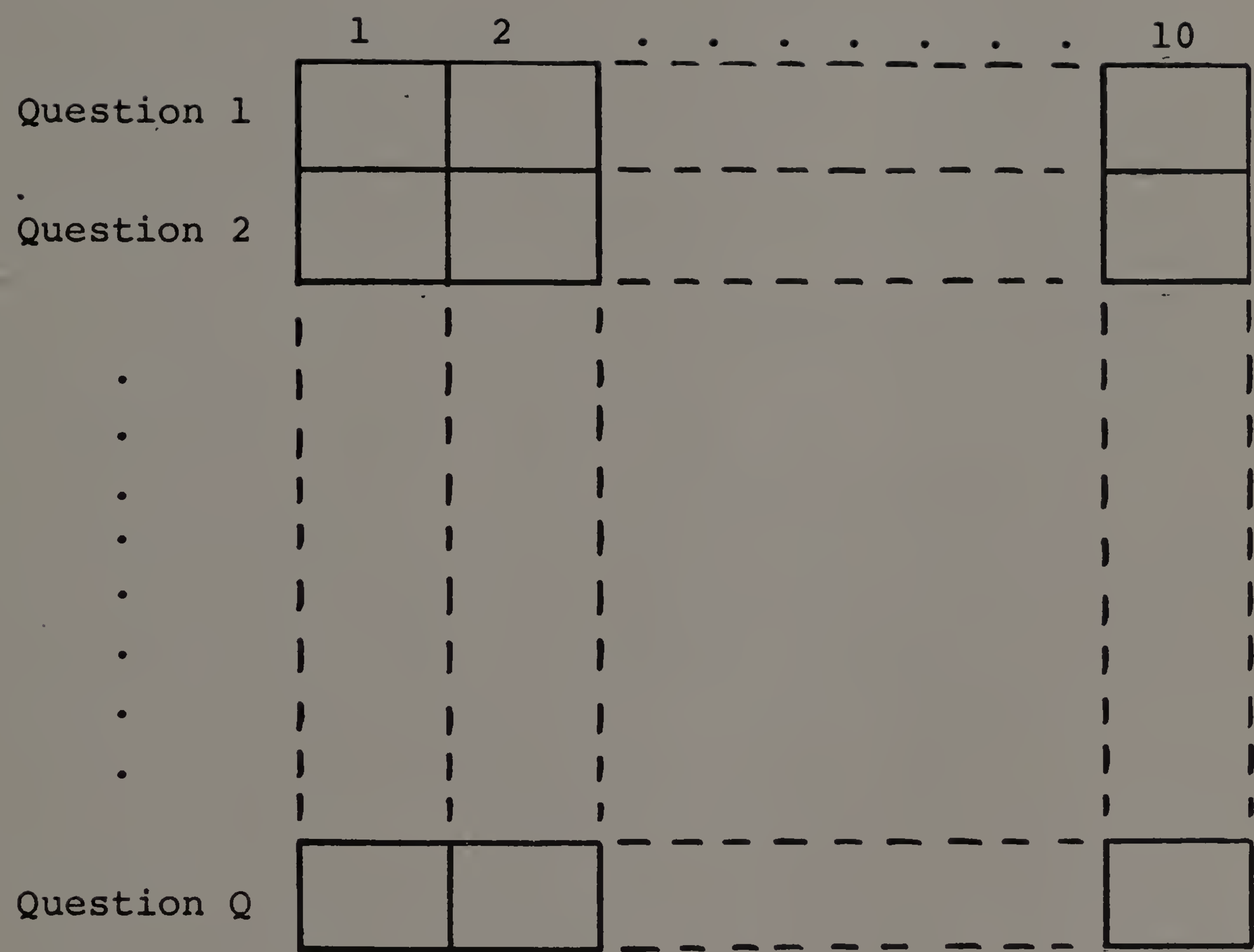

Figure 5-8 - File Structure of GRAPH

file will be discussed below.

This is followed on all rounds, but the first, by a selection of comments from the previous round as in the following example:

SIGNIFICANT COMMENTS ON THIS QUESTION FROM ROUND 1 WERE:

COMMENT 1 ON QUESTION 1 - LINE 1 OF 3
COMMENT 1 ON QUESTION 1 - LINE 2 OF 3
COMMENT 1 ON QUESTION 1 - LINE 3 OF 3

COMMENT 2 ON QUESTION 1 - LINE 1 OF 2
COMMENT 2 ON QUESTION 1 - LINE 2 OF 2

Significant comments presented in each round are selected by the moderator via program STATUS (discussed below). Figure 5-9 shows the file structure for the COMRND_ series of files. If Z contains a "1" J$, K$, and L$ are printed out as significant; if Z contains a "0", these string variables are not printed out.

The program then requests a numerical response:

WHAT IS YOUR RESPONSE FOR THIS ROUND?

The input, if it passes all error checks, is placed in matrix A and is eventually re-written into file ROUNDS. Figure 5-10 shows the file structure of ROUNDS.

Thus the user's input is placed in A(I,N) where:

I = Q*S + 1 thru (S+1)*Q (Note: S contains the number of rounds completed.)

N = the user's identification number

If the user inputs 99 then the five remaining string variables read from QUESTS are printed out. The contents

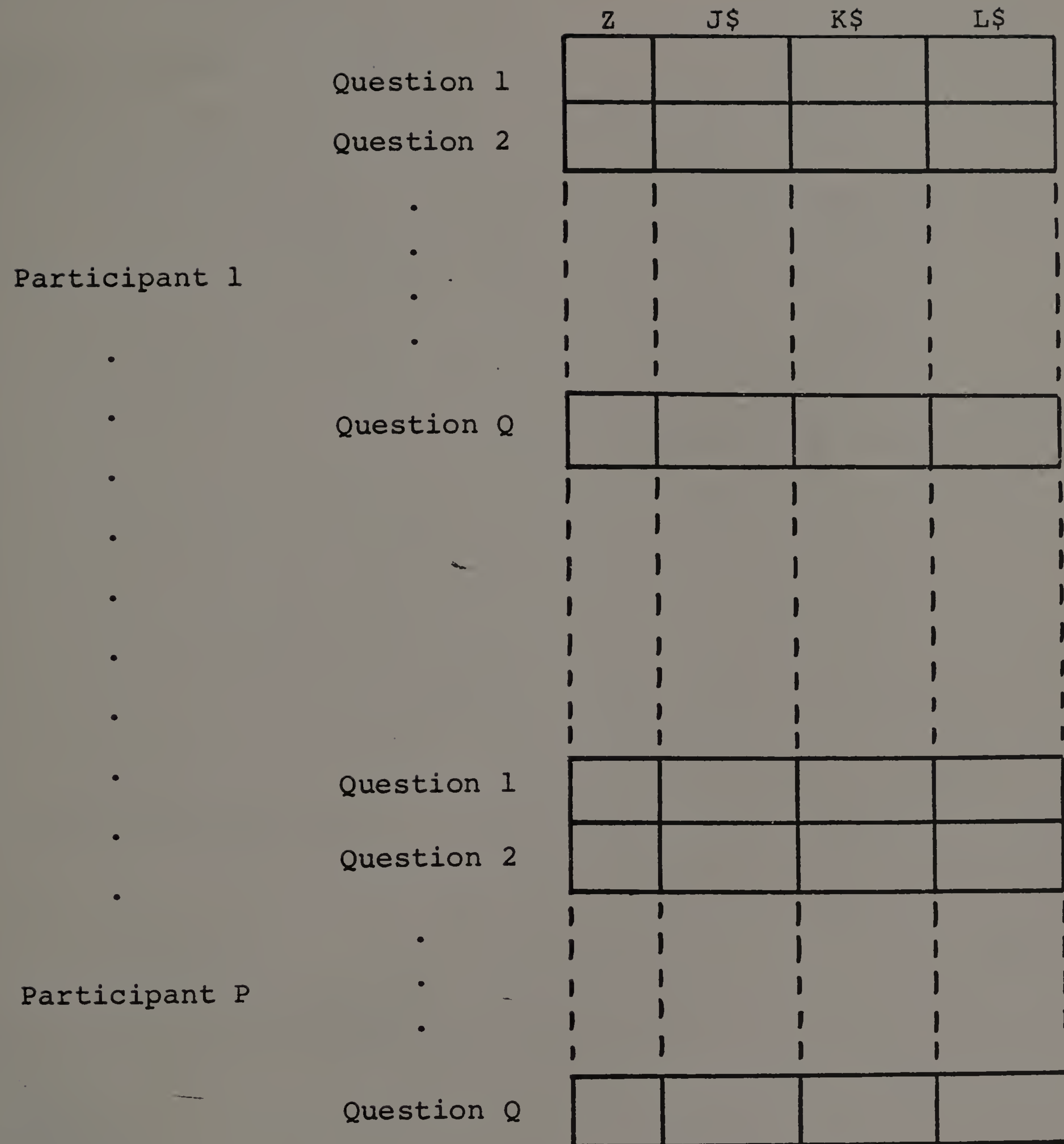

Figure 5-9 - File Structure of COMRND_ Files

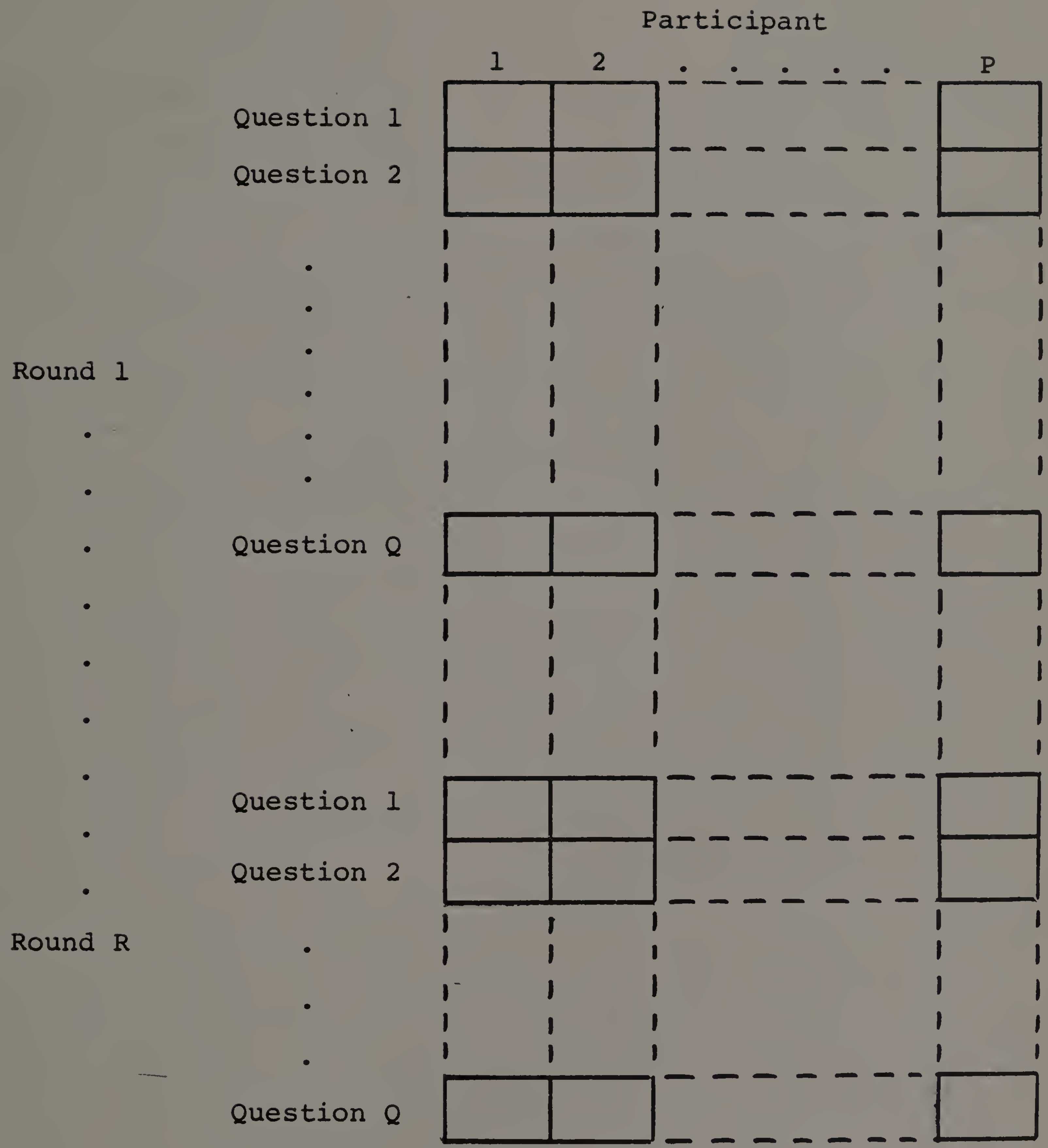

Figure 5-10 - File Structure of ROUNDS

of these variables are used to supplement the basic information in the questions. They may contain clarification, definitions, etc. that may help the user to formulate his response. After printing this information out the program loops back and requests:

WHAT IS YOUR RESPONSE FOR THIS ROUND?

After the response is accepted (after error checking) the program now prints out:

DO YOU HAVE ANY COMMENTS TO SUPPORT YOUR RESPONSE?
?

and, on the first question only, adds the following directions:

ALL COMMENTS ARE ALLOWED THREE TELETYPE LINES. IF A
LINE IS NOT USED, ENTER A BLANK (SPACE), A COMMA, AND
CARRIAGE RETURN. DO NOT USE COMMAS OTHERWISE.

The comments are placed into J$, K$ and L$ and are filed in the appropriate COMRND_ file preceeded by variable Z set equal to "0". the COMRND_ files are organized in accordance with Figure 5-9.

Since the string variables contain a variable number of computer words it is not possible to use an algorithm (as is done elsewhere in the programs) to find the starting pointer location for the retrieval of any particular set of comments. Instead a matrix of starting pointer locations is created in P. Matrix P is filed in POINTER and is then used as the source of information for the pointer operations required in the use of The COMRND_ files. Figure 5-11 shows

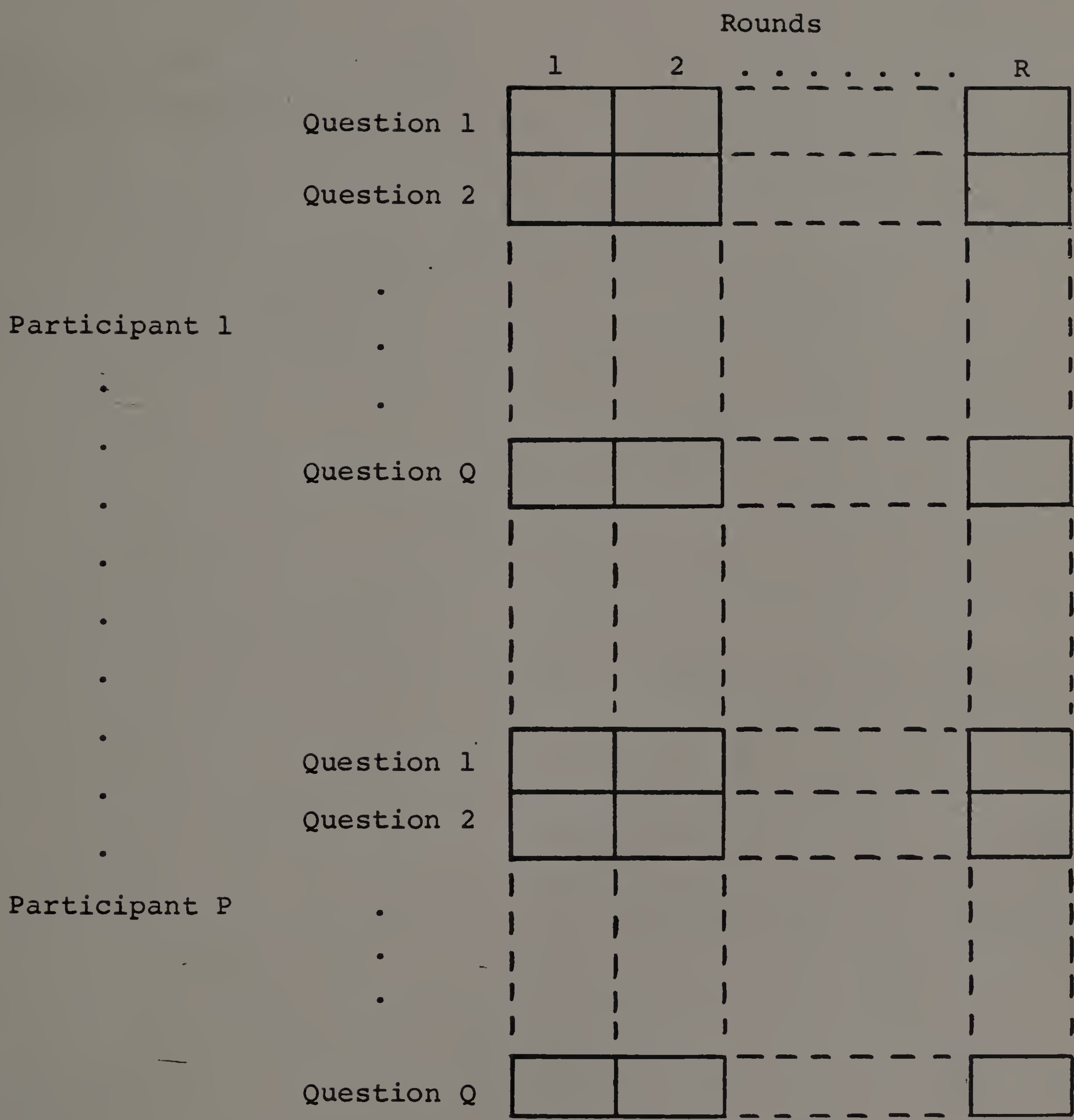

Figure 5-11 - File Structure of POINTER

the file structure for POINTER.

The final pointer location from the drum unit holding the new comments file is placed in variable K7.

At this point final housekeeping operations are begun in the program. Variable T is incremented by 1. This is a counter representing the number of users who have participated in a given round.

If T=P the variable is reset to "0" (since all participants have then completed the round and a new round should be readied). K7 is reset to "0" (since a new COMRND_ file will be used in the next round). Variable S is also incremented by 1. S contains the number of rounds completed. Variable W is set to "1". This will prevent further participation by the users until the moderator has reviewed the comments given in the round just completed and has selected a subset (perhaps, all) of these to be presented in the next round.

In all cases, variable Y, which has prevented other participants from accessing the files during the operation of this program, is reset to "0". Variables P,Q,R,S,T,W,K7, and Y are then re-written into file PARAS.

If T contains a "0" (after incrementing and reseting if appropriate) matrix G is updated. This matrix is a Q by 10 matrix. For each question the number of responses that were 1 are counted and the sum is placed in the first cell of the question's row; the same procedure is followed for all responses through 10. This is repeated for all questions. This matrix is then filed in GRAPH.

In the second round this matrix is used to create the output bar graph presented for each question. At the end of each round the file is updated and the old data is destroyed.

Additionally, if the round has been completed, i.e. if T has been reset to "0", elements N(1,2) through N(1,P+1) are also reset to "0". As described above each of these elements were set to "1" when each identification number was accepted by the program. At the completion of the round these elements will have been all set to "1" and must be reset for the start of the new round. The N matrix is then re-written in file NUM.

<u>Program STATUS</u>. This program is used by the moderator to monitor the progress and the status of the exercise. The program requires 16K of core.

File PARAS is first read. This is essential since this file contains the basic parameters that not only determine the dimensions of all matrices and arrays used by the program but also concisely state the status of the program at any given moment. The moderator is offered a choice of seven options as follows:

```
THE FOLLOWING OPTIONS ARE AVAILABLE TO YOU:
   1 PARAMETERS AND CURRENT STATUS OF EXPERIMENT
   2 QUESTIONS AND ADDITIONAL INFORMATION
   3 CHANGES TO QUESTIONS AND/OR ADDITIONAL INFORMATION
   4 NAMES OF PARTICIPANTS
   5 NUMERICAL RESPONSES
   6 PREVIOUS ROUND BAR GRAPHS
   7 COMMENTS REVIEW
```

If W contains a "1", i.e. if a round has been completed, the following is an example of a note appended to the above list:

```
NOTE: ROUND 1 HAS BEEN COMPLETED.  THE EXPERIMENT CAN-
      NOT CONTINUE UNTIL A SELECTION OF COMMENTS HAS
      BEEN MADE FROM ROUND 1 TO BE PRESENTED IN
      ROUND 2 . TO DO THIS INPUT 7.
```

The moderator is then requested to make his choice:

```
WHAT OPTION DO YOU WANT?  INPUT THE APPLICABLE NUMBER
SHOWN ABOVE.
?
```

The output resulting from a choice of the first option is illustrated by the following example:

```
PARAMETERS AND CURRENT STATUS OF EXPERIMENT:
   TOTAL PARTICIPANTS: 9
   TOTAL QUESTIONS: 6
   TOTAL ROUNDS: 3
   CURRENT ROUND: 1
   PARTICIPANTS COMPLETING THIS ROUND: 3
```

These parameters are obtained from PARAS. "TOTAL PARTICIPANTS" is contained in P, "TOTAL QUESTIONS" is contained in Q, and "TOTAL ROUNDS" is contained in R. The "CURRENT ROUND" is one plus the contents of S (the number of rounds completed) and the "PARTICIPANTS COMPLETING THIS ROUND" is, during the round, the contents of T and, at the completion of the round (i.e. W contains "1"), the contents of P.

If W contains a "1" the "CURRENT ROUND:" is replaced by

"ROUND n COMPLETED" where n represents the round number. If S=R then the "CURRENT ROUND" is replaced by "EXPERIMENT COMPLETED".

The output resulting from a selection of the second option involves a simple listing of each question in the system followed by its additional information (explanatory material). It is presented in the following form for each of the Q sets of questions and additional information:

```
QUESTIONS AND ADDITIONAL INFORMATION:

QUESTION 1 :
QUESTION 1 - LINE 1 OF 3
QUESTION 1 - LINE 2 OF 3
QUESTION 1 - LINE 3 OF 3

   ADDITIONAL INFORMATION ON QUESTION 1 :
ADDITIONAL INFORMATION - QUESTION 1 - LINE 1 OF 5
ADDITIONAL INFORMATION - QUESTION 1 - LINE 2 OF 5
ADDITIONAL INFORMATION - QUESTION 1 - LINE 3 OF 5
ADDITIONAL INFORMATION - QUESTION 1 - LINE 4 OF 5
ADDITIONAL INFORMATION - QUESTION 1 - LINE 5 OF 5
```

This information is obtained by reading the QUESTS file.

Option 3 gives the moderator the capability of changing or modifying any of the questions and/or the additional information. As the study progresses it may be necessary to clarify issues that are nebulous or to replace questions of low interest with questions of greater saliency to the participants. The following instructions are offered:

```
QUESTIONS AND/OR ADDITIONAL INFORMATION MAY BE CHANGED.

ALL QUESTIONS ARE ALLOWED THREE TELETYPE LINES. ADDI-
TIONAL INFORMATION ON EACH QUESTION IS ALLOWED FIVE
TELETYPE LINES.  IF A LINE IS NOT USED, ENTER A BLANK
(SPACE), A COMMA, AND CARRIAGE RETURN.  DO NOT USE
COMMAS OTHERWISE.
```

Questions and/or additional information may be modified.

Specifically which of these is next determined.

DO YOU WISH A QUESTION CHANGED? ANSWER
EITHER YES OR NO.
?

If the response is YES then the following results:

WHICH QUESTION DO YOU WISH TO CHANGE? ANSWER BY
NUMBER.
?

The moderator inputs the number of the question. This is followed by:

WHAT IS THE NEW QUESTION 1 ?

The moderator inputs the new question which is followed by:

DO YOU WISH ANOTHER QUESTION CHANGED? ANSWER
EITHER YES OR NO.
?

The cycle repeats for a YES response. If the response is NO either at this point or on the first pass the program prints out:

DO YOU WISH ADDITIONAL INFORMATION CHANGED? ANSWER
EITHER YES OR NO.
?

If the response is YES then the following output results:

WHICH SET OF ADDITIONAL INFORMATION DO YOU WISH
CHANGED? ANSWER BY NUMBER.
?

The moderator, as above, inputs the number of the set of additional information to be changed. This is followed by:

WHAT IS THE NEW ADDITIONAL INFORMATION FOR QUESTION 1 ?

The new set of additional information is accepted and the program responds with:

DO YOU WISH MORE ADDITIONAL INFORMATION CHANGED? ANSWER EITHER YES OR NO.
?

The cycle repeats for a YES response. If the response is NO either at this point or above the option is complete. As a last step the questions and the sets of additional information, which have been organized in core as 8 one dimensional arrays, are re-written as a new QUESTS file.

The selection of option 4 offers, in general, a choice between two sub-options. The following is printed out:

DO YOU WISH A LIST OF ALL PARTICIPANTS IN THE EXPERIMENT OR A LIST OF THOSE WHO HAVE PARTICIPATED SO FAR THIS ROUND? ANSWER EITHER ALL OR ROUND.
?

If the moderator responds ALL then a list of all those participating in the exercise is printed out. These names were accumulated during each participant's first round and were filed in NAMES. If variable W contains a "1", i.e. a round is complete, then no sub-option is offered and a list of all participants is printed.

If the moderator responds ROUND, the NUM file is read. All elements of matrix N from N(1,2) through N(1,P+1) are checked. Names from NAMES corresponding to those cells in N containing a "1" are printed out. These names will belong to those users who have participated so far in the current round. If variable S contains a "0", i.e. the first round is not yet finished, no sub-option is offered and only a list of all participants to date is printed out.

THE RESULTS OF ROUND 1 FOR QUESTION 1 WERE AS FOLLOWS:

```
  1Ø I
     I
   8 I
     I
   6 I
     I
   4 I                           x
     I                           x
   2 I                       x   x   x
     I---------------x-------x---x---x---x--------
         1   2   3   4   5   6   7   8   9   10
                 RESPONSE
```

This is similar to the output made in program STINT if the first option were taken. The data required for this print-out is contained in file GRAPH and is updated at the end of each round.

Option 7 may be exercised only at the completion of a round, i.e. if variable W contains a "1". If a round has been completed then a note is appended to the original listing of options indicating that the exercise of option 7 is required.

If a round has not been completed and option 7 is selected then output similar to the following example is generated:

```
ROUND 2 IS NOT COMPLETED YET. SELECTION OF COMMENTS
OCCURS ONLY AT THE END OF A ROUND.
```

Otherwise the program will print out for each question the comments made by all participants concerning that question. These comments are obtained from the appropriate COMRND_ file. The program then prints out:

```
PLEASE INDICATE WHETHER OR NOT YOU WANT EACH COMMENT
PRESENTED IN THE NEXT ROUND. ANSWER EITHER YES OR NO.
```

and for each comment in sequence prints out in the form of the example:

```
COMMENT 1 ?
```

If the moderator responds YES the Z variable associated with the three string variables containing that comment is set to "1". If the response is NO no change is made, i.e. variable Z continues to hold "0". The P matrix filed in POINTER is used to locate all comments.

At the completion of option 7 variable W (using W1 as a surrogate) is reset to "0" and the next round may begin.

All options in STATUS may be exercised by the moderator in any order and any number of times per round (except for option 7). At the completion of an option the following is printed out:

```
DO YOU WISH TO EXERCISE ANOTHER OPTION? ANSWER EITHER
YES OR NO.
?
```

If the response is YES the program begins the cycle again by requesting the number of the new option desired. If the response is NO the program terminates.

Summary

This chapter has reviewed a working model of an interactive MIS based on the theoretical analysis provided in the previous chapters.

The MIS gives to a user the ability to flexibly organize modules into a desired hierarchical structure. In order to accomplish this the programs are organized into two categories: the system and the module.

The system category contains one program (STINT) with its associated file. This is the tool used to organize the MIS for a particular application. A master module is designated and information on the structure of the MIS is contained on file in this module. Each module is contained in a separate access area on the timesharing system. For each module the access number, the access code and a list structure designating subordinate modules are contained in the master file.

The module category contains three programs (BASE, DELPHI, and STATUS). These programs are all interrelated through various files. Each module will utilize these programs; although the parameters in one module may differ greatly from the parameters in another module. The module is organized as an interactive Delphi. A module may obtain the results arrived at in its subordinate modules, but cannot access into other than its own subordinate modules.

The system was designed to be both interactive and flexible. It was also designed in such a way that relatively inexperienced users might be able to successfully participate and contribute to the management information system.

The next and last chapter will take a final overview of the system described. It will also take a look at some directions for future research in this area.

Footnotes

1. Assuming the maximum of five modules subordinate to each module for five levels, the total equals 1 + 5 + 25 + 125 + 625 = 781.

2. In the BASICX programming language on the UMASS system a simple alphanumeric variable may contain up to 8 alphanumeric characters and occupies one computer word. A string variable may contain up to 80 alphanumeric characters and occupies a computer word for every 8 characters or part thereof plus one control word. Thus anywhere from 2 to 11 words may be written on disk for each string variable entry. For example a variable containing 35 characters would occupy 6 computer words.

3. Under some conditions it might be preferable to issue random numbers to the partipants. This could be done by using the RND(X) function and saving the numbers created.

4. In BASIC/BASICX on the UMASS system a subscripted array and a simple variable may unambigously have the same simple alphabetic name, e.g. N.

CHAPTER VI

CONCLUSIONS

The last chapter described a working model of an interactive management information system designed on the basis of a hierarchical arrangement of Delphi modules. These modules were self-contained but results obtained in any module could be read by its immediate superior in the hierarchical structure. The programs and the files required for the operation of such an MIS were described and examples of output to the user (participant or moderator) were shown.

This final chapter will summarize the general theoretical framework presented in the dissertation and its incorporation into the working model of an MIS. It will also outline some areas that may possess potential for further research. Using the current status of the MIS as a base it will suggest questions for further exploration that may serve to expand the flexibility and capabilities resulting from this approach to MIS design.

Summary

The organization was viewed as an entity not in isolation. It was looked upon as an open system. As an open system the organization was, by definition, affected by its environment. Between such a system and its environment exists an interchange. This interchange may consist of materials, men, information, etc. singly or in combination. Although it is true that a completely closed system is an abstraction nevertheless a system may be more or less open, i.e. capable of interacting to a greater or to a lesser extent with its environment. The degree of openness is a key factor in the determination of many characteristics of the organization. As a result of the interactions occurring across its boundaries the organization is changed or modified in reaction to them and, in turn, changes or modifies elements within the environment.

An analogy with the human body was drawn. The body attempts to maintain the values of certain critical physiological variables within acceptable ranges (homeostasis). This is achieved through an unusually complex feedback system. The organization was viewed as attempting to homeostatically adapt to its environment but not in a static way as in the body but in a dynamic manner, i.e. the "acceptable ranges" may change also.

Viewed in the light of a hierarchy of systems capability the organization is at the most sophisticated level, i.e. capable of goal changing, in its adaptive movements.

Information was analyzed as that which reduces alternative choices. Information was derived from data but, in general, could not be inferred automatically. Data had to be reviewed within the context of a model. Out of data within a context arose information. A clear implication of this view was that differing models applied to the same data, in general, resulted in differing "pieces" of information.

A sub-set of the organizational adaptive process concerned only with information was next studied. Intelligence was looked at as an organizational function concerned with the reconciliation of information into a coherent whole or its definition of the alternative interpretations that could be reasonably inferred. Intelligence was viewed as always purposeful, i.e. it could be judged only in terms of a specific question or set of questions. Additionally the data under study must originate both internal to the organization and internal to the environment. Successful adaptation of the organization involves the utilization of data from both sources.

Strategic intelligence was that branch of intelligence concerned with the long range, with the very goals and objectives of the organization, and with questions that affect a significant part of the total effort of the organization. It could be oriented towards either the present or the future; although in most realistic applications these two orientations intertwine so extensively that both orientations must form an integral part of the intelligence effort. Strategic intelligence may also involve elements of planning, forecasting or both. It deals with uncertainty and may contain elements that are either self-fulfilling or self-defeating.

Strategic intelligence tends to take on a hierarchical aspect. The decomposition of a complex problem into simpler (and therefore more manageable) sub-problems appears to be both natural and effective. Such simplification with accompanying specialization reduces the danger of information overload and allows a movement from the general to the particular.

Intelligence system pathologies can probably not be completely eliminated. Any system designed for strategic intelligence purposes must take into account their omnipresent threat and must attempt to minimize their effect.

The Delphi technique is a systematic method for soliciting data that is difficult to quantify. Through controlled feedback and a series of iterations involving updating of participant responses the probability of a better interpretation of data is increased. This interpretation may approach consensus or may result in more sharply defined differences among the participants. The structure of the exercise involves anonymity which may reduce the influence of some irrelevant variables.

A Hegelian or a dialectical inquiry system is a philosophical approach that is appropriate to problems that are ill-defined, have opposing objectives, and require human experience or intuition. This system is a conflictual one. It is in the clash of ideas that the assumptions behind different positions will be exposed and subjected to rigorous challenge. Out of this dialectic will arise a more informed analysis and interpretation of the data.

Strategic intelligence does not fit the traditional mold of management science, which deals with well structured problems. Instead it closely fits the mold described as appropriate for a Hegelian inquiry system. As an ill-structured problem requiring much human judgement and "pattern recognition" it calls forth different models from those who attempt to infer information from a given set of data. Additionally there are policy considerations, i.e. the acceptance or, at least, toleration of the interpretation achieved may be required by some of all of the participants.

The human information processor is particularly efficient at abstracting patterns but inefficient at processing more than a small set of data. The digital computer, on the other hand, is efficient at the processing of data and inefficient at pattern recognition, where pattern recognition may be considered as a search for invariants, i.e.a quest for the familiar in a data-rich environment.

A management information system designed as a tool for organizational strategic intelligence applications has been described. This MIS was based on a two tier design and a working model was implemented on the UMASS timesharing system.

The fundamental building block was an interactive Delphi based module. A single module consisting of three programs and associated files was located in an individual access area on disk. The module was designed to be operated singly and autonomously as a single Delphi exercise.

The MIS consisted of interconnection of the basic modules into a hierarchical structure. A particular structure has to be created for a particular strategic intelligence application. Results from subordinate modules were made available to their immediately superior module. Except for this information flow capability all modules were designed so as to be independent of all other modules.

The described MIS was designed as a working model and not for an application for a particular organization within a particular environment. The goal was to demonstrate the feasibility of the design approach. It is suggested that systems of this type may serve as a valuable adjunct to more traditional management information systems.

Areas for Further Research

As stated above the MIS described would probably require adaptation for a particular area of application. The maximum value that a parameter can assume within a module, the number of string variables contained in each comment or question, and the maximum number of levels in the hierarchy are all examples of possible such adjustments. Such changes, in general, would not involve more than a minimal amount of re-programming. The areas for further research to be suggested in this section are more significant or far-reaching than these.

Answers or responses obtained in any investigation are no better than the questions asked. Responses obtained to the wrong question, even if consensus is achieved, may be correct (in some sense) but irrelevant to the study. Program STATUS offers the moderator the option of changing or modifying questions during an exercise. Such modification would normally be the result of participant inputs or an attempt to clarify or to reduce ambiguity in a question.

The basis for the initial set of questions, however, has not been investigated. This initial set could be the result of inputs from the participants; but the selection of participants is heavily dependent on the questions needing answers. Thus, although an adaptive capability with respect to questions is built into the MIS the development of an approach to making the initial selection has not been considered.

The second area for further study involves the weighting of participant or expert response. Implicit in the described MIS is an equal weighting of responses for all participants. Under some circumstances varied degrees of expertise in the subject area on the part of different participants might warrant different weightings, e.g. a participant with greater expertise might merit a heavier weight than a participant with less expertise in the relevant area. If this refinement is considered applicable then the determination of the appropriate weightings becomes important. The question of who should determine the weightings comes to the fore. There appear to be three possible answers: the participant, an objective outsider (perhaps the moderator), or the system itself.

The participant might rate himself (e.g. on a scale ranging from 0 to 1) on his own degree of expertise in the area under consideration. This factor could then be used to weight his responses throughout the exercise. In two different areas the same participant might weight his responses quite differently. If some of the participants have a personal involvement in the outcome of the exercise the results will be biased by their assignment of weights greater than that objectively justified. In an exercise involving no such involvement this approach might have some merit.

An outside weighter might be considered in some cases. However, in areas involving significant technical knowledge or experience only an expert can judge. The question may then be asked whether or not this objective outsider possessing such a background should not himself participate as an expert.

Another approach to weighting might be to build into the MIS a learning feature. The system could assume equal weighting for all participants as a starting point. After every strategic intelligence study the weighting factors could be updated, i.e. either reduced or increased. A participant could be rated on more than one area of expertise. The difficulty here is the determination of what basis to use to increase or decrease the weights. It cannot be argued that the "success" or "failure" of the intelligence estimate provides the rationale. Estimates may be inherently self-defeating or self-fulfilling. Beyond this it may be difficult to judge what is a good estimate. If it is granted that a good intelligence estimate was obtained it may be difficult to determine which participants contributed most to it.

Thus the question of non-equal weighting is a complex one but one that possesses significant potential for further research.

A third area is that of presentation of the previous round results. The MIS model described presents numerical responses in the form of a histogram. This format prevents the loss of information through filtering or statistical condensation. The question of whether or not this is the best format in a particular application remains an open one.

A fourth area involves expansion of the capability of the described MIS so as to include access into data bases outside of those directly required as MIS files. At present a simple approach to the obtaining of additional data is provided in the QUESTS file. This may be updated by the moderator when required. Between rounds within a module access to additional data beyond this must be obtained elsewhere. It should be possible to expand the options available to the participants so as to provide access to, at least, some independently established data bases of known file structure.

In short the described interactive hierarchical Delphi based MIS is a first step towards the development of an effective organizational tool for application in strategic intelligence.

A P P E N D I X A

IDENTIFICATION OF VARIABLES

THE SYSTEM

Program STINT

Simple Variables:

A - access number

C - access code

H
I - subscripting variables, indexes
J

K - counter containing next pointer location available in file HIER

L - number of levels in the hierarchy

L1
L2 - indexes
L3
L4

S - number of modules directly subordinate to another module

S1 - number of modules directly subordinate to the level 1 module

S2 - number of modules directly subordinate to a level 2 module

S3 - number of modules directly subordinate to a level 3 module

S4 - number of modules directly subordinate to a level 4 module

T - number of modules at a given level

X - pointer location

Y - option number (1 or 2)

Z - pointer location

Subscripted Variables:

M - matrix of pointer locations of subordinate module information (option 1)

- matrix of pointer locations of subordinate module information for level 1 module only (option 2)

N - matrix of pointer locations of subordinate module information for level 2 module

O - matrix of pointer locations of subordinate module information for level 3 module

P - matrix of pointer locations of subordinate module information for level 4 module

Q - dummy matrix of pointer locations of subordinate module information for level 5 module

THE MODULE

Common

Simple Variables:

I
J - miscellaneous indexes
K

K7 - pointer location for start of next comment

P - number of participants

Q - number of questions

R - number of rounds

S - number of rounds completed

T - number of participants completing current round

U
V - alphanumeric variables containing name of participant

W - switch to indicate end of round; prevents DELPHI from proceeding until comments are reviewed by STATUS (1=hold, 0=do not hold)

Y - switch to prevent two participants from accessing files at the same time; it is set to 1 at the start of a DELPHI execution and reset to 0 at the end

Z - switch to indicate whether or not particular comment will be presented in the next round (1=present, 0=do not present)

Subscripted Variables:

A - matrix containing numerical responses
1st dimension: number of questions x number of rounds
2nd dimension: number of participants

B$
C$ - string variable arrays containing questions
D$ dimension: number of questions

E$
F$
G$ - string variable array containing additional
H$ information
I$ dimension: number of questions

J$
K$ - string variable arrays containing comments
L$ dimension: number of participants

G - matrix of data for bar graph plots
1st dimension: number of questions
2nd dimension: 10

N - matrix containing identification information
1st dimension: 1
2nd dimension: number of participants +1
N(1,1) - counter for assigning ID numbers; each additional cell acts as a switch to indicate whether or not a participant (by ID number) has taken part during the current round (1=participated, 0=not participated)

P - matrix of pointers for comment locations
1st dimension: number of questions x number of participants
2nd dimension: number of rounds

Program BASE (Unique)

Simple Variables:

A - access number read from HIER file

C - access code read from HIER file

A1 - access number of master module

C1 - access code of master module

A2 - access number of interrogating module

C2 - access code of interrogating module

S1 - alphanumeric variable indicating whether or not the subordinate module option is exercised (YES or NO)

S2 - alphanumeric variable indicating whether or not the initializing option is exercised (YES or NO)

S9 - surrogate for S

Subscripted Variables:

M - matrix of pointer locations of modules directly subordinate to interrogating module

O - matrix of pointer locations of modules two levels subordinate to interrogating module

Program DELPHI (Unique)

Simple Variables:

F - alphanumeric variable indicating whether or not the current entry into the system is the participant's first (YES or NO)

G
H
K
K1 - miscellaneous pointer settings

N - identification number of current participant

X - variable used as surrogate for S

Subscripted Variables:

None

Program STATUS (Unique)

Simple Variables:

W1 - variable used as a surrogate for W

X1 - option number selected

X2 - alphanumeric variable indicating whether or not a question is to be changed (YES or NO)

X3 - number of question to be changed

X4 - alphanumeric variable indicating whether or not additional information is to be changed (YES or NO)

X5 - number of set of additional information to be changed

X6 - alphanumeric variable indicating type of list of participants desired (ALL or ROUND)

X7 - alphanumeric variable indicating whether or not a comment is to be presented in the next round (YES or NO)

X8 - alphanumeric variable indicating whether or not another option is to be exercised (YES or NO)

Subscripted Variables:

None

A P P E N D I X B

IDENTIFICATION OF FILES

THE SYSTEM

HIER - contains the access numbers, access codes and the hierarchical relationship between all modules in the system

THE MODULE

COMRND1 - contains the comments made by participants in round 1; contains data from three string variables (J$, K$, L$) and one simple variable (Z) per question per participant

COMRND2 - similar to above but contains comments from round 2

COMRND3 - similar to above but contains comments from round 3

COMRND4 - similar to above but contains comments from round 4

COMRND5 - similar to above but contains comments from round 5

GRAPH - contains data from subscripted variable G; used to plot bar graphs on previous round

NAMES - contains data from two simple alphanumeric variables (U,V) holding a name for each participant

NUM - contains data from subscripted variable N

PARAS - contains data from 8 simple variables (P,Q,R,S,T,W, K7, Y) with various parameter and status information

POINTER - contains data from subscripted variable P

QUESTS - contains data from 8 alphanumeric variables holding both the module questions (B$, C$, D$) and the sets of additional information (E$, F$, G$, H$, I$)

ROUNDS - contains data from subscripted variable A

NOTE: all files are binary.

A P P E N D I X C

PROGRAM LISTINGS

THE SYSTEM

Program STINT:

```
10 DIM M(1,5),N(1,5),O(1,5),P(1,5),Q(1,5)
20 OPEN 1,"HIER"
30 PRINT "THE FOLLOWING OPTIONS ARE AVAILABLE:"
40 PRINT "   1. INITIAL SET-UP OF SYSTEM ORGANIZATION"
50 PRINT "   2. PRINT OUT OF SYSTEM ORGANIZATION"
60 PRINT
70 PRINT "WHICH OPTION DO YOU WISH? ENTER NUMBER."
80 INPUT Y
90 IF Y=2 THEN 330
100 IF Y=1 THEN 130
110 PRINT "INPUT MUST BE EITHER 1 OR 2. PLEASE TRY AGAIN."
120 GO TO 80
125 #
130 PRINT "HOW MANY LEVELS IN THE SYSTEM";
140 INPUT L
160 IF L<1 THEN 1100
170 IF L>5 THEN 1100
180 IF L<>INT(L) THEN 1100
190 PRINT "FOR LEVEL 1 :"
200 J=1
210 GOSUB 800
220 FOR I=2TOL
230 N=T-N
240 PRINT
250 T=N
260 PRINT "FOR LEVEL";I;":"
270 FOR J=1TON
280 GOSUB 800
290 NEXT J
300 NEXT I
305 CLOSE 1
310 STOP
320 #
330 PRINT
340 PRINT "LEVEL 1   LEVEL 2   LEVEL 3   LEVEL 4   LEVEL 5"
350 READ (1) A,C,S1
360 MAT READ (1) M
370 PRINT A:A
380 FOR L1=1TOS1
390 X=M(1,L1)
400 SETPTR 1,X
410 READ (1) A,C,S2
420 MAT READ (1) N
430 PRINT "            ";A:A
```

```
440 FOR L2=1TOS2
450 X=N(1,L2)
460 SETPTR 1,X
470 READ (1) A,C,S3
480 MAT READ (1) O
490 PRINT "                              ";A:A
500 FOR L3=1TOS3
510 X=O(1,L3)
520 SETPTR 1,X
530 READ (1) A,C,S4
540 MAT READ (1) P
550 PRINT " "," ",A:A
560 FOR L4=1TOS4
570 X=P(1,L4)
580 SETPTR 1,X
590 READ (1) A,C
600 MAT READ (1) Q
610 PRINT " "," ","             ";A:A
620 NEXT L4
630 NEXT L3
640 NEXT L2
650 NEXT L1
660 CLOSE 1
670 STOP
680 #
800 PRINT "WHAT IS THE ACCESS NUMBER FOR MODULE";J;
810 INPUT A:A
820 PRINT "WHAT IS THE ACCESS CODE FOR MODULE";J;
830 INPUT C:A
840 S=0
850 IF I=L THEN 880
860 PRINT "HOW MANY MODULES ARE DIRECTLY SUBORDINATE TO THIS MODULE";
870 INPUT S
880 WRITE (1) A,C,S
890 FOR H=1TOS
900 M(1,H)=K+H*8
910 NEXT H
920 FOR H=S+1TO5
930 M(1,H)=9999
940 NEXT H
950 MAT WRITE (1) M
955 IF S=0 THEN 970
960 K=M(1,S)
970 GETPTR 1,Z
980 T=T+S
990 RETURN
1000 #
1100 PRINT "THE NUMBER OF LEVELS MUST BE AN INTEGER BETWEEN 1 AND 5."
1110 PRINT "PLEASE TRY AGAIN."
1120 GO TO 140
9999 END
```

THE MODULE

Program BASE:

```
10 # STINT MODULE BASE
20 DIM A(50,15),N(1,16),P(150,5),M(1,5),O(1,5)
30 PRINT "DO YOU WISH ACCESS TO SUBORDINATE MODULE RESULTS? ANSWER"
40 PRINT "EITHER YES OR NO."
50 INPUT S1:A
60 IF S1="NO" THEN 900
70 IF S1="YES" THEN 90
80 GOSUB 2000
85 GO TO 50
90 PRINT "FOR THE MASTER MODULE PLEASE SUPPLY THE FOLLOWING:"
100 PRINT "   ACCESS NUMBER";
110 INPUT A1:A
120 PRINT "   CODE";
130 INPUT C1:A
140 PRINT
150 PRINT "FOR THIS MODULE PLEASE SUPPLY THE FOLLOWING:"
160 PRINT "   ACCESS NUMBER";
170 INPUT A2:A
180 PRINT "   CODE";
190 INPUT C2:A
200 IF A1=A2 THEN 220
210 ACCESS A1,C1
220 OPEN 1,"HIER"
230 GETPTR 1,K,L
240 FOR I=1TOL/3
250 READ (1) A,C,S
260 MAT READ (1) M
270 IF A=A2 THEN 330
280 NEXT I
290 PRINT "ACCESS NUMBER DOES NOT MATCH MASTER FILE. PLEASE TRY AGAIN.
300 IF A1=A2 THEN 320
310 ACCESS A2,C2
320 GO TO 140
330 FOR I1=1TOS
340 X=M(1,I1)
350 SETPTR 1,X
360 READ (1) A,C,S1
370 MAT READ (1) O
380 ACCESS A,C
390 OPEN 3,"PARAS"
400 READ (3) P,Q,R,S9,T,W,K7,Y
410 CLOSE 3
415 MAT P=ZER(Q*P,R)
420 OPEN 4,"POINTER"
430 MAT READ (4) P
440 CLOSE 4
```

```
450 IF S9=R THEN 490
455 PRINT
460 PRINT "MODULE ";A:A;"HAS NOT BEEN COMPLETED YET. PLEASE TRY AGAIN"
470 PRINT "LATER."
480 GO TO 820
490 ON S9-1 GO TO 500,520,540,560
500 OPEN 4,"COMRND1"
510 GO TO 570
520 OPEN 4,"COMRND2"
530 GO TO 570
540 OPEN 4,"COMRND3"
550 GO TO 570
560 OPEN 4,"COMRND4"
570 OPEN 5,"QUESTS"
580 FOR I=1TOQ
590 READ (5) B$(I),C$(I),D$(I),E$(I),F$(I),G$(I),H$(I),I$(I)
600 NEXT I
610 CLOSE 5
615 PRINT
620 PRINT "RESULTS FROM MODULE ";A:A;":"
630 PRINT
632 OPEN 6,"GRAPH"
634 MAT G=ZER(Q,10)
636 MAT READ (6) G
638 CLOSE 6
640 FOR J=1TOQ
645 PRINT
650 PRINT B$(J)
660 PRINT C$(J)
670 PRINT D$(J)
680 PRINT
685 GOSUB 2100
690 PRINT "FINAL SIGNIFICANT COMMENTS ON THIS QUESTION WERE:"
700 PRINT
710 FOR K=JTOQ*PSTEP Q
720 K1=P(K,S9-1)
730 SETPTR 4,K1
740 READ (4) Z,J$,K$,L$
750 IF Z=0 THEN 790
760 PRINT J$
770 PRINT K$
780 PRINT L$
790 NEXT K
800 NEXT J
810 ACCESS A2,C2
815 CLOSE 4
820 NEXT I1
830 CLOSE 1
890 #
900 PRINT
905 PRINT "DO YOU WISH TO INITIALIZE THIS MODULE? ANSWER EITHER"
910 PRINT "YES OR NO."
```

```
920 INPUT S2:A
930 IF S2="NO" THEN 9999
940 IF S2="YES" THEN 970
950 GOSUB 2000
952 GO TO 920
955 #
960 # INITIALIZE "PARAS" FILE
970 PRINT
980 PRINT "FOR THE EXPERIMENT PLEASE ANSWER THE FOLLOWING QUESTIONS."
990 PRINT
1000 PRINT "   WHAT IS THE NUMBER OF PARTICIPANTS? (A MAXIMUM OF 15"
1010 PRINT "   IS ALLOWED.)"
1020 INPUT P
1030 IF P>15 THEN 1890
1040 IF P<1 THEN 1890
1050 IF P<>INT(P) THEN 1890
1060 PRINT
1070 PRINT "   WHAT IS THE NUMBER OF QUESTIONS? (A MAXIMUM OF 10"
1080 PRINT "   IS ALLOWED.)"
1090 INPUT Q
1100 IF Q>10 THEN 1920
1110 IF Q<1 THEN 1920
1120 IF Q<>INT(Q) THEN 1920
1130 PRINT
1140 PRINT "   WHAT IS THE NUMBER OF ROUNDS? (A MAXIMUM OF 5"
1150 PRINT "   IS ALLOWED.)"
1160 INPUT R
1170 IF R>5 THEN 1950
1180 IF R<1 THEN 1950
1190 IF R<>INT(R) THEN 1950
1200 PRINT
1210 S,T,W,K7,Y=0
1220 OPEN 1,"PARAS"
1230 WRITE (1) P,Q,R,S,T,W,K7,Y
1240 CLOSE 1
1250 #
1260 # INITIALIZE "QUESTS" FILE
1270 OPEN 2,"QUESTS"
1280 PRINT
1290 PRINT "ALL QUESTIONS ARE ALLOWED THREE TELETYPE LINES. ADDI-"
1300 PRINT "TIONAL INFORMATION ON EACH QUESTION IS ALLOWED FIVE"
1310 PRINT "TELETYPE LINES. IF A LINE IS NOT USED, ENTER A BLANK"
1320 PRINT "(SPACE), A COMMA, AND CARRIAGE RETURN. DO NOT USE"
1330 PRINT "COMMAS OTHERWISE."
1340 PRINT
1350 FOR I=1 TO Q
1360 PRINT "WHAT IS QUESTION";I;
1370 INPUT B$(I)
1380 INPUT C$(I)
1390 INPUT D$(I)
1400 PRINT
```

```
1410 PRINT "WHAT ADDITIONAL INFORMATION DO YOU HAVE ON QUESTION";I;
1420 INPUT E$(I)
1430 INPUT F$(I)
1440 INPUT G$(I)
1450 INPUT H$(I)
1460 INPUT I$(I)
1470 PRINT
1480 PRINT
1490 WRITE (2) B$(I),C$(I),D$(I),E$(I),F$(I),G$(I),H$(I),I$(I)
1500 NEXT I
1510 CLOSE 2
1520 #
1530 # INITIALIZE "NUM" FILE
1540 OPEN 3,"NUM"
1550 MAT N=ZER(1,P+1)
1560 MAT WRITE (3) N
1570 CLOSE 3
1580 #
1590 # INITIALIZE "NAMES" FILE
1600 OPEN 4,"NAMES"
1610 FOR I=1TOP
1620 U,V="          "
1630 WRITE (4) U,V
1640 NEXT I
1650 CLOSE 4
1660 #
1670 # INITIALIZE "GRAPH" FILE
1680 OPEN 5,"GRAPH"
1690 MAT G=ZER(Q,10)
1700 MAT WRITE (5) G
1710 CLOSE 5
1740 #
1750 # INITIALIZE "ROUNDS" FILE
1760 OPEN 6,"ROUNDS"
1770 MAT A=ZER(Q*R,P)
1780 MAT WRITE (6) A
1790 CLOSE 6
1800 #
1810 # INITIALIZE "POINTER" FILE
1820 OPEN 7,"POINTER"
1830 MAT P=ZER(Q*P,R)
1840 MAT WRITE (7) P
1850 CLOSE 7
1860 GO TO 9999
1870 #
1880 # ERROR MESSAGES
1890 PRINT "THE NUMBER OF PARTICIPANTS MUST BE AN INTEGER BETWEEN"
1900 PRINT "1 AND 15. PLEASE TRY AGAIN."
1910 GO TO 1020
1920 PRINT "THE NUMBER OF QUESTIONS MUST BE AN INTEGER BETWEEN"
1930 PRINT "1 AND 10. PLEASE TRY AGAIN."
1940 GO TO 1090
```

```
1950 PRINT "THE NUMBER OF ROUNDS MUST BE AN INTEGER BETWEEN 1 AND"
1960 PRINT "5. PLEASE TRY AGAIN."
1970 GO TO 1160
2000 PRINT "YOUR RESPONSE MUST BE EITHER YES OR NO. PLEASE TRY AGAIN.
2010 RETURN
2090 #
2100 # PRESENTATION OF FINAL BAR GRAPH
2110 PRINT "THE RESULTS FOR QUESTION";J;"WERE AS FOLLOWS:"
2120 PRINT
2130 FOR I3=PTO1STEP-1
2140 IF I3/2<>INT(I3/2) THEN 2180
2142 PRINT USING 2145
2145 FIELD (1H )
2150 PRINT USING 2160, I3
2160 FIELD (1H-,F4.0," I")
2170 GO TO 2210
2180 PRINT
2190 PRINT USING 2200
2200 FIELD (1H-,4X," I")
2210 FOR I2=1TO10
2220 IF G(J,I2)<>I3 THEN 2270
2230 G(J,I2)=G(J,I2)-1
2240 PRINT USING 2250
2250 FIELD (1H-,3X,"X")
2260 GO TO 2290
2270 PRINT USING 2280
2280 FIELD (1H-,4X)
2290 NEXT I2
2300 PRINT USING 2310
2310 FIELD (1H+)
2320 NEXT I3
2330 PRINT
2340 PRINT "         -------------------------------------------"
2350 PRINT "           1   2   3   4   5   6   7   8   9  10"
2360 PRINT "                       RESPONSE"
2370 PRINT
2380 RETURN
9999 END
```

Program DELPHI:

```
10 # AN INTERACTIVE DELPHI
20 DIM A(50,15),N(1,16),P(150,5)
30 #
40 # EXPERIMENT PARAMETERS
50 OPEN 1,"PARAS"
60 READ (1) P,Q,R,S,T,W,K7,Y
70 IF W=1 THEN 2820
80 IF Y=1 THEN 2850
90 X=S
100 Y=1
110 REWIND 1
120 WRITE (1) P,Q,R,S,T,W,K7,Y
130 CLOSE 1
140 MAT N=ZER(1,P+1)
150 MAT P=ZER(Q*P,R)
160 MAT A=ZER(Q*R,P)
170 OPEN 2,"NUM"
180 MAT READ (2) N
190 N=N(1,1)+1
200 OPEN 1,"POINTER"
210 MAT READ (1) P
220 CLOSE 1
230 #
240 # ID SECTION
250 IF S<>0 THEN 330
260 PRINT
270 PRINT "IS THIS YOUR FIRST ROUND FOR THIS EXPERIMENT?"
280 PRINT "ANSWER EITHER YES OR NO."
290 INPUT F:A
300 IF F="YES" THEN 440
310 IF F<>"NO" THEN 1670
320 GO TO 1740
330 PRINT
340 PRINT "WHAT IS YOUR ID NUMBER?"
350 INPUT N
360 PRINT
370 IF N>P THEN 1700
380 IF N<1 THEN 1700
390 IF N<>INT(N) THEN 1700
400 IF N(1,N+1)<>1 THEN 420
410 GO TO 1740
420 IF S=R THEN 650
430 GO TO 580
440 OPEN 3,"NAMES"
450 PRINT
460 PRINT "WHAT IS YOUR NAME? (IT WILL BE KEPT CONFIDENTIAL.)"
470 PRINT "YOUR NAME MUST BE FROM 9 TO 16 CHARACTERS LONG"
480 PRINT "INCLUSIVE. USE BLANKS, IF NECESSARY."
490 INPUT U:A,V:A
```

```
500 K=2*(N-1)
510 SETPTR 3,K
520 WRITE (3) U,V
530 CLOSE 3
540 PRINT
550 PRINT "YOUR IDENTIFICATION NUMBER FOR THIS EXPERIMENT IS";N
560 PRINT "PLEASE REMEMBER IT FOR FUTURE ROUNDS."
570 PRINT
580 REWIND 2
590 N(1,N+1)=1
600 N(1,1)=N
610 MAT WRITE (2) N
620 CLOSE 2
630 #
640 # RESPONSE SECTION
650 OPEN 4, "QUESTS"
660 FOR I=1TOQ
670 READ (4) B$(I),C$(I),D$(I),E$(I),F$(I),G$(I),H$(I),I$(I)
680 NEXT I
690 CLOSE 4
700 IF S=R THEN 780
710 GOSUB 2600
720 PRINT "ALL QUESTIONS SHOULD BE ANSWERED ON A SCALE RANGING"
730 PRINT "FROM A LOW OF 1 TO A HIGH OF 10."
740 PRINT "IF YOU WISH ADDITIONAL INFORMATION ON ANY QUESTION"
750 PRINT "ANSWER 99."
760 OPEN 5,"ROUNDS"
770 MAT READ (5) A
780 OPEN 6,"GRAPH"
790 MAT G=ZER(Q,10)
800 MAT READ (6) G
810 J=1
820 SETPTR 6,G
830 FOR I=Q*S+1TO(S+1)*Q
840 PRINT
850 PRINT B$(J)
860 PRINT C$(J)
870 PRINT D$(J)
880 PRINT
890 IF S=0 THEN 980
900 GOSUB 3000
960 PRINT
965 IF S=R THEN 980
970 GOSUB 2300
980 J=J+1
990 IF S=R THEN 1190
1000 PRINT "   WHAT IS YOUR RESPONSE FOR THIS ROUND?"
1010 INPUT A(I,N)
1020 IF A(I,N)<>99 THEN 1090
1030 PRINT E$(J-1)
1040 PRINT F$(J-1)
1050 PRINT G$(J-1)
```

```
1060 PRINT H$(J-1)
1070 PRINT I$(J-1)
1080 GO TO 1000
1090 IF A(I,N)>10 THEN 1150
1100 IF A(I,N)<1 THEN 1150
1110 IF A(I,N)<>INT(A(I,N)) THEN 1150
1120 IF S=R-1 THEN 1190
1130 GOSUB 2000
1140 GO TO 1190
1150 PRINT
1160 PRINT "YOUR RESPONSE MUST BE AN INTEGER BETWEEN 1 AND 10."
1170 PRINT "PLEASE TRY AGAIN."
1180 GO TO 1000
1190 NEXT I
1200 GETPTR 7,K7
1210 IF S=R THEN 1340
1220 REWIND 5
1230 MAT WRITE (5) A
1240 #
1250 # UPDATE PARAMETERS
1260 CLOSE 7
1270 OPEN 1,"PARAS"
1280 T=T+1
1290 IF T<>P THEN 1330
1300 T,K7=0
1310 S=S+1
1315 IF S=R THEN 1330
1320 W=1
1330 Y=0
1340 WRITE (1) P,Q,R,S,T,W,K7,Y
1350 CLOSE 1
1360 IF T<>0 THEN 1610
1390 #
1400 # CALCULATE GRAPH DATA
1410 MAT G=ZER(Q,10)
1420 X=(S-1)*Q*P
1430 SETPTR 5,X
1440 FOR I=1TOQ
1450 FOR J=1TOP
1460 READ (5) H
1470 G(I,H)=G(I,H)+1
1480 NEXT J
1490 NEXT I
1500 MAT WRITE (6) G
1510 CLOSE 5
1520 CLOSE 6
1530 #
1540 # RESET "NUM" FILE AT END OF ROUND
1550 OPEN 2,"NUM"
1560 FOR I=2 TO P+1
1570 N(1,I)=0
1580 NEXT I
```

```
1590 MAT WRITE (2) N
1600 CLOSE 2
1605 #
1610 OPEN 1,"POINTER"
1620 MAT WRITE (1) P
1630 CLOSE 1
1640 GO TO 1870
1650 #
1660 # ERROR MESSAGES
1670 PRINT "YOUR RESPONSE MUST BE EITHER YES OR NO."
1680 PRINT "PLEASE TRY AGAIN."
1690 GO TO 290
1700 PRINT "YOUR ID NUMBER MUST BE AN INTEGER BETWEEN 1 AND";P
1710 PRINT "IT WAS THE NUMBER ASSIGNED TO YOU IN ROUND 1. PLEASE"
1720 PRINT "TRY AGAIN."
1730 GO TO 340
1740 PRINT
1750 PRINT "ROUND";S+1;"IS NOT COMPLETED YET. PLEASE TRY AGAIN"
1760 PRINT "AT A LATER TIME."
1770 OPEN 1,"PARAS"
1780 Y=0
1790 WRITE (1) P,Q,R,S,T,W,K7,Y
1800 CLOSE 1
1810 GO TO 9999
1820 #
1830 # FINAL MESSAGES
1840 PRINT
1850 PRINT "THANK YOU FOR PARTICIPATING IN THIS EXPERIMENT."
1860 GO TO 1770
1870 IF X+1<>R THEN 9999
1880 PRINT
1890 PRINT "THE RESULTS OF THIS FINAL ROUND WILL BE AVAILABLE"
1900 PRINT "TO YOU AT ITS CONCLUSION."
1910 GO TO 9999
1920 #
2000 # COMMENTS INPUT
2010 PRINT
2020 PRINT "DO YOU HAVE ANY COMMENTS TO SUPPORT YOUR RESPONSE?"
2030 IF I<>1 THEN 2070
2040 PRINT "ALL COMMENTS ARE ALLOWED THREE TELETYPE LINES. IF A"
2050 PRINT "LINE IS NOT USED, ENTER A BLANK (SPACE), A COMMA, AND"
2060 PRINT "CARRIAGE RETURN. DO NOT USE COMMAS OTHERWISE."
2070 INPUT J$
2080 INPUT K$
2090 INPUT L$
2100 Z=0
2110 GETPTR 7,K1
2120 WRITE (7) Z,J$,K$,L$
2130 P(Q*(N-1)+J-1,S+1)=K1
2140 RETURN
2150 #
```

```
2300 # COMMENTS OUTPUT
2310 PRINT "SIGNIFICANT COMMENTS ON THIS QUESTION FROM ROUND";S;
2320 PRINT "WERE:"
2330 PRINT
2340 FOR K=J TO Q*P STEP Q
2350 K1=P(K,S)
2360 SETPTR 8,K1
2370 READ (8) Z,J$,K$,L$
2380 IF Z=0 THEN 2430
2390 PRINT J$
2400 PRINT K$
2410 PRINT L$
2420 PRINT
2430 NEXT K
2440 RETURN
2450 #
2600 # COMMENTS FILES SELECTION
2610 IF S=0 THEN 2700
2620 ON S GO TO 2630,2650,2670,2690
2630 OPEN 8,"COMRND1"
2640 GO TO 2700
2650 OPEN 8,"COMRND2"
2660 GO TO 2700
2670 OPEN 8,"COMRND3"
2680 GO TO 2700
2690 OPEN 8,"COMRND4"
2700 ON S+1 GO TO 2710,2730,2750,2770,2790
2710 OPEN 7,"COMRND1"
2720 GO TO 2800
2730 OPEN 7,"COMRND2"
2740 GO TO 2800
2750 OPEN 7,"COMRND3"
2760 GO TO 2800
2770 OPEN 7,"COMRND4"
2780 GO TO 2800
2790 OPEN 7,"COMRND5"
2800 SETPTR 7,K7
2810 RETURN
2815 #
2820 PRINT "ROUND";S;"IS NOT COMPLETED YET. PLEASE TRY AGAIN"
2830 PRINT "AT A LATER TIME."
2840 GO TO 9999
2850 PRINT "THE SYSTEM IS CURRENTLY BEING USED. PLEASE TRY AGAIN"
2860 PRINT "AT A LATER TIME."
2870 STOP
2990 #
3000 # PRESENTATION OF BAR GRAPH
3010 PRINT "THE RESULTS OF ROUND";S;"FOR QUESTION";J;"WERE AS FOLLOWS
3020 PRINT
3030 FOR I1=PTO1STEP-1
3040 IF I1/2<>INT(I1/2) THEN 3080
3042 PRINT USING 3045
```

```
3Ø45 FIELD (1H )
3Ø5Ø PRINT USING 3Ø6Ø, I1
3Ø6Ø FIELD (1H-,F4.Ø," I")
3Ø7Ø GO TO 3Ø9Ø
3Ø8Ø PRINT
3Ø85 PRINT USING 3Ø86
3Ø86 FIELD (1H-,4X," I")
3Ø9Ø FOR I2=1TO1Ø
31ØØ IF G(J,I2)<>I1 THEN 315Ø
311Ø G(J,I2)=G(J,I2)-1
312Ø PRINT USING 313Ø
313Ø FIELD (1H-,3X,"X")
314Ø GO TO 317Ø
315Ø PRINT USING 316Ø
316Ø FIELD (1H-,4X)
317Ø NEXT I2
318Ø PRINT USING 3185
3185 FIELD (1H+)
319Ø NEXT I1
3195 PRINT
32ØØ PRINT "        -----------------------------------------"
321Ø PRINT "          1   2   3   4   5   6   7   8   9  1Ø"
322Ø PRINT "                      RESPONSE"
323Ø PRINT
324Ø RETURN
9999 END
```

Program STATUS:

```
010 # MODERATORS ACCESS TO FILES
020 DIM A(50,15),N(1,16),P(150,5)
040 OPEN 1,"PARAS"
050 READ (1) P,Q,R,S,T,W,K7,Y
055 W1=W
060 MAT A=ZER(Q*R,P)
070 MAT N=ZER(1,P+1)
080 MAT P=ZER(Q*P,R)
090 #
100 PRINT "THE FOLLOWING OPTIONS ARE AVAILABLE TO YOU:"
110 PRINT "   1 PARAMETERS AND CURRENT STATUS OF EXPERIMENT"
120 PRINT "   2 QUESTIONS AND ADDITIONAL INFORMATION"
130 PRINT "   3 CHANGES TO QUESTIONS AND/OR ADDITIONAL INFORMATION"
140 PRINT "   4 NAMES OF PARTICIPANTS"
150 PRINT "   5 NUMERICAL RESPONSES"
160 PRINT "   6 PREVIOUS ROUND BAR GRAPHS"
170 PRINT "   7 COMMENTS REVIEW"
180 PRINT
190 IF W<>1 THEN 250
200 PRINT "NOTE: ROUND";S;"HAS BEEN COMPLETED. THE EXPERIMENT CAN-"
210 PRINT "      NOT CONTINUE UNTIL A SELECTION OF COMMENTS HAS"
220 PRINT "      BEEN MADE FROM ROUND";S;"TO BE PRESENTED IN"
230 PRINT "      ROUND";S+1;". TO DO THIS INPUT 7."
240 PRINT
250 PRINT "WHAT OPTION DO YOU WANT? INPUT THE APPLICABLE NUNBER"
260 PRINT "SHOWN ABOVE."
270 INPUT X1
280 IF X1<1 THEN 320
290 IF X1>7 THEN 320
300 IF X1<>INT(X1) THEN 320
310 ON X1 GO TO 400,600,800,1500,1800,2100,2300
320 PRINT "YOUR INPUT MUST BE AN INTEGER BETWEEN 1 AND 7."
330 PRINT "PLEASE TRY AGAIN."
340 GO TO 270
390 #
400 PRINT
410 PRINT "PARAMETERS AND CURRENT STATUS OF EXPERIMENT:"
420 PRINT "   TOTAL PARTICIPANTS:";P
430 PRINT "   TOTAL QUESTIONS:";Q
440 PRINT "   TOTAL ROUNDS:";R
450 IF W=1 THEN 500
460 PRINT "   CURRENT ROUND:";S+1
470 IF S+1<>R THEN 540
480 PRINT "      (THIS IS THE FINAL ROUND.)"
490 GO TO 540
500 IF S=R THEN 530
510 PRINT "   ROUND";S;"COMPLETED"
520 GO TO 540
530 PRINT "   EXPERIMENT COMPLETED"
```

```
540 IF W=1 THEN 570
550 PRINT "   PARTICIPANTS COMPLETING THIS ROUND:";T
560 GO TO 2830
570 PRINT "   PARTICIPANTS COMPLETING THIS ROUND:";P
580 GO TO 2830
590 #
600 PRINT "QUESTIONS AND ADDITIONAL INFORMATION:"
610 OPEN 2,"QUESTS"
620 PRINT
630 FOR I=1 TO Q
640 READ (2) B$(I),C$(I),D$(I),E$(I),F$(I),G$(I),H$(I),I$(I)
650 PRINT "QUESTION";I;":"
660 PRINT B$(I)
670 PRINT C$(I)
680 PRINT D$(I)
690 PRINT
700 PRINT "   ADDITIONAL INFORMATION ON QUESTION";I;":"
710 PRINT E$(I)
720 PRINT F$(I)
730 PRINT G$(I)
740 PRINT H$(I)
750 PRINT I$(I)
760 PRINT
770 NEXT I
775 CLOSE 2
780 GO TO 2830
790 #
800 OPEN 2,"QUESTS"
801 FOR I=1TOQ
802 READ (2) B$(I),C$(I),D$(I),E$(I),F$(I),G$(I),H$(I),I$(I)
803 NEXT I
804 REWIND 2
805 PRINT "QUESTIONS AND/OR ADDITIONAL INFORMATION MAY BE CHANGED."
810 PRINT
820 PRINT "ALL QUESTIONS ARE ALLOWED THREE TELETYPE LINES. ADDI-"
830 PRINT "TIONAL INFORMATION ON EACH QUESTION IS ALLOWED FIVE"
840 PRINT "TELETYPE LINES. IF A LINE IS NOT USED, ENTER A BLANK"
850 PRINT "(SPACE), A COMMA, AND CARRIAGE RETURN. DO NOT USE"
860 PRINT "COMMAS OTHERWISE."
870 PRINT
880 PRINT "DO YOU WISH A QUESTION CHANGED? ANSWER"
890 GO TO 910
900 PRINT "DO YOU WISH ANOTHER QUESTION CHANGED? ANSWER"
910 PRINT "EITHER YES OR NO."
920 INPUT X2:A
930 IF X2="NO" THEN 1130
940 IF X2<>"YES" THEN 1070
950 PRINT "WHICH QUESTION DO YOU WISH TO CHANGE? ANSWER BY"
960 PRINT "NUMBER."
970 INPUT X3
980 IF X3<1 THEN 1100
990 IF X3>Q THEN 1100
```

```
1000 IF X3<>INT(X3) THEN 1100
1010 PRINT "WHAT IS THE NEW QUESTION";X3;
1020 INPUT B$(X3)
1030 INPUT C$(X3)
1040 INPUT D$(X3)
1050 PRINT
1060 GO TO 900
1070 PRINT "YOUR ANSWER MUST BE EITHER YES OR NO. PLEASE"
1080 PRINT "TRY AGAIN."
1090 GO TO 920
1100 PRINT "YOUR QUESTION NUMBER MUST BE AN INTEGER BETWEEN"
1110 PRINT "1 AND";Q
1120 GO TO 970
1130 PRINT "DO YOU WISH ADDITIONAL INFORMATION CHANGED? ANSWER"
1140 GO TO 1160
1150 PRINT "DO YOU WISH MORE ADDITIONAL INFORMATION CHANGED? ANSWER"
1160 PRINT "EITHER YES OR NO."
1170 INPUT X4:A
1180 IF X4="NO" THEN 1400
1190 IF X4<>"YES" THEN 1340
1200 PRINT "WHICH SET OF ADDITIONAL INFORMATION DO YOU WISH"
1210 PRINT "CHANGED? ANSWER BY NUMBER."
1220 INPUT X5
1230 IF X5<1 THEN 1370
1240 IF X5>Q THEN 1370
1250 IF X5<>INT(X5) THEN 1370
1260 PRINT "WHAT IS THE NEW ADDITIONAL INFORMATION FOR QUESTION";X5;
1270 INPUT E$(X5)
1280 INPUT F$(X5)
1290 INPUT G$(X5)
1300 INPUT H$(X5)
1310 INPUT I$(X5)
1320 PRINT
1330 GO TO 1150
1340 PRINT "YOUR ANSWER MUST BE EITHER YES OR NO. PLEASE"
1350 PRINT "TRY AGAIN."
1360 GO TO 1170
1370 PRINT "YOUR NUMBER MUST BE AN INTEGER BETWEEN 1 AND";Q
1380 GO TO 1220
1400 FOR I=1TOQ
1410 WRITE (2) B$(I),C$(I),D$(I),E$(I),F$(I),G$(I),H$(I),I$(I)
1420 NEXT I
1430 CLOSE 2
1440 GO TO 2830
1490 #
1500 OPEN 3,"NAMES"
1510 IF S=0 THEN 1590
1520 IF W=1 THEN 1640
1530 PRINT "DO YOU WISH A LIST OF ALL PARTICIPANTS IN THE EXPERIMENT"
1540 PRINT "OR A LIST OF THOSE WHO HAVE PARTICIPATED SO FAR THIS"
1550 PRINT "ROUND? ANSWER EITHER ALL OR ROUND."
1560 INPUT X6:A
```

```
1570 IF X6="ALL" THEN 1640
1580 IF X6<>"ROUND" THEN 1770
1590 OPEN 4,"NUM"
1600 MAT READ (4) N
1605 PRINT
1610 PRINT "PARTICIPANTS SO FAR IN ROUND";S+1;":"
1620 PRINT
1630 GO TO 1680
1635 PRINT
1640 PRINT "PARTICIPANTS IN EXPERIMENT:"
1660 PRINT
1670 MAT N=CON(1,P+1)
1680 FOR I=1TOP
1690 READ (3) U,V
1700 IF N(1,I+1)=0 THEN 1730
1710 PRINT "NAME";I;"IS: ";U:A;V:A
1720 PRINT
1730 NEXT I
1740 CLOSE 4
1750 CLOSE 3
1760 GO TO 2830
1770 PRINT "YOUR ANSWER MUST BE EITHER ALL OR ROUND. PLEASE"
1780 PRINT "TRY AGAIN."
1790 GO TO 1560
1795 #
1800 OPEN 5,"ROUNDS"
1805 PRINT
1810 PRINT "NUMERICAL RESPONSES:"
1820 PRINT
1830 MAT READ (5) A
1840 FOR I=1 TO S+1-W
1850 PRINT "ROUND";I
1860 PRINT "----- -"
1880 PRINT "                    PARTICIPANT NUMBER"
1885 PRINT "                    ";
1890 FOR J=1 TO P
1900 PRINT USING 1910,J
1910 FIELD (1H-,F4.0)
1920 NEXT J
1930 PRINT
1940 FOR J=Q*(I-1)+1 TO I*Q
1950 PRINT USING 1960,J-Q*(I-1)
1960 FIELD(1H-,"QUESTION ",F2.0,2X)
1970 FOR K=1 TO P
1980 PRINT USING 1990,A(J,K)
1990 FIELD (1H-,F4.0)
2000 NEXT K
2010 PRINT
2020 NEXT J
2030 PRINT
2040 NEXT I
2045 IF W=1 THEN 2070
```

```
2050 PRINT "NOTE: A ZERO ENTRY SIGNIFIES THAT NO RESPONSE HAS"
2060 PRINT "       BEEN MADE YET."
2070 PRINT
2080 CLOSE 5
2090 GO TO 2330
2095 #
2100 IF S<>0 THEN 2125
2105 PRINT "A BAR GRAPH IS NOT AVAILABLE UNTIL THE COMPLETION"
2110 PRINT "OF, AT LEAST, THE FIRST ROUND."
2115 PRINT
2120 GO TO 2330
2125 OPEN 6,"GRAPH"
2127 MAT G=ZER(Q,10)
2128 MAT READ (6) G
2129 FOR J=1TOQ
2130 PRINT "THE RESULTS OF ROUND";S;"FOR QUESTION";J;"WERE AS FOLLOWS:
2135 PRINT
2140 FOR I1=PTO1STEP-1
2145 IF I1/2<>INT(I1/2) THEN 2175
2150 PRINT USING 2155
2155 FIELD (1H )
2160 PRINT USING 2165, I1
2165 FIELD (1H-,F4.0," I")
2170 GO TO 2190
2175 PRINT
2180 PRINT USING 2185
2185 FIELD (1H-,4X," I")
2190 FOR I2=1TO10
2195 IF G(J,I2)<>I1 THEN 2220
2200 G(J,I2)=G(J,I2)-1
2205 PRINT USING 2210
2210 FIELD (1H-,3X,"X")
2215 GO TO 2230
2220 PRINT USING 2225
2225 FIELD (1H-,4X)
2230 NEXT I2
2235 PRINT USING 2240
2240 FIELD (1H+)
2245  NEXT I1
2250 PRINT
2255 PRINT "       ----------------------------------------"
2260 PRINT "        1   2   3   4   5   6   7   8   9  10"
2265 PRINT "                    RESPONSE"
2270 PRINT
2272 NEXT J
2275 GO TO 2330
2280 #
2300 OPEN 8,"POINTER"
2310 MAT READ (8) P
2320 CLOSE 8
2330 IF W=0 THEN 2300
2340 ON S GO TO 2350,2370,2390,2410,2430
```

```
2350 OPEN 7,"COMRND1"
2360 GO TO 2440
2370 OPEN 7,"COMRND2"
2380 GO TO 2440
2390 OPEN 7,"COMRND3"
2400 GO TO 2440
2410 OPEN 7,"COMRND4"
2420 GO TO 2440
2430 OPEN 7,"COMRND5"
2440 PRINT
2450 PRINT "COMMENTS MADE IN ROUND";S;"WERE:"
2460 FOR I=1 TO Q
2470 PRINT
2480 PRINT "QUESTION";I;":"
2490 PRINT
2500 FOR J=1 TO P
2510 PRINT "    PARTICIPANT";J;":"
2520 K=P(Q*(J-1)+I,S)
2530 SETPTR 7,K
2540 READ (7) Z,J$,K$,L$
2550 PRINT J$
2560 PRINT K$
2570 PRINT L$
2580 PRINT
2590 NEXT J
2600 PRINT "PLEASE INDICATE WHETHER OR NOT YOU WANT EACH COMMENT"
2610 PRINT "PRESENTED IN THE NEXT ROUND. ANSWER EITHER YES OR NO."
2620 REWIND 7
2630 FOR J=1 TO P
2640 PRINT "COMMENT";J;
2650 INPUT X7:A
2660 IF X7="NO" THEN 2770
2670 IF X7<>"YES" THEN 2750
2680 K=P(Q*(J-1)+I,S)
2690 SETPTR 7,K
2700 READ (7) Z,J$,K$,L$
2710 Z=1
2720 SETPTR 7,K
2730 WRITE (7) Z,J$,K$,L$
2740 GO TO 2770
2750 PRINT "YOUR RESPONSE MUST BE EITHER YES OR NO. PLEASE TRY AGAIN.
2760 GO TO 2650
2770 NEXT J
2780 NEXT I
2785 W1=0
2790 GO TO 2820
2800 PRINT "ROUND";S+1;"IS NOT COMPLETED YET. SELECTION OF COMMENTS"
2810 PRINT "OCCURS ONLY AT THE END OF A ROUND."
2820 CLOSE 7
2830 PRINT
2840 PRINT "DO YOU WISH TO EXERCISE ANOTHER OPTION? ANSWER EITHER"
2850 PRINT "YES OR NO."
```

```
2860 INPUT X8:A
2870 IF X8="NO" THEN 2920
2880 IF X8<>"YES" THEN 2900
2890 GO TO 250
2900 PRINT "YOUR ANSWER MUST BE YES OR NO. PLEASE TRY AGAIN."
2910 GO TO 2860
2920 REWIND 1
2930 WRITE (1) P,Q,R,S,T,W1,K7,Y
2940 CLOSE 1
9999 END
```