INDICATIONS AND WARNING ANALYSIS MANAGEMENT SYSTEM (IWAMS)

FINAL REPORT

Albert Clarkson

Laurence Krasno

Jerry Kidd

A Project Sponsored By

Cybernetics Technology Office

Defense Advanced Research Projects Agency

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INDICATIONS AND WARNING ANALYSIS MANAGEMENT SYSTEM (IWAMS)

A Design Study

March 1980

by

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Sponsored by:

Cybernetics Technology Office
Defense Advanced Research Projects Office
Technical Monitor: Dr. Judith Ayres Daly

DARPA Order Number	3571
Contract Number	MDA903-79-C-0011
Contractor	ESL, Incorporated
Effective Date of Contract	October 26, 1978
Contract Expiration Date	March 31, 1980
Principal Investigator	Albert Clarkson (408) 738-2888
Short Title of Work	IWAMS Study - Final Report

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ACKNOWLEDGEMENTS

We could not have performed this research without the support and guidance of Judith Ayres Daly, of the Defense Advanced Research Projects Agency.

Nor could we have achieved our present progress without the research opportunities made possible by Captain Thomas Curry, USN, to whom we are deeply grateful.

We thank our good friends and colleagues, John W. Sutherland and Gerald L. Fuller, for pursuing with us many discussions on several aspects of the research.

We owe a considerable debt to many others as well, friends and colleagues who offered insights, sound advice and encouragement; and who bear no responsibility for failures and weaknesses in the study. Among these friends are: Thomas G. Belden; LtC. Bigelow Bland; Frances Calloway; Capt. John Dillon, USN (Ret.); Don R. Harris; Vince Heyman; Joshua Lederberg; Col. R.A. Littlefield; Benny Meyer; James Grier Miller; George Nisihara; Jack Omen; Capt. Frederick W. Robitschek, Jr.; Russell J. Smith; Malcolm Stewart; and L.A. Zadeh.

Special thanks to Jo Franklin and Terri Monk who patiently drafted the manuscript.

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INTRODUCTION

The present report summarizes research for the Defense Advanced Research Projects Agency to design an advanced system for the management of indications and warning (I&W) analysis. That system, designated the indications and warning analysis management system (IWAMS), is computer-based and designed to perform these functions:

- Monitor selected analytic operations at DoD I&W centers
- Extract and display measures of analytic effectiveness, readiness and maintenance
- Facilitate warning analysis
- Be compatible with normal analytic operations
- Be capable of being integrated into existing computer-based analyst support systems

The IWAMS project began in late 1978. Members of the project team have spent approximately 2 months on-site at I&W centers observing operations, conducting a dialog with analysts and managers, and testing IWAMS concepts. We have built a model of the process of warning analysis; defined analysis performance measures; designed a system of analysis methods, including projection techniques; and designed the software architecture for the IWAMS computer-based component.

Figure 1 is an artist's simplified graphic representation of the IWAMS concept. The largest rectangle symbolically reflects two tasks completed on the project: modeling the process of warning

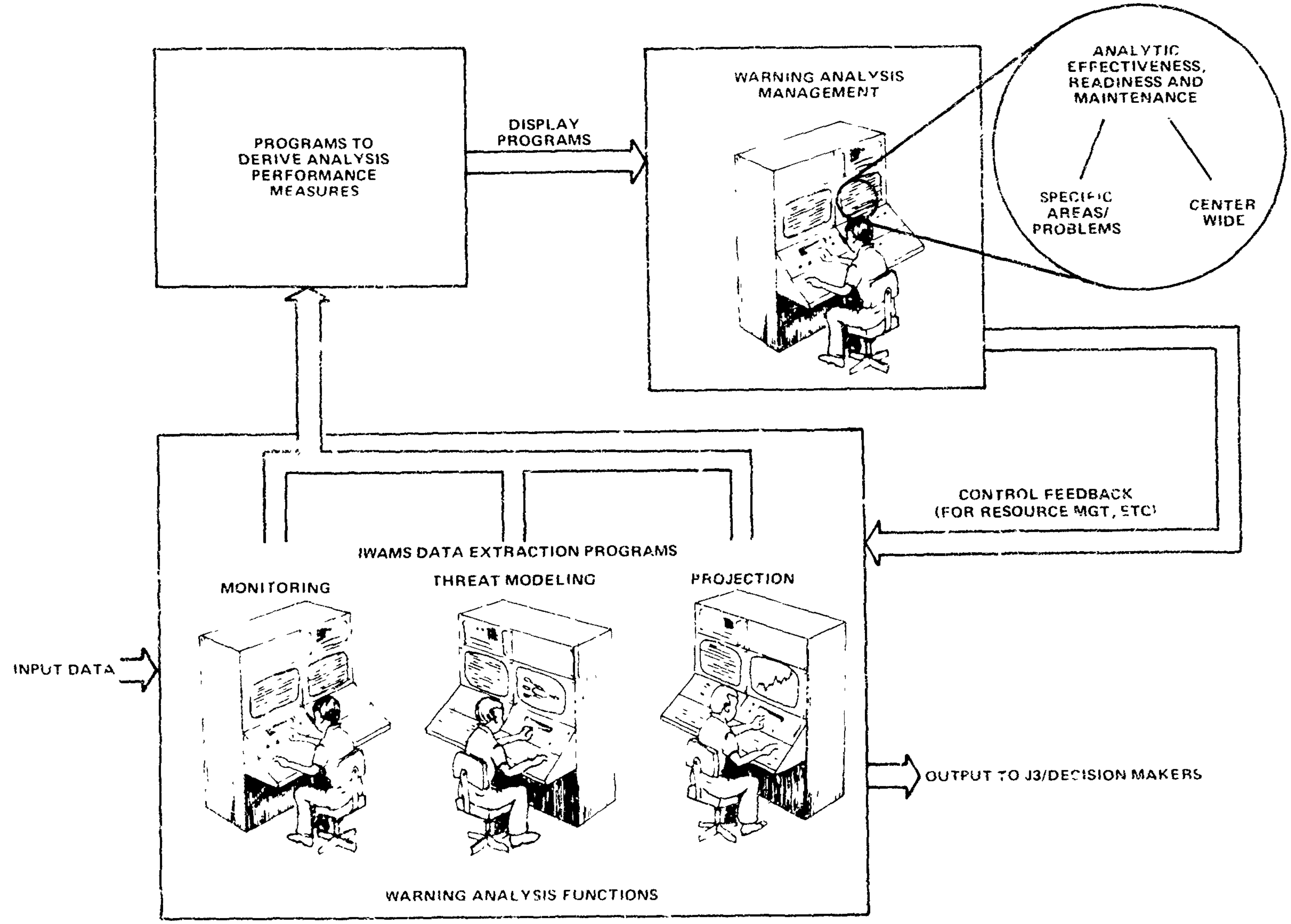

Figure 1. IWAMS Concept

analysis and the design of new analytic procedures. The model is composed of three major stages: monitoring, threat recognition and projection, each involving numerous procedures and steps. The second task culminated in the design of analytic methods to be used in each of these three major stages. IWAMS is intended to provide selective computer support to the analyst in each stage.

The detail in the other two rectangles conveys the concept of computer-based warning analysis management. IWAMS is designed to provide managers access to the status of analysis and to enhance management feedback. The circle in the top right rectangle underscores the essential need for measures of analytic effectiveness, readiness, and maintenance. The development of these measures was a major and challenging task.

Overall, Figure 1 correctly depicts IWAMS as a computer-based cybernetic system in which man-machine interactions which occur during the pursuit of warning analysis generate data for measuring analysis performance and fostering productive interaction among analysts and managers. The system is described in detail in the body of the report.

IWAMS is an advanced system concept The designers have spent substantial time on-site at warning centers and have become familiar with warning analysis operations and the support systems for analysts. We have discussed fundamental issues of warning with managers and analysts now or formerly in the warning community. We have reviewed most of the basic documentation on the warning problem recently generated by the Department of Defense, other government agencies, and congressional committees. We are knowledgeable in the general literature of warning and related intelligence problems. Our purpose, however, is not to review or comment at length on current warning operations. Our purpose, difficult enough, is to develop practical and useful advanced concepts for the management and performance of warning analysis, particularly with reference to computer-based technology and its supporting role in human analytic operations. We have not been directly concerned with the problems of data collection.

Part of the difficulty derives from long-standing political, institutional and cultural obstacles to improved warning by the U.S. Documented more fully of late, these obstacles are indeed formidable. However, advanced research has great potential for surmounting these obstacles and hence a strong obligation to contribute substantially to the improvement of warning capability. It is not difficult to see why this improvement is needed. Warning is central to the intelligence process and effective intelligence is central to national security in an increasingly dangerous world where the premium on alertness is rapidly rising.

There is also another, very fundamental constraint: conceptual obstacles, problems of method, which are not overcome by decree and according to schedules. As one thinks increasingly about the warning issue and explores both the history and current operations, the tendency is strongly to believe that perhaps among the greatest challenges are a series of conceptual problems at the heart of analysis and interpretation. As the present research was intended to establish, some of these problems are known to us, can be understood and, given our technology, appear subject to amelioration. But clearly we must increase our understanding at the conceptual level in order to apply one of our great weapons, advanced technology -- in this case, primarily information technology -- successfully to the problem.

The watershed literature of warning exhibits both diagnostic and prescriptive tendencies. <u>Post mortems</u> such as Wohlstetter's <u>Pearl Harbor</u>, Whaley's <u>Codeword Barbarossa</u>, and Schlaim's <u>National</u>

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Intelligence Failures: The Case of the Yom Kipper War are classics with, in our view, primarily a diagnostic thrust. Although not focused strongly on the analysis problem as such, the historical lessons laid out are highly relevant. The prescriptive aspect is represented by a set of recent writings by Thomas Belden, members of the Defense Intelligence Agency (DIA) and various others that is focused primarily, though certainly not exclusively, on present warning operations, particularly the concept of a network or community of analysts. What we hope to do in the present research is contribute to both diagnostic and prescriptive thought that can affect the future of warning analysis.

Developed at length in the body of the text is a fundamental and complex argument behind the IWAMS concept that we should summarize at the beginning.

1. At present there is an epistemological crisis which throws into doubt our interpretive ability, our success in making sense of events, our ability to project outcomes. There is a deep pessimism on the part of many well-informed, well-intentioned people about prospects for improving human capabilities to project ahead and anticipate crises. Theories, both formal and informal, assert that the root causes of our difficulties are certain very old psychophysiological constraints on the human mind. Moreover, these root causes are percieved as being continually and increasingly exacerbated by the modern information deluge (perceived now as an "overload"), a sort of huge and peculiar collagé added-to daily but perversly discontinuous which, while it promises much, now frustrates our interpretive impulse and conditions us to limited perspectives. It tends to cut off our inquiry into these problems. There is a siren quality about it, a kind of anesthetic effect.

2. Two major constraints on the mind, described variously, are considered very important to the warning problem. The first concerns man's difficulty in reconstructing his past analytic perspectives. In greatly simplified terms, it is a "failure" of memory which seems naturally to occur as we perform cognition through time; we forget as we learn. Discussed in detail below, this problem impairs post mortems, thereby curtailing diagnosis and prescription. In particular, Richard J. Heuer, Jr. has written extremely valuably about this problem.

The second constraint is the difficulty of the mind in rapidly perceiving ramifications in meaning through complex frameworks of coherent perspectives -- through, in short, many assumptions and elements of logic -- that occur when individual judgments are made about small portions of the overall framework. In essence we have difficulty in rapidly realizing implications. However, the vital creation of complex frames of reference, arising from man's essential strategy of building models of past, present, and future reality, has not been powerfully accomplished in warning operations owing to many factors, not the least of which is the modern information overload. Yet we desperately need higher context for developing meaning in warning analysis and to mitigate the information overload; and we intend both to exemplify such contexts and to show that the machine will help in providing and sustaining them. But as we develop such context we must insure that the human analyst can see ramifications of meaning throughout it; in short, that the analyst perceives registrations of new meaning.

3. These and other fundamental obstacles have led us to solutions that involve computer technology -- the machine. But we must be emphatic that human intelligence, not "artificial intelligence," is what we seek to promote. We can suggest our outlook by citing this passage by Edward Rothstein:

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> The brain itself may be more of a probabalistic system than a formal one, more of a cloud than a clock, to use Karl Popper's metaphors, and its interaction with the rest of the body would also make it difficult to consider it as a different independent system. Researchers in AI hope they will never have to model the physiology of the brain; they concentrate upon the workings of the mind, attempting to mirror its features. But this project seems just as enormous. The achievement of AI's project would mean that one would have a program, a finite set of instructions, that would give a literal structure of the human mind, a 'string' of statements in which one could read a universal grammar of creativity. Such a project is probably of the same order of difficulty as the search for the secrets of life itself.
>
> But in some sense this dream of AI is the archetypal dream of much of contemporary inquiry. It is not to find a 'universal language' whose syntax would reveal the truth of the world -- Gödel proved such a language to be impossible -- but to find a 'universal hermeneutics' that would reduce the fullness of the world to an underlying syntax, to basic 'structures', and that would, conversely, be able to read the complexity surrounding us in these basic strings. This is the dream not only of AI but of much contemporary genetics, linguistics, and advanced literary theory ....

We have not minimized the obstacles to effective warning analysis by the human -- there is ample discussion of these below -- but it seems obvious to us on every level that no machine can be programmed to substitute for the human analyst in any final sense. Moreover, Gödel's Incompleteness Theorem not only undermines confidence in the "dream" of AI, but is one of many signs that reality will likely continue to surpass our models and theories.

The human analyst is limited; the machine, if differently, is much more limited; and we find ourselves without choice engaged in an heuristic process. The important immediate question becomes: how should we aid the now largely unaided human mind in performing warning analysis? To sum up very simply the major thrust of our research: we argue for a computer-based extrasomatic memory of analytic operations which in its various forms also holds the analytic context developed heuristically by the analysts, themselves, over time. The machine allows us to record and thereby reconstruct past analytic perspectives, safely removed from the losses of human memory. At the same time, the machine allows us -- indeed, must prompt us -- to build and preserve as well as review, criticize, dismantle and recreate, the vital context for making warning judgments. Extrasomatic is an appropriate term because it connotes something apart from, but also an extension of, human capabilities. And indeed, for many reasons the warning analytic context we speak of as being stored extrasomatically must complement the schemata (or templates) of the mind, those mental constructs which allow us to recognize portions of reality, interpolate and extrapolate, infer, and perform other mental operations. We give many examples below, but note for the present that the warning analytic context can range from simple chronological models of hypothetical threat situations to sophisticated forecasting maps. But what we are talking about here are forms within which context and meaning may change.

Computer technology is essential for a number of reasons, many of which can be summed up in the need to maintain requisite speed of operations to complement the dynamics of human cognitive processes. For this reason the electronic visual medium -- computer-driven displays and their rhetoric such as color coding and dynamic lines -- becomes increasingly important. By these means, the machine can truly extend the powers of the human mind performing warning analysis.

The incentive for such analysis basically resides in our interpretive impulse, the need for knowledge for survival. The incentive is enhanced by virtue of the extended abilities, and hence satisfaction, of meeting the challenge more effectively. This increase in incentive should apply both to the individual analyst and to communities of analysts. Indeed, it should strengthen both in all respects.

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4. As we have said, the development of more effective methods and techniques of warning analysis, especially projections, must be an heuristic process. There is now no satisfactory means of projection for problems in international warning. But the interesting issue is not that there are now enormous difficulties; rather, it is in the prospects for improvement. In our judgment it is arrogant and naive to suppose that prospects are meager. We have not adequately employed man-machine approaches to this problem, and we will not mitigate the fundamental constraints on the unaided human mind in doing such analysis until we bring computer technology to bear more powerfully, <u>and in the hands of the working analyst</u>. He must emerge as the chief innovator. In our view, the speed and breadth of analytic operations potentially available through such computer-based support systems, together with the secure memory these systems afford, is directly related to enormous possibilities of increasingly sophisticated and realistic human interpretation of reality. There seems a clear imperative in the fact that very few manhours have ever been expended doing such analysis in actual warning operations. We believe we have developed in the present research a promising first-generation approach, a beginning that can be refined by analysts doing analysis.

5. Of the many challenges to improving the effectiveness of warning analysis, three seem especially prominent. First, we must understand the process of warning analysis; we must develop an adequate functional model. In the present research we have divided analysis into three interrelated stages -- monitoring, threat recognition, and projection -- and identified a number of procedures and steps associated with each stage. In our modeling we have striven for coherence. Activities in the monitoring stage are intended to reinforce and ramify through the other stages. The entire process should culminate in a series of predictions and forecasts about the relative likelihood of various threats and situations.

From our perspective, perhaps the major pathology in warning analysis occurs when the human analyst fails to complete the full process of warning analysis, to follow through. A second pathology would be exhibited when the analyst completes the steps but fails to provide appropriate warning.

These two major pathologies suggest the next challenge in pursuing the issue of effectiveness: the development of measures of analytic performance. We have built a system of interconnected measures of analytic effectiveness, readiness, and maintenance, derived by monitoring three variables associated with information and analytic dynamics: backlog, relationality (the degree to which the data is analyzed in relation to established analysis steps, procedures and methods); and signification (the assignment of meaning to the data). We cannot summarize the measurement system here, but do note that we have distinguished between real and estimated effectiveness in warning. One can see the relationship between the problem of real effectiveness and constraints on the human mind with respect to post mortems and hindsight analysis.

The third challenge is to design computer-aided analysis methods whose enactment creates systematic, thorough analysis as we have modeled it and thereby also creates the measurement data. In very simple terms, our approach is this: we have designed the structure of a working context for warning analysis -- a memory of accumulated analysis -- largely recorded and expressed in twelve forms against which new data is analyzed for meaning. Highly changeable through a machine-manipulated configurational language, these forms consist of classes of diagrammatic structures -- a language of modeling -- well-suited for computer-driven displays. There is great flexibility within the internal structure of the forms to accommodate the idiosyncracies of individual analytic styles, to allow for innovation, and also to permit easy registration of new meanings and rationale as changes are made to the analytic context.

Thus within the language of the forms, the individual analyst can perform, record and display his particular analysis. The twelve forms, each pertaining to a different point in the warning analysis process, are interrelated and progressive -- a logical chain of outputs of different analytic steps and procedures -- and thus form an analytic language with a syntax. The forms are used through an analytic routine, an itinerary of interrelated analysis steps intended to produce rigor whose results are localized, focused, recorded and displayed in the context of the forms. The routine, which embodies the steps and procedures in the model of analysis, is an overall grammar of analysis. The performance measures are implemented simply by using the computer-based system. When forms are changed in certain ways and steps in the routine are implemented, the associated computer operations and other activities provide the needed data for generating the measures.

6. We thus arrive at the following perspective: if we concede that one of the strongest and most essential impulses in man is the interpretive impulse, and if we recognize that the warning problem is among the most serious contemporary problems of interpretation, then we may think of the present situation as one in which there is a frustration, a blunting, of the interpretive impulse. We can appreciate the major pathologies of analysis -- the case in which analysis is incomplete and the case in which complete analysis is inadequate. We can think especially of two sources of constraints on analysis. One consists of psychophysiological obstacles such as those discussed above. The second is conceptual in nature. This latter obstacle is reflected in part in our struggles with warning analysis methodology, particularly in the projection stage. In our view the second obstacle cannot be readily overcome until the first obstacle is to some degree mitigated: until the cognitive limitations are offset, prescriptive breakthroughs will be that much more

difficult. Overcoming the conceptual limitations will be accomplished largely by analysts through the heuristic process. Computer-based support appears vital to that process.

Finally, an apology is due the reader owing to the considerable expository difficulty of attempting to convey the nature of operations on IWAMS. Given our goals, it is incumbent on us to convey those processes. As reported below, a mock-up version of the system was briefly tested informally at a warning center late in the research and has given us added confidence in its feasibility. Indeed, as we discuss below, there are no technical obstacles to its rapid development and implementation. But the fact remains that it is difficult to convey through prose and static diagrams a sense of the real flow of analysis by an experienced analyst, taking cognizance of the analyst's background knowledge and the IWAMS high context system, and assuming interaction with computer-based support whose operation the analyst has mastered. We have attempted to offset this expository difficulty as best we could be reminding the reader when we are proceeding painstakingly and slowly through processes that in actuality would be far different in speed and impact.

We may now turn to the detailed discussions that summarize the research. We will first examine the model of warning analysis. This will be followed by a detailed discussion of the system of measures of warning analysis performance. Following that is a section in which the methods of warning analysis developed in the research are described and exemplified. The subsequent section contains a description of the software design for the IWAMS system. This is followed by a concluding section in which feasibility and incentives are discussed.

The first task is to develop a useful model of warning analysis. Given the encouraging contemporary progress in the understanding and modeling of human cognition, we nevertheless remain far too ignorant to make any pretense of modeling all activities in a mental process as elusive and complex as warning analysis. We must be content with a functional model which identifies major stages, procedures and decision points. From there we must identify crucial variables in the cognitive process which can be monitored, change measurably, and which are diagnostic. Such a model is essential in developing management information systems yielding analysis performance measures.

Better, more sophisticated models of the analysis process constitute a goal, a hoped-for benefit from gathering empirical data through IWAMS. The present model is a start.

Figure 2 shows the area of emphasis within the overall IWAMS concept of the present discussion.

Elements of Warning Analysis

A useful functional model must take account of the major elements of warning analysis. What are these elements? Thomas Belden's view of warning as differing from other intelligence functions because it implies decision seems a fundamental distinction Beyond that, several definitions of warning as an analytic process, a category of intelligence, and a type of intelligence product have been formulated. Various organizations and individuals have made definitions (not always in agreement) of "tactical warning", "strategic warning",

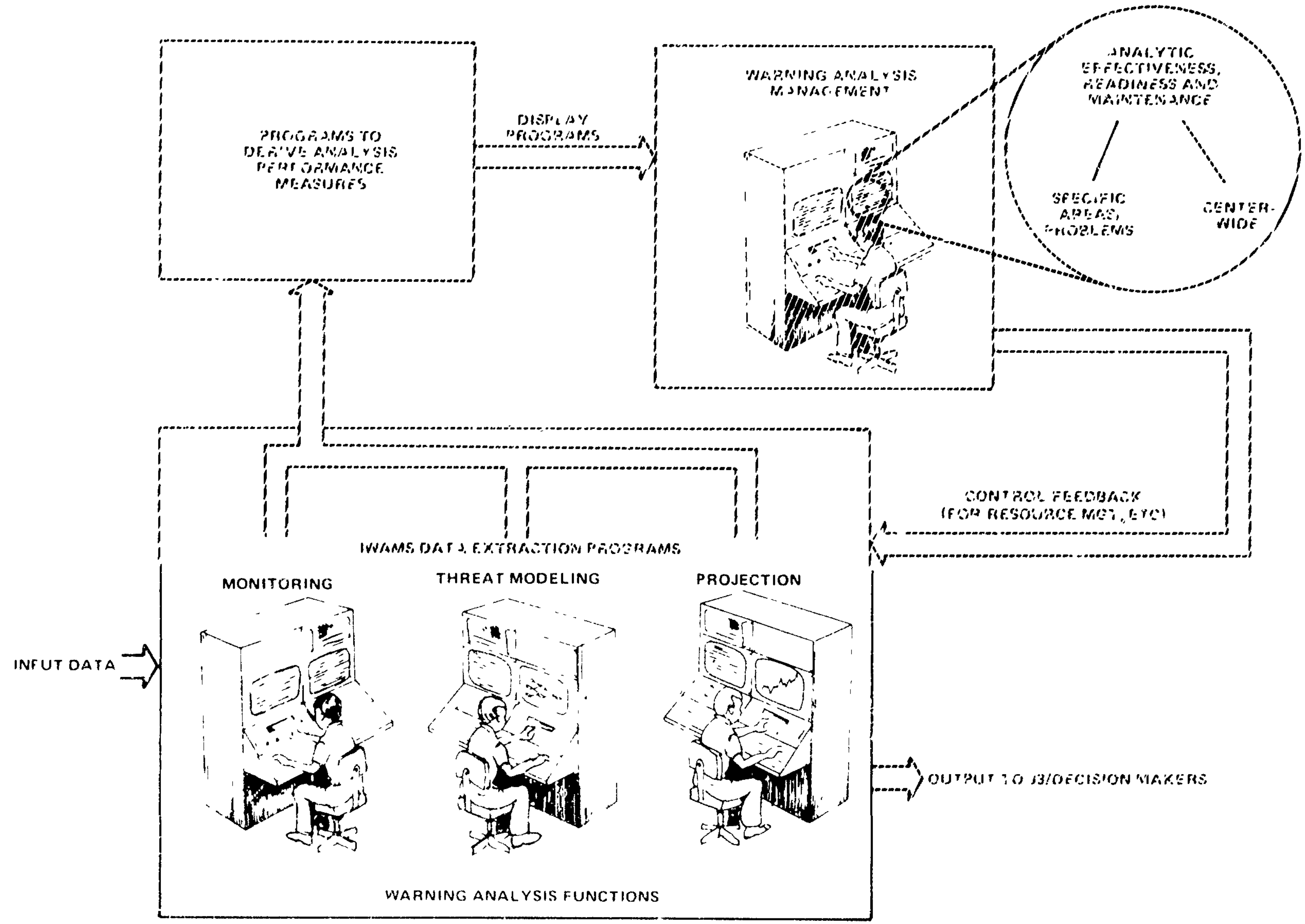


Figure 2. Modeling Emphasis in IWAMS

"indications and warning intelligence", "indicator", "indication", "threat", "indications analysis", etc.

The present model of warning analysis, taking into account current definitions, is intended to contribute to a needed comprehensive conceptual framework. At minimum the authors believe that warning analysis shows the following characteristics:

- It involves projections.
- It uses current, estimative, and basic intelligence.
- It is concerned with capabilities and intentions of other nations and entities.
- It is concerned with military, political, economic, and cultural dimensions.
- It involves a time-critical, watch-linked current intelligence orientation.
- It also involves a long-range, nontime-critical, estimative orientation.
- It consists of a set of discernible stages, one suitable description of which is: monitoring, threat recognition and projection.
- It is arguably the most important intelligence activity.

- It is a great challenge, there being enormous epistemological, cognitive, institutional and other constraints on its effectiveness.

Captain Frederick Robitschek, Jr., USAF, has developed a useful negative definition of warning analysis which complements the above list, pointing out that warning is not:

- Restricted to warning/forecasting of an attack
- Restricted to evaluation of military developments
- Restricted to events with a direct impact on the U.S. and its allies
- Solely the purview of the watch
- Limited to indications analysis
- A separate and arcane branch of intelligence
- An exercise in futility - impossible to produce.

But it is warning analysis as a cognitive process that most concerns the authors. The model of this process described below reflects the authors' understanding of warning analysis as observed during protracted visits to I&W centers. The model also includes stages and procedures not necessarily pursued formally now in the manner described, but which analysts and managers have concurred with as necessary and promising.

Stages of Warning Analysis

Figure 3 shows what the authors believe are the major progressive, interrelated functional stages in warning analysis: monitoring, threat recognition, and projection.

The monitoring stage, outlined in Table 1, may be viewed as a sequence of steps and procedures beginning with the review of input data at a warning center, followed by the sorting of the data into different categories of interest, a comparison of the data with predetermined indicators whose activity is judged to have significance in terms of emerging threats, an identification and display of correlations, a preliminary evaluation and specification of the significance of activity, and the movement of the results to the next stage of analysis.

Note that steps 8 and 9 comprise a safeguard procedure against analyst tendencies to overlook novel situations. The analyst must guard against cognitive biases and problems with information which may impede his recognizing the onset of such conditions. As the Soviets are inclined to point out, the analyst should be examining "ambiguous" and "anomalous" data since it may actually signify a threatening situation not previously well-imagined and modeled by an analytic community. The problem of novel threats is, of course, a fundamental challenge. Steps 8 and 9 begin a safeguard routine within the analytic procedures which develops further in later stages.

The input data to an I&W center will include several categories of message traffic from various collectors and a variety of bound reports which originate with various government agencies and departments. The message traffic can contain a considerable diversity of military, political, economic and other information. The additional input may be in the form of daily reports on various subjects,

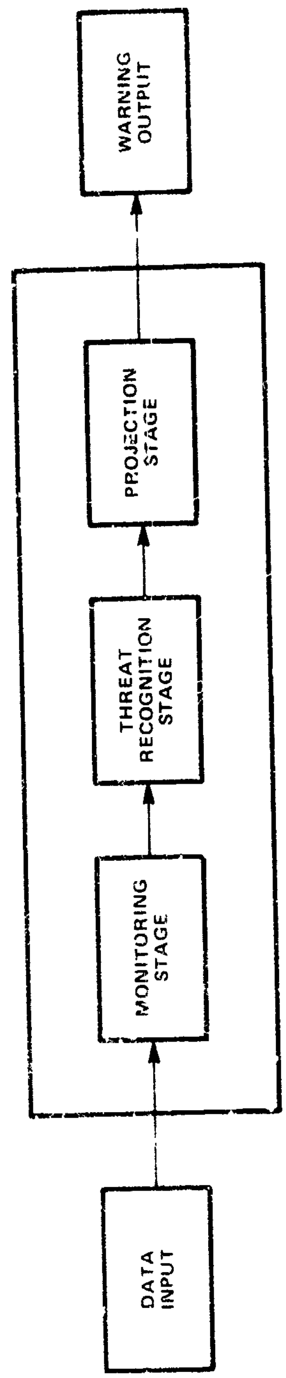


Figure 3. Major Functional Stages in Warning Analysis

Table 1. Functional Outline of Monitoring Stage

<u>Step 1</u>: Review input data

<u>Step 2</u>: Sort input data

<u>Procedure 1</u>: Geographic
<u>Procedure 2</u>: Military
<u>Procedure 3</u>: Political
<u>Procedure 4</u>: Economic
<u>Procedure 5</u>: Cultural
<u>Procedure 6</u>: Other

<u>Step 3</u>: Match sorted data against predetermined indicators

<u>Step 4</u>: Identify correlations

<u>Step 5</u>: Display correlations

<u>Step 6</u>: Make preliminary evaluation of indicators

<u>Procedure 1</u>: Assess relative levels of activity
<u>Procedure 2</u>: Assign significance to activities

<u>Step 7</u>: Route results to next analysis stage

<u>Step 8</u>: Review residual data

<u>Step 9</u>: Move appropriate residual data forward for further analytic review

weekly reports, monthly reports, and a number of aperiodic reports which may be written in response to various developing situations.

The threat recognition stage begins where the monitoring stage leaves off. The steps and procedures are described in Table 2.

The analyst now progresses from matching input data with individual indicators to associating active indicators with threat situations ("scenarios") previously modeled in some chronological and sequential form. This is a higher level of cognitive challenge: some indicators -- at early enough stages perhaps a sizeable portion of them -- may seem capable of being associated with roughly equal probabilities to more than one possible threat.

The future cannot, of course, be precisely modeled. The fundamental risk that novel situations will occur whose shape and dimensions are not recognizably analogous to models currently in an analyst's inventory -- and, indeed, may be obscured by undue focus on existing models -- is omnipresent. Yet models abound. They have been developed in many forms and levels of detail many times in the history of intelligence and will continue to appear. Surely all intelligence organizations of any magnitude and sophistication have constructed scenarios depicting how adverse actions might be taken by opponents. Models are both imperfect and a valid and necessary response to the challenges facing the warning analyst. The important ideas are that models be viewed as approximations and treated with appropriate skepticism, and that in an era of information technology they be constructed in useful, flexible forms (e.g., rapidly displayable and changeable). (In subsequent discussions, considerable attention will be focused on these issues.)

Table 2. Functional Outline of Threat Recognition Stage

Step 1: Match indicators from monitoring stage against predetermined threat models

Procedure 1: Call up preestablished threat models

Procedure 2: Match indicators against models

a. Call out critical events/stages (or nodes) of threat models

b. Search for correlations to indicators

c. Identify correlations

d. Review correlations against other critical events whose occurrence has been previously detected within developing situational context

e. Assign confidence values to results of c and d

f. Identify key events and activities whose occurrences have not been detected

g. Identify further information needs

h. Compare all preestablished threat models to which the data has correlated

(1) Duplications
(2) Similarities
(3) Differences

i. Explore for possible alternative explanations/hypotheses for data

Step 2: Move pertinent threat models to projection stages of analysis

Step 3: Conduct novel threat analysis

Procedure 1: Formulate new threat hypotheses
Procedure 2: Display threat hypotheses
Procedure 3: Compare residual data against hypotheses

Step 4: Move appropriate novel threat models to projection phase of analysis

The projection stage represents the final and by far the most formidable analytic challenge. The analyst now surpasses his role as historian and explores the future. The making of projections is a pervasive and highly refractory enterprise. From weather forecasting through human resources planning to economic prognostication, it is rarely done to the satisfaction of the forecaster or the consumer of such forecasts. Nonetheless, we confidently advance a set of procedures for threat projection that seem to us to be thorough, easily usable, and useful to analysts. This set of procedures is described in detail below in Section 4.

We distinguish four types of projections significant in warning analysis. First, projections may take two forms: predictions and forecasts. By our definition, prediction involves an estimate by analysts of conditions necessary for given situations. However, predictions are not necessarily held to be likely (or very likely) by analysts. They will, however, tend to address situations of great interest from the warning viewpoint. A practical view of predictions is to consider them a vehicle of analytic preparation. In the process of forming and refining predictions, the analyst thinks about (indeed, analyzes) various existing, imminent and/or remote conditions whose occurrence could create threats.

The term, forecast, is used to refer to a projection in which an analyst estimates that the event or situation will occur. Hence a forecast may be thought of as a prediction which the analyst now believes will in fact take place with an implicit or explicit probability attached.

Further, both predictions and forecasts may be of two types: unimpeded and influenced. An unimpeded projection, whether a prediction or a forecast, is one in which the analyst judges that under the current friendly-side posture, the projected situation is likely to occur in a given form. In other words, the analyst judges that unless U.S./friendly decisionmakers intervene and change conditions over which they are presumed to have control, the projected outcome is likely to take a certain form, designated the unimpeded projection. The influenced projection is one in which the analyst considers the impact of certain activities which his decisionmaker may introduce and their impact on the outcome. This becomes the influenced projection.

Table 3 (see page 26) is an outline of functional procedures and steps in the projection stage. Most of the procedures are self-explanatory (and will be elaborated on in later discussions of methodology), but comments are appropriate for procedures 1-3 under step 1. For each of the four types of projection, the first procedure entails an important transformation: the analyst translates the individual threat models from the preceding stage into a predictive format organized according to the basic information categories -- who, what, where, how, when, and why. In our judgment, projections should ultimately be expressed in a very fundamental grammar, namely, the information categories linked together in English sentence structure. This grammar of projections can accommodate simple or complex projections. (Examples are given below of the transformation of threat models into this format.)

The second step entails comparing the specificities of individual threat projections. A Specificity Rating Scale by which analysts may estimate the degree of specificity for each of the information categories in any given threat projection has been developed and is described below. Predictions and forecasts expressed formally in terms of who, what, when, where, how, and why may be compared quantitatively in each category. For example, the category, when, may be highly specific (described, say, to the hour) or extremely general.

The third procedure for each type of projection is to develop and elucidate the rationale. This, of course, is the greatest challenge to the analyst, the most difficult single analytic challenge in the entire process of performing warning analysis. The analyst must analyze the conditions that might lead to various threat enactments and assess the relative importance and interdependence of the conditions. The conditions could include military capabilities, political aspects, economic factors, social and cultural conditions and forces, decisionmaker/leadership perceptions and predispositions, and other key variables. This third procedure must receive the greatest emphasis in methodology.

The Model and Current Operations

It is not within the present scope to treat this topic comprehensively, but some comments are useful.

Formal procedures and supporting technology for the monitoring stage are evidenced in current operations. Procedures for systematically reviewing input data against preestablished indicators, and reporting results, are well established. Various computer-based systems for quantifying aspects of indicator activity are being explored and tested operationally. Some of these are described below.

In terms of threat recognition and projection, however, less formal structure has been created to date. We are just beginning to see greater focus being placed on the issue of analytic rigor. Plans exist now for further research in threat modeling (e.g., modeling past crises as aids to warning analysts) and in projection methodologies. Thus some momentum is being built up.

Importantly, emphasis on automatic-data-processing support to analysts is also generally increasing. The ability to perform the kind of thorough and comprehensive analysis implicit in the model described above -- and the prospects for rapidly evolving refinements in analytic procedure -- are crucially related to design and development of useful computer-based analytic support technology.

Themes Sounded in the Discussion of the Model

Several very basic themes in the warning problem have been sounded which will be discussed further in subsequent sections. These include: limitations in understanding and modeling human cognition; cognitive and other obstacles to warning analytic effectiveness; the relationship of information technology to advanced warning analysis; areas of conceptual confusion; the methodological crisis; and the problems of monitoring and managing analysis. A separate theme is the expository difficulty in conveying the actual dynamics, excitement and incentive in performing complete warning analysis, as modeled above. But the major theme is this: the primary pathology of warning analysis is the failure to complete the full process of analysis.

All these issues -- and others as well -- are at the heart of the next problem we must confront: the development of analysis performance measures.

Table 3. Functional Outline of Projection Stage

Step 1: Compare candidate threats in unimpeded, predictive domain

Procedure 1: Translate individual threats into predictive format based on information categories

a. Who (or what)
b. (Could do) what
c. (to) whom (or what)
d. Where
e. How
f. When
g. Why (or because X conditions apply)

Procedure 2: Compare specificities of individual threat predictions

Procedure 3: Elucidate rationale behind specificities

a. Estimate conditions that would support various threat enactments, and their relative importance and interdependence

(1) Military capabilities

(2) Political situation

(3) Economic conditions

(4) Social/cultural conditions and forces

(5) Decisionmaker/leadership perceptions and predispositions

(6) Other

b. If conditions now hold, estimate earliest possible occurrence in future of threat enactment

c. Identify any missing conditions

d. For missing conditions, estimate earliest occurrence in future

Table 3. -- Continued.

e. Estimate earliest point in future pertinent threats could occur after missing conditions occur.

Procedure 4: Indicate sources (e.g., outside expertise)

Procedure 5: Indicate/summarize assumptions

Procedure 6: Indicate/summarize uncertainties and data requirements

Procedure 7: Across predictions, and added to previous comparisons, isolate and identify by information category the following

a. Duplications
b. Similarities
c. Differences

Procedure 8: Compare predictions in terms of probability against selected timelines

Step 2: Compare candidate threats in influenced predictive domain

Procedure 1: Consider potential U.S. influences on development of situations

a. Identify U.S. influence options

Procedure 2: Translate influenced threat models into predictive format (as in step 1 above)

Procedure 3: Repeat rest of procedures in step 1

Procedure 4: Make grand comparison of unimpeded and influenced predictions.

Step 3: Perform similar procedures for unimpeded and influenced forecasts.

3

WARNING ANALYSIS MEASURES

Two points should be made at the outset. First, we will explore and develop measures of warning analysis without direct concern about how they would be implemented. The primary purpose at this point is a conceptual analysis of the measurement problem. Implementation is described below in detail in Sections 4 and 5.

Second, the overall system of measures should be previewed. It is a comparatively simple system. There are three major (and classic) measures: analytic effectiveness, readiness, and maintenance. These measures are obtained essentially by monitoring three crucial, interrelated variables in the flow of information through the stages and procedures of warning analysis: data backlog, data relationality, and data signification. This in turn creates the opportunity to monitor a number of other variables.

The matrix below shows the essential relationship of the measures to the model of warning analysis.

Model	Measures		
	Effectiveness	Readiness	Maintenance
Monitoring			
Threat Recognition			
Projection			

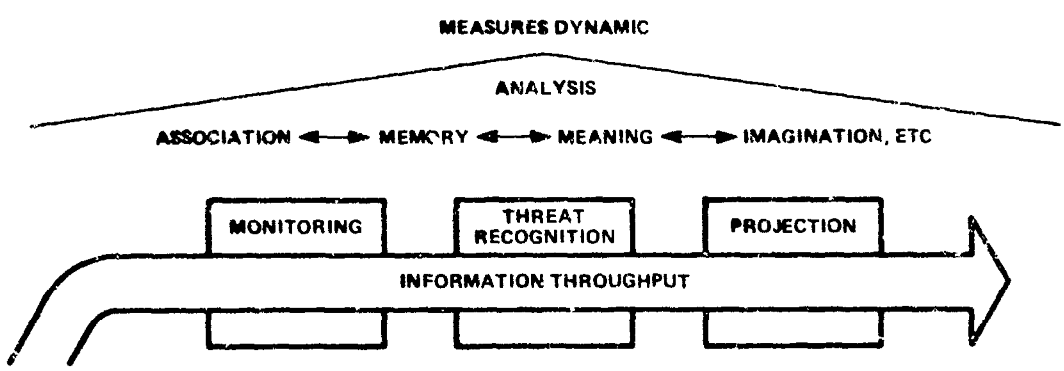
The remainder of the present section will discuss in detail the definition of the measures and the development of a measurement system. Figure 4 shows the area of emphasis in the present discussion with respect to the overall IWAMS concept.

The Conceptual Framework

Development of the measures proved one of the most difficult challenges in the research. Little previous research seemed directly applicable. Yet measuring an elusive cognitive process of rationality and intuition requires building a conceptual framework. We shall sketch in this framework as background to discussion of the measures.

- The Essential Dynamic of Analysis. Analysis, a cognitive process, is described in terms such as "association", "interpretation", "meaning," "imagination," "intuition," "rationale," "induction", "deduction", etc. In analysis, essentially we associate different data and assign meaning. Because the analyst makes projections, warning analysis heavily involves the imagination.

A major point is the importance of the information throughput. Given that input data is needed for the analytic dynamic to occur, and that warning analysis takes place when the analyst reviews the data and assigns meaning, this process occurs throughout the analytic stages as the data is throughput. The basic dynamic can be depicted as follows:



WARNING ANALYSIS MEASURES

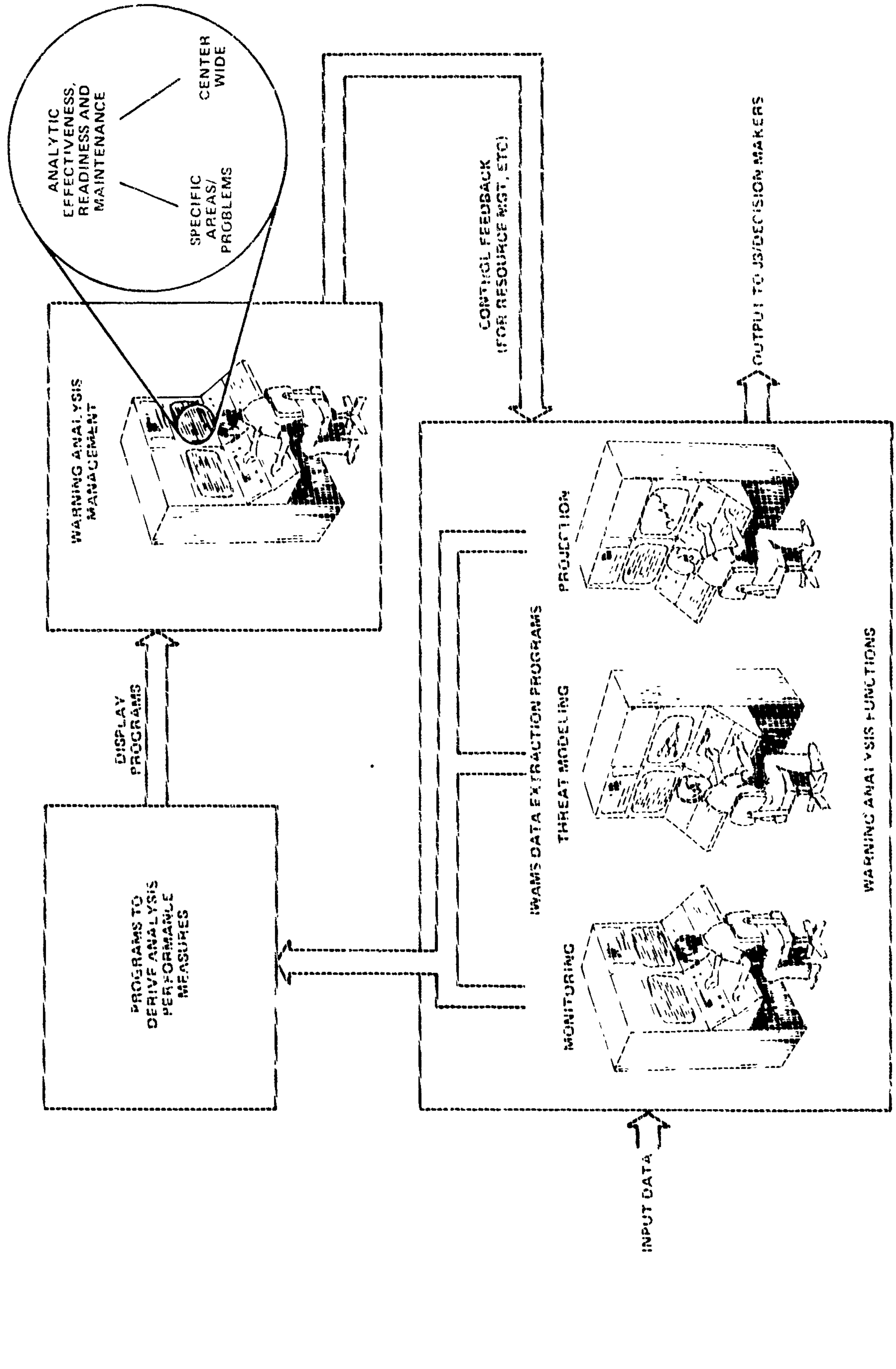


Figure 4. Measures Emphasis in IWAMS

The essential measurement strategy is to identify key variables within the analytic functions in each of the three stages and then design a means of monitoring the variables.

• <u>Perspectives From Living Systems Theory</u>. Portions of James Grier Miller's work on the theory of living systems have been useful in developing a conceptual framework for measures development. Miller views living systems, ranging from cells to supranational organizations, as open systems composed of subsystems which process inputs, throughputs, and outputs of various forms of matter, energy and information. He identifies six information subsystems as common across the range of living systems: the input transducer, the decoder, associative functions, memory, the decider, and the encoder. The internal transducer is the sensory subsystem which receives markers from subsystems or components within the system bearing information about significant alterations in those subsystems or components. Association and memory are linked in representing the two basic elements of the learning process within a system. The decider makes judgments about the significance of information. The decoder takes input information and translates it into an internal or private code useful within the system. The encoder translates the final output into what might be designated a public code for dissemination.

We implicitly have been viewing warning analysis as cognition within a general system through which data progresses and whereby perspective is created. Figure 5 associates our warning model with some of the structure of living systems theory. Such theory can aid us in deriving useful categories and structure for exploring the problem of analytic measures. In sum, warning analysis, a process involving people, information, software, hardware, and other elements, may be thought of as a system with various measurable states of activity, some appropriate and some to be avoided.

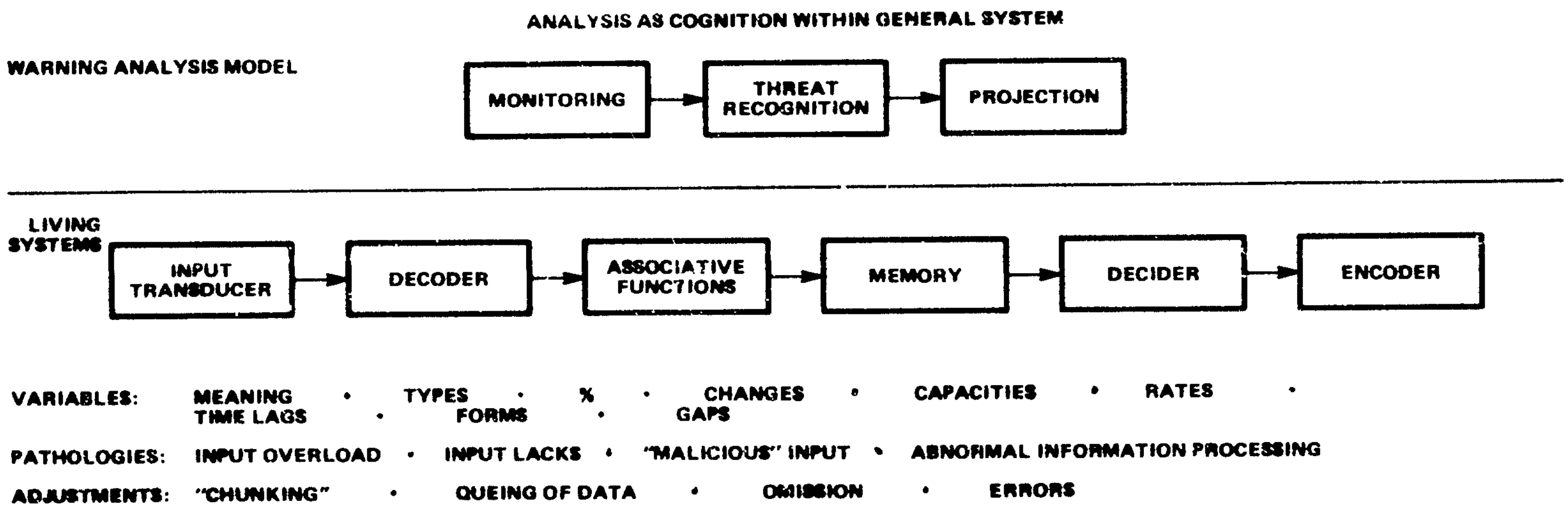


Figure 5. Warning Analysis and Elements of Living Systems Structure

Figure 5 lists some key variables in information systems, some classic pathologies in such systems, and typical adjustments to the pathologies. In subsequent discussions of specific warning measures, portions of Miller's living systems structure, particularly the variables, will be explored further.

- Perspectives From Information Theory. From information theory we must consider the problem of meaning, for meaning is central to the measurement of warning analysis. We have developed the ability to measure rates of information as it throughputs systems. It is the measurement of meaning that has eluded us, for meaning cannot be objectively quantified since it involves a human observer, a human participant, and hence subjectivity. Meaning may be defined as follows:

> Meaning represents the significance of information to the system which processes it. Meaning constitutes a change in that system's processes elicited by the information input, often resulting from associations made to it on previous experience with it. Furthermore, this change can occur immediately or later.

Another crucial concept is entropy in its relationship to information. Information, taken as a retained model of reality, will suffer entropy over time. In warning analysis, scenarios of possible threats (e.g., from North Korea, U.S.S.R., Libya, etc.) obviously must be updated periodically. Models are static approximations of a reality that is always changing in manifold ways. The key concept for the measurement problem is that new information can counteract entropy.

- Perspectives From Learning Theory. A fundamental issue is the relationship among input data, association, memory, and imagination: the learning process of a warning analyst as it entails mental operations on data. The discussion of analytic technique and methodology (Section 4) in part involves the learning process, especially as supported by advanced technology -- computer-based extrasomatic memories which represent collectively created, coherent records of analysis immune to obscurring processes of the human memory.

- Perspectives from Cybernetics. Cybernetics obviously is at the core of the present research. Since we are designing a management system, we have emphasized the basic concept of feedback control, and this is implicit at all points in the discussion.

Basic Measures

Three basic measures of warning analysis are effectiveness, readiness, and maintenance. Analytic effectiveness is an outcome, a result. Analytic readiness is a state, a condition. Analytic maintenance is an activity. The diagram below is meant to reinforce the interrelated, interdependent nature of the measures.

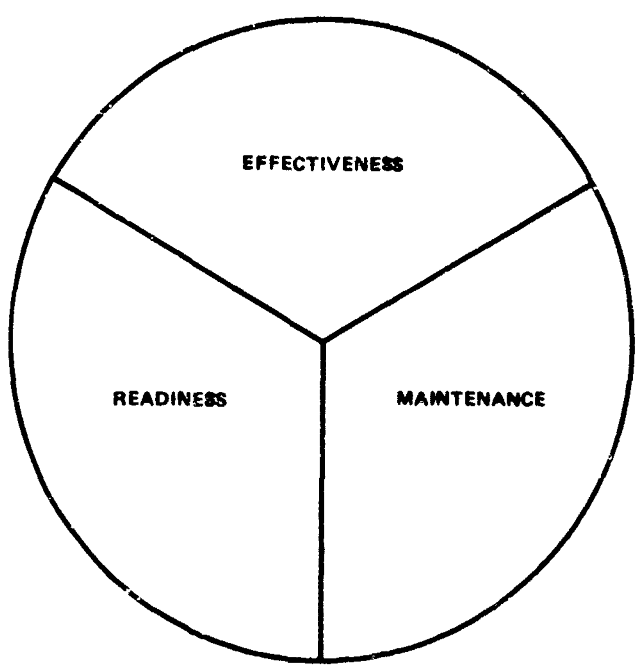
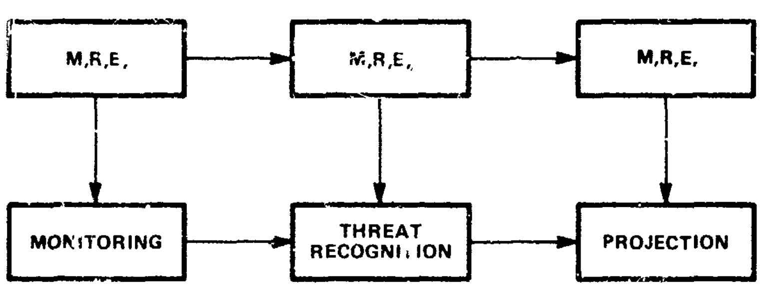


Figure 6 shows a simplified concept of a hierarchy of the measures and supporting variables. Effectiveness, readiness and maintenance (E, R, M) are derived by monitoring certain information-related variables which can be thought of in hierarchical terms. For example, data backlog at various stages in the analysis will become an important variable, and in turn will be associated with other information-related "subvariables" such as percentages of information by type (for example, military, economic, political, COMINT, ELINT, etc.). Many combinations of variables might be monitored and analyzed. An IWAMS design goal is to insure that enough data of interest is collected to allow multiple correlations among different variables in the future, including correlations whose interest was not anticipated earlier. As the remarks on living systems theory suggested, certain key variables are associated with information processing systems at all levels and should be accounted for in the design structure.

Figure 6 also identifies important variables which are not exclusively information-related, such as the dimensionality of the threat models and the use of anti-bias analysis procedures.

Finally, the diagram below conveys the IWAMS design principle that all three measures should be monitored at each major stage of analysis. It is implicit that the measures must ultimately



M,R,E ARE DERIVED FOR EACH STAGE/SUBSTAGE OF ANALYSIS. CUMULATIVE M,R,E ALSO DERIVED

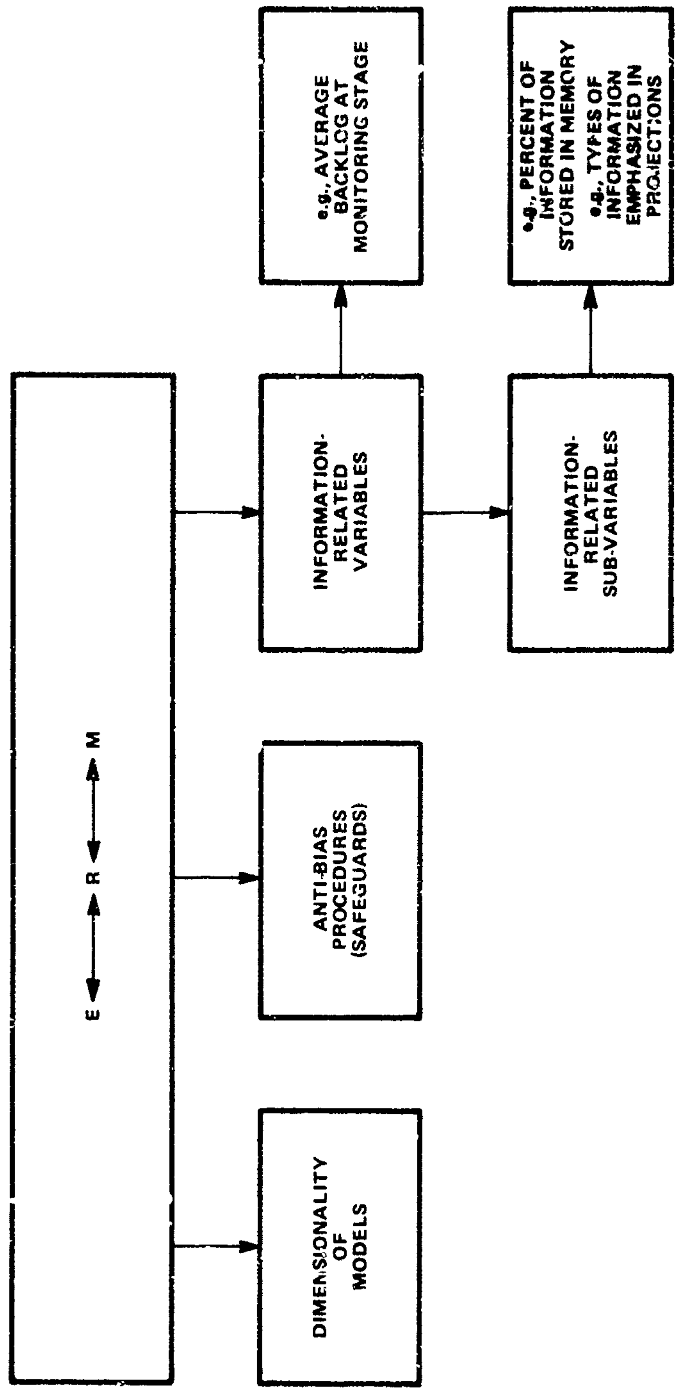


Figure 6. Hierarchy of Measures

reach the steps and procedures within each stage. Further, cumulative values must be obtained by integrating measurement data across and among the various stages to foster diagnosis.

These points have established a context for the detailed discussion of the development of measures to which we now turn.

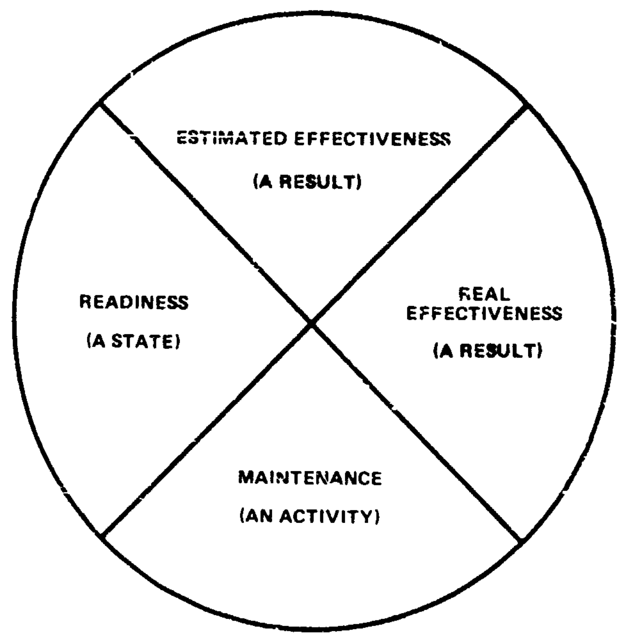
Effectiveness

By far the most complex and difficult measure is effectiveness. Effectiveness is a measure of the ability to provide accurate, specified warning in a timely manner. It differs from readiness and maintenance as follows: Readiness is a measure of the ability to carry out existing analytic procedures and methodology. Maintenance concerns the activity by which analytic procedures, models, and memories are sustained against entropy, kept current, and rendered operational.

The important point about the effectiveness measure is that there are really two kinds of warning analysis effectiveness: estimated effectiveness and real effectiveness. The warning analyst confronts the future. Real effectiveness must be verified after the fact; validation is delayed, occurring through the post mortem. Yet there is a trap: hindsight analysis is perilous. There are sweeping arguments against the validity of historical reconstruction itself: under what conditions can warning be reliably connected causually to an outcome? Skeptics of post mortems on intelligence failures cite problems in validly reconstructing past meanings of information to analysts and analytic communities, which is indeed a very critical problem we must deal with subsequently.

WARNING ANALYSIS MEASURES

The diagram now shows the analysis measures expanded to include real effectiveness.



Estimated effectiveness, an a priori measure, is based on assumptions. These include the assumption that usually multidimensionality is good in warning analysis: that it is better to take into account several frames of reference (political and economic and military, etc.) in interpreting a situation than only one. Another major assumption is that warning analysis ought to incorporate safeguard procedures designed to offset the inevitable epistemological constraints and human tendencies toward bias which lead to susceptibility to deception, both natural and instigated by adversaries. Estimated effectiveness therefore becomes a wager that thoroughness, rigor, and systematic approach in the methods of performing analysis will lead to greater real effectiveness.

<u>Basic Obstacles to Effectiveness</u>. The antithesis of warning is surprise. Effectiveness in warning analysis must ultimately be measured in the context of avoiding surprise. The authors believe there is a shortfall in prescriptive research on mitigating surprise, although fascinating, useful discussions of problems in warning analysis have been made in Wohlstetter's study of Pearl Harbor, Schlaim's study of warning failures in the Middle East, Whaley's studies of deception, and Chan's work on warning failures. Outside the literature of warning there are, of course, many discussions of basic epistemological and cognitive constraints on man's ability to analyze the past, present, and future.

Certainly warning analysis pursued energetically is a hard business, a struggle. The analyst might liken himself to Sisyphus, condemned forever to attempt to push a heavy rock up and over a hill, forever to be defeated near the top by insurmountable inertia. Most basically, the analyst is implicitly striving for literal realism in a bewildering reality which does not necessarily arrange itself according to his mental constructs and images. Not that he has a choice in any final sense. He will do what, in Joan Didion's words, all humans do:

> We tell ourselves stories in order to live ... we interpret what we see, select the most workable of the multiple choices. We live entirely ... by the imposition of a narrative line upon disparate images, by the 'ideas' with which we have learned to freeze the shifting phantasmagoria which is our actual experience.

As we shall discuss later, there is some degree of kinship between the analyst and journalists and writers; between epistemological crises in the arts and fundamental problems in warning analysis. There is less distance between concepts such as narratology and the problem of warning analysis than might at first seem the case. The analyst, after all, seeks to interpret reality, to impose order on the flux of events. For example, the impulse to model possible threatening situations comes from the analyst's need to reduce a bewildering flux of events to some orderly system. Of late there is an announced crisis of confidence in epistemological terms on the part of some journalists, novelists and other artists, centered around issues of nonfiction versus fiction novels; the problem of interpretation in journalism; and other aspects in turn related to the perversity of reality in relation to our interpretive models and constructs. At the heart of the problem of analytic effectiveness is the problem of modeling a complex, multifaceted reality greater than our ability to perceive it. Our organizing models of reality can only be approximations.

Besides making sense of current situations (and usually remote ones), the analyst confronts and must explore the future. Of course very few events now are actually projectable by man with great specificity. Using the example of attempting to project the activity of a human being, Edward O. Wilson writes:

> Even though human behavior is enormously ... complicated and variable ... theoretically it can be specified. Genetic constraints and the restricted number of environments in which human beings can live limit the array of possible outcomes substantially. But only techniques beyond our present imagining could hope to achieve even the short-term prediction of the detailed behavior of an individual human being, and such an accomplishment might be beyond the capacity of any conceivable intelligence. There are hundreds or thousands of variables to consider, and minute degrees of imprecision in any one of them might easily be magnified to alter the action of part or all of the mind. ... it may be a law of nature that no nervous system is capable of acquiring enough knowledge to significantly predict the future of any other intelligent system in detail.

Problems in projection are compounded when one considers the challenge of projecting changes in large-scale systems.

Given that warning projections must be imperfect in the above sense, a major strategic aspect of warning analysis becomes more apparent. The warning analyst will serve a valuable role by alerting the command sufficiently that it may in turn take action designed to preclude the possibility of an adverse situation and outcome. The distinction made above between unimpeded and influenced projections implies this strategy.

Given the severe constraints on warning analysis, a natural approach to developing effectiveness measures is to begin with classification of the specific obstacles to analytic effectiveness, and then to conceive of measures which bear on capabilities and strategies for overcoming the obstacles.

Epistemological Obstacles. Several generic difficulties can be identified:

- Limited Availability of Key Data. Information is a model of the real world. By definition, information will be limited with respect to total reality. Key data may not be available at a given time to the observer.

- Analyst Limitations in Experience and Knowledge. A given analyst's own knowledge and experience may not connect with given situations. In Soviet literature, the example is given of a Japanese commander fighting on a remote Pacific island in World War II who refuses to believe reports of the atomic bombing of Hiroshima and Nagasaki. The Commander has no real concept of the development and potential destructive applications of atomic power in that period and is caught up on the local combat. He has no appropriate context or frame of reference.

- <u>Novel Threat Situations</u>. A serious problem in warning analysis, the novel threat situation seems novel because its characteristics have (or appear to have) little or no historical antecedents. Its features may appear innocent or go unnoticed for periods.

- <u>Similarity in Situations</u>. Some situations may be difficult to recognize because of their similarity in early stages to other possible situations. For example, when analysts develop a set of threat models, it is not unlikely that the early events postulated in various models will be similar.

- <u>Numerous Possible Situations</u>. Since there are so many variations of possible situations, it is always somewhat futile (if necessary) to attack the recognition problem by assembling <u>a priori</u> catalogs of events presumed typical of threat conditions. The classic pattern recognition problem is a good deal simpler: a closed alphabet of patterns is assembled and the viewer must essentially sort out the patterns which are throughput. There are, however, effectively an infinite number of variations in real situations, so that an analyst must view preestablished threat models with appropriate skepticism.

Without pushing too far the distinction between "cognitive" and "epistemological," it is useful to discuss certain cognitive obstacles:

- <u>Restricted Perspective</u>. As Schlaim in particular discusses, analysts sometimes tend to work within narrow hypotheses. This is certainly understandable, for one can provide only so many models of the future. Constructing such models (or scenarios) of real world situations, in both the arts and sciences, is one of the most challenging and exhausting endeavors we can undertake. Further, once they are constructed there is a psychology of preservation powerfully at work. One must also believe that the sense of imperfection about the models can at times diminish the will to struggle with them. In short, hypotheses may be hard won and defended stubbornly.

- Bias. A related problem is bias, which is seen in tendencies to establish low thresholds for input data that confirm prior assumptions and high thresholds for input data that may suggest other explanations.

- Methodological Inflexibility. Analysts may tend to work with only one or two "proven" techniques of analysis, rather than selecting from a variety of methodological alternatives in an effort to fit technique to problems. One basic assumption about effective analysis is that it is better to analyze information from several viewpoints, using a variety of techniques. The premise is that one of the analyst's defenses against the complexity of reality is to search for meaning by taking several cognitive paths.

- Susceptibility to Deception. The problems of warning analysis can be aggravated by the adversary as deceiver. Clever deception will try to exploit epistemological and cognitive weaknesses. The world itself deceives the human observer easily enough; clever deception operations can raise further the challenge to the warning analyst.

Experimentation has, of course, demonstrated much about cognitive biases. Psychologists have charted limitations in man's memory, attention span, reasoning capability and other cognitive functions. These limitations considerably affect man's ability to process data to arrive at judgmental decisions, estimates, etc. As we have said, the limitations result in part from the complexity of our environment: it forces us to adopt simplifying strategies of perception, comprehension, inference, and decision. These remarkably adaptive strategies allow us to deal with the multiplicity of information we take in and must process; yet ironically they result often in erroneous judgment. Thomas Beldon has denoted one consequence of cognitive biases in intelligence analysis as the condition of "hardening of the categories".

Preliminary Concepts of Effectiveness Measures. We can now perceive concepts of possible measures of effectiveness. A few examples are:

- Ability to monitor on the basis of integrated indicators (military plus political plus economic).

- Existence and use of analytic safeguards to offset epistemological and cognitive problems in warning, such as:

  -- Threat-search procedures for avoiding the trap of overlooking threats not previously imagined and modeled, e.g., techniques for learning from "ambiguous" and "incomplete" information.

-- Procedures/techniques for weighing opposing hypotheses.

-- Procedures that foster systematic use of a mixture of analytic approaches (e.g., various forecasting and prediction techniques) to increase objectivity and offset the inevitable bias resulting from overemphasis on any one approach or type of data.

-- Ability to perform easily the functions keyed to estimation and dissemination, such as: marshall evidence; develop statistical presentations; argue by precedent, individual indicators, and/or patterns of indicators; and use of modeling techniques.

Especially when we discuss information-related variables, we shall resume the exploration and development of concepts of measures of analytic effectiveness. It is useful now, however, to proceed to a discussion of the readiness measure.

Readiness

Readiness has been characterized as a state, a condition, a measure of the ability to undertake the procedural and methodological activity within warning analysis. Readiness applies to all the stages, steps and procedures within the model of analysis; it must be measurable for any and all of them.

At the beginning we need to examine an important aspect of the relationship of readiness to effectiveness. We have discussed the problems of imperfect effectiveness in warning analysis; that the sources of imperfection are epistemological and human cognitive problems. In an important sense, readiness is subordinate to, dependent upon, effectiveness. One can develop a system of analytic methods that entails certain procedures, techniques and methodology designed to foster analytic effectiveness, and upon which readiness can be based. The whole analysis system, however, must be imperfect in the face of reality. It cannot guarantee success.

The significant point is this: analysts in analytic groups must therefore be said to be in high (or low) states of readiness to follow an imperfect system of analysis. The effectiveness-readiness relationship bears on a number of aspects of the present research. For example, consider the use to which measurement data might be put in a <u>post</u> <u>mortem</u> with respect to the issue of an "intelligence failure." Given that analysts are working with imperfect techniques, the obligation to be effective must be defined within conditional terms; the obligation for readiness, however, may be viewed independently of the question of real effectiveness.

There is also an important relationship between readiness and maintenance. Readiness is a state which derives from maintenance activity, such as the activity of keeping the information in analysis models of threats up to date and thereby maintaining the currentness of the models.

<u>Obstacles to Readiness</u>. There are a number of obstacles, such as the following:

- <u>Entropy of Analysis Procedures and Models</u>. Procedures and models tend to fall out of date. For example, a working threat model involving possible hostilities between the U.S. and another country will tend to go out of date because of evolutions in weapon systems, new political postures, economic changes, etc. The basic antidote is the process of analytic maintenance whereby new information is used to update the given model.

- Difficulty in Implementing Analysis. A serious obstacle to readiness can arise when analytic tools and procedures -- including those up to date -- cannot quickly and efficiently be employed by analysts. For example, quite realistic and useful threat scenarios may be developed spanning a very reasonable range of possibilities, yet be documented in forms not easily used by analysts during time-critical periods. Computer-based support systems which include displays of models might greatly facilitate the ease of employment of the models and techniques. However, the accessibility of the computer-stored data then becomes a readiness concern.

- Unavailability of Experienced Analysts. An obvious obstacle to readiness is lack of training and experience applicable to different problem areas.

- Analysts' Resistance to Analytic Procedure and Technique. Analysts may become ill-disposed to employ certain procedures and techniques of analysis. Problems in psychological readiness can arise from a variety of causes and are discussed in succeeding portions of the analysis, particularly in the context of incentives.

Typical questions which center on the issue of readiness are: Is there a backlog of input data to filter through given models? How long does it take to retrieve various portions of memory stored in given computers? How long does it take to compare past data to present by an analyst? How comprehensively can a given number of analysts worry different sides of a problem within a limited time frame?

Preliminary Concepts of Readiness Measures. Clearly there are several dimensions to readiness within the warning analysis problem, such as: analyst readiness, system readiness, and supporting technology readiness. Analysts must have experience and training to assure analytic readiness. The system of analysis itself -- the models, techniques, procedures -- may be more or less ready. Further, the operations the analyst performs in recalling information, displaying information, matching disparate data sets, etc., involve readiness.

Readiness as a state, a condition, is ultimately the state of the entire analysis system. Readiness must be reflected in a set of values on some scale which the key variables of that system have at any given instant. Discussion of information-related variables will allow us to explore further and define detailed readiness measures.

Maintenance

The third major measure is analytic maintenance. Maintenance is an activity; it is a measure of the sustaining of analytic procedures, the keeping current of the analytic memories. Maintenance is, in short, partly accomplished through the act of analysis itself.

It does not matter that we are talking about a cognitive activity: when analysts update models, refine procedures, review input data, and generally perform analysis, they are maintaining readiness, readiness of their own capabilities and readiness of the supporting methodological and technological systems. This in turn influences effectiveness.

Obstacles to Maintenance. Some examples are as follows:

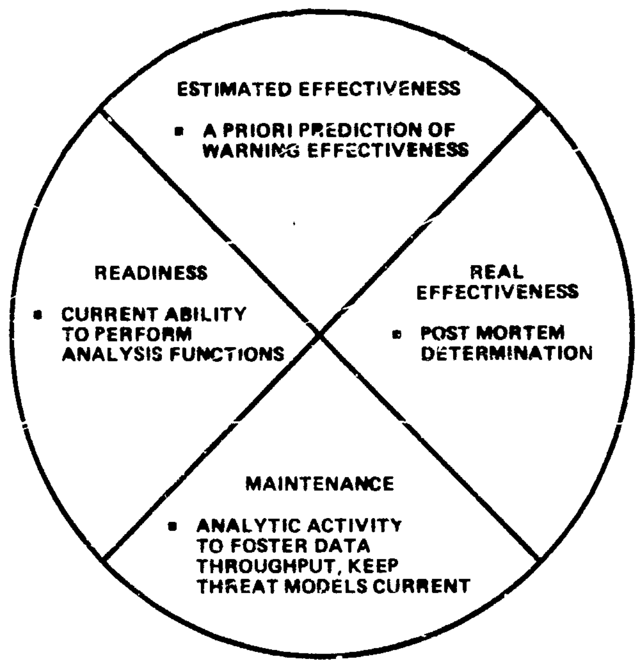
- Failure to route input data through analytic procedures, techniques, and models: When input data is not routed through the analytic process, entropy is risked. Maintenance arises out of the connection of data throughput to the cognitive functions of analysis. If the analyst does not periodically run the data through the system, then the system must lack maintenance.

- Failure to checkout adequately technical support systems: This classic aspect of maintenance refers to preventative maintenance of the hardware and software support systems. A display system that frequently is down for repair, an unreliable computer-based system, and a software package not fully debugged are obvious examples.

Preliminary Concepts of Maintenance Measures. Typical maintenance questions include: What is the periodicity with which new input data has been run through the system of analysis? How much preventative maintenance has been done, and when, with respect to any given support systems within the I&W center?

As the diagram below shows, we have now completed a general discussion of the four major measures of analysis performance.

WARNING ANALYSIS MEASURES



Key Information-Related Variables

To derive real and estimated effectiveness, readiness and maintenance, key information-related variables must be monitored. The variables should have certain characteristics. They should be interrelated within the overall process of analysis; they should be recognizable (monitorable) and intelligible by observers such as managers and analysts choosing to attend to the system; they must be variables which change over time; they must be sensitive and significant for diagnostic purposes; and their change must be measurable.

Three information-related variables have been developed as fundamental to deriving the measurements:

- Data backlog
- Data relationality
- Data signification

In the discussion which follows, each of the variables will be defined, explained as to choice, and exemplified. Specific connections between the variables and the measures will then be specified. The ultimate intent is to show how the key variables combine with the measures to produce a meanginqful, tightly coherent system of linked, interrelated measures.

We will also explore certain important subvariables which could be examined on the basis of empirical data generated by monitoring the three key information-related variables. That discussion will be followed by a consideration of the best uses of the data; primarily focused on the problems in warning analysis that might best be approached with various kinds of data generated by the measurement system. Finally, certain conditional variables related more to the information input aspect than throughput will be discussed.

Backlog

The classic variable of backlog here refers essentially to identifying information anywhere in the analytic process which is in a waiting position, which has yet to be fully analyzed by warning analysts; which has, in short, not completed throughput. We must think of the backlog in relation to all points -- stages, procedures, steps -- in the total model of the analytic process.

It is desirable to measure a number of backlog values, such as: the size of the backlog, the nature of the backlog (e.g., the types of data which comprise it), the time duration of the backlog, and such dynamic measurements as the rate of decrease or increase of backlog, the acceleration values within the rates of increase and decrease, and other measures. These of course could be related to other variables such as number of analysts, technical support, etc.

Backlog is a fundamental variable within the system, for a great portion of the entire approach is founded on the need and desirability of throughput. Readiness, maintenance and effectiveness have all been related in different fashions to the process of throughput. (In their extended visits to I&W centers, the authors have become fully aware of the relatively large volumes of input data typically on hand that must be processed and analyzed. We will discuss the "volume" problem in a later section, indicating for now that we do not view it as an insurmountable obstacle to achieving necessary backlog determination.)

Relationality

The relationality variable involves the extent to which throughput data is related to the full system of analytic stages, steps, procedures, and methods in the overall methodology. Relationality embodies the following question: was the data analyzed, or is the data now being analyzed, through all or some (and if so, which) of the procedural routines, models, and projection techniques which comprise the analytic system of warning? The analytic system is the analyst's best (if inevitably imperfect) means of attacking the epistemological and cognitive problems in warning. The extent to which the analyst appropriately follows that system bears directly on, first, estimated effectiveness; second, real effectiveness (to the extent that the system has been demonstrated as empirically effective); third, maintenance, since the act of analysis itself comprises a large portion of analytic maintenance; and finally, readiness, since readiness is the state or condition of certain analytic abilities. In short, relationality, like backlog, is fundamental to the basic measures.

Furthermore, relationality and backlog have an important complementarity: reduction of data backlog should occur through relationality to the procedures and methods within the warning system. The two variables are interrelated; together they indicate far more about warning analysis than taken separately.

Signification

The most important of the three variables, signification, is also the most difficult, the most experimental. Signification involves the meaning assigned to data by analysts. Signification is captured by recording changes at certain nodes in the analytic process; for example, changes in variables in threat models and changes to the structure of threat models and the reason(s) for the change. As discussed above, meaning, taken as constituting the significance of information to a system which processes it, incurs a change in that information system's processes elicited by the information input, the change often resulting from associations made to the data based on previous experience with it. Change can occur immediately or later. Given that we are viewing analysis in systemic terms -- a process with stages, steps, procedures -- the monitoring of meaning through changes expressed at nodes in our functional model becomes a natural strategy.

The warning analyst essentially attempts to determine the meaning of input information in terms of the degree (if any) to which it may signify the emergence of a threatening situation. The Soviets distinguish this act as a form of decisionmaking, referring to it as an information decision. (The analyst is also interested in recognizing nonthreatening situations and therefore assigns meaning to the data in any event.) The crucial point is this: if we wish to explore real effectiveness, we must be able to perform post mortems which essentially are reconstructions of past analytic states and perspectives, which leads us directly to the need for a selective history of meaning.

The question invariably arises, Why take on a problem as complex and subtle as the problem of measuring meaning? We know that objective quantification is not possible at the present time. We know that contemporary models of human cognition are by no means complete, and that we can make no pretense of fully understanding and hence capturing the detailed (and mercurial) processes by which meaning occurs in a living system. What, then, are the propects for achieving useful results? What are the circumscribed goals? To answer these questions, we must re-explore a central issue in warning.

The Problem of Real Effectiveness. Real effectiveness is, of course, the ultimate frame of reference for warning analysis. Its measurement vehicle is the post mortem. Post mortems can be formal, informal, limited to "failures," conducted in all seasons, etc. But stated simply, real effectiveness involves these questions: Looking back, how well did we do? And why?

Besides the political and technical difficulties, the post mortem process is beset with evidentiary difficulties arising from cognitive and other constraints. These latter kinds of difficulties in conducting hindsight analysis will always (and most fundamentally) complicate the determination of real effectiveness.

A useful starting point is this: analytic memory is crucial for post mortems and the determination of real effectiveness. But there are serious constraints involved with analytic memory. The problems may usefully be expressed in terms of cognitive biases such as discussed earlier. Richards J. Heuer, Jr., has recently reviewed and constructively interpreted the research literature in this area. He concludes that:

- Analysts tend to overestimate the worth and accuracy of their past analytic judgments.
- The consumer of the information (in this case the user of intelligence information) tends to underestimate the value of that intelligence to him.
- The manager conducting a *post mortem* tends to conclude that events were more readily foreseeable (or less so) than was in fact the case.
- *In short, we seem to have a systematic tendency toward faulty memory of our past estimates.*

The explanation for these problems comes largely out of experimental research. As Heuer has told us, there are several key points:

- It appears that additional information available for hindsight analysis actually changes our perceptions of a situation so naturally and so immediately that we are largely unaware of the change.
- The new input data is immediately (and probably unconsciously) assimilated into our prior knowledge.

- If the new data adds significantly to our knowledge -- tells us a situation outcome -- our mental images are reconstructed.

- Apparently it is then virtually impossible for us to reconstruct our prior mental set.

- Thus, we may recall but not reconstruct.

Ironically the human being at this stage of his mental development has a memory, a data base, which is perturbed, altered and, in fact, progressively lost in important ways; and lost, more-over, somewhere within the vital and necessary act of taking in new data, throughputting the data within the human congitive process, and changing perspective on the external world. Thus in the act of learning we also forget.

In principle, there is a remedy: extrasomatic memory. In discussing the development and outlook for human intelligence, Carl Sagan and others have stressed the importance of information stored outside the body -- the early invention of libraries of the written word, and the future prospects of more advanced, inter-actively dynamic forms of extrasomatic information bases which use computer technology. In some commentaries, there is a sense of urgency, the belief that the world is changing more quickly than ever before, and that to perceive the changes and react in ways that foster survival, learning systems supported by advanced information technology are crucial.

The image of the world changing ever more quickly -- with the change substantially of our own making -- and the change increasingly taxing our perceptual, cognitive and hence survival powers, obviously and fundamentally bears on the warning problem. For the present, it is instructive to cite only one of the many problems in the current dilemma. This is the problem of the increasingly stringent requirements to monitor significant change, especially threatening change, in areas physically remote from the immediate environment of the perceiver. The "remote" quality obviously carries over into political, cultural, economic, and other dimensions, thereby complicating recognition by the watcher on all levels of analysis. The need to watch events abroad is not, of course, new; the problem is that the reaction times and other constraints on the watch are growing more severe. Yet the evolution of human intelligence may be at a stage in which we are still operating in part as if the threat from extinct predators is more real than the complex international/intercontinental threats. Can there be any doubt that unaided human perception, analysis and decision-making are inadequate to the challenge? It seems obvious that information technology is essential to survival. Certainly it is our view that information technology is now, and increasingly will be, vital to the warning analyst.

Focusing on the warning issue -- the problem of real effectiveness, <u>post</u> <u>mortems</u> and learning -- let us suppose that as analysis progressed in an analytic community we could succeed in steadily, continuously capturing signification values (as well as backlog and relationality values) and storing them in an extrasomatic memory, where computer programs would perform search-recall-reduction-reconstruction functions and display the results in various forms, including boiled down sequential or narrative accounts of the history of the development of given analytic rationales -- the input data, its impact, the assumptions, and the logic (or methodologies).

In theory, there would be several benefits. The recorded memory of meaning would be preserved safe from the perturbations in the human memory. Further, the basis would be laid for an improved instititionalized procedure for reliably obtaining a permanent, accurate record of certain key analytic constructs -- constructs developed by changing communities and groups of analysts over time -- which we would need for post mortems and the measurement of real effectiveness as well as for operations research and the definition of R&D requirements. Among other things, the data base developed would be beneficial to research and innovation in methodology, analytic incentives, and in other critical areas in which the basic constraints on analytic effectiveness must be challenged if there is to be progress. Finally, we would be creating the basis for continuous post mortems internal to the analytic community and conducted by analysts and managers at all levels. Handled properly, this capability would hold some advantages over (if not necessarily remove the need for) post mortems done essentially by "outsiders" such as appointed committees who explore an intelligence failure. Of course, the computer-based technology supporting the extrasomatic memory must be designed such as to eliminate unacceptable drain on analysts' time. Obviously behavioral ironies created by such a system among analysts and managers is also a serious potential problem to weigh carefully.

Levels of Signification. Two related questions now arise: To what extent can we measure signification? To what extent should we measure it? The answers to both involve our knowledge of human cognicive processes. As we know, brain research has led to mappings and models of the brain to varying levels and in various dimensions -- chemical, electrical, neurological, functional, etc. Mental processes have been classified (intuition, rationality) and associated with cognitive activities (counting, writing, language comprehension, nonverbal ideation, etc.) More elaborately defined models are being developed as new research leads to further understanding. We have known for some time, however, that the operations of the mind on data are enormously complex. There are, for example, millions of light receptors associated with the retina of the human eye which receives visual input. There are perhaps a million ganglion cells which receive signals from the receptors in the retina for processing prior to the throughput of the data to a section of the cerebral cortex, to be followed by other micro operations of great complexity. Thus when we refer to the information subsystem within a human system (input transducer, decoder, encoder, associative functions, memory, etc.) we are considering a process which in its fundamental levels involves millions of parts and processes.

The need therefore arises for a tractable yet viable model of human cognitive activity, constructed at a level of detail suitable for present purposes. Too simplistic a model will not yield enough variables for productive strategies of system development to emerge. Too intricate a model -- a detailed, neurologically-based model, for example -- would obscure the focus on key warning analysis problems.

The attempt to develop a functional model of the cognitive steps in warning analysis (Section 2) is thus judged an appropriate general strategy. However, we must search for a real and usable analog in human cognition to the potential signification-measurement points in the model. Recall, we have adopted the following strategy for measuring signification: we will create a set of models of threat situations; projection models; and other nodes in the analytic process which are (a) subject to change by an analyst as a function of the significance of input data, (b) visible to monitoring, and (c) likely to reflect important changes. Recorded changes would comprise the memory, which should be extrasomatic. (We will exemplify and discuss the design features of such nodes in detail in Section 4.)

We know that we cannot claim that such an approach will capture all aspects of signification. This is because of factors such as (a) we do not now understand mental processes thoroughly enough, (b) changes in the analyst's mind caused by input data and reflecting meaning are "subjective," (c) the changes are virtually continuous, (d) they are perhaps not fully conscious, and (e) they are always subject to loss in the sense discussed above. Thus we will have an incomplete record of signification. For example, even within a system in which analysts indicated and recorded signification according to certain criteria and within a schedule, there would still be some loss, especially in terms of the items listed immediately above.

Can we, though, have a realistic and useful if limited record? One that serves both a valuable present purpose and becomes the first-generation memory in an evolving series of increasingly refined and productive memories? In the authors' judgment the answer is that we can.

First, there is an apparent solution to the problem of finding a functional analog in the human mind to the extrasomatic system of measuring signification. Specifically, there is something of an analog between an extrasomatic model of a threat situation stored in a computer and recallable in display graphics form and whose nodes of activity can be changed by an analyst through the new meaning conveyed by input data (signification), and a configuration carried within the human brain which cognitive psychologists call schemata or plans (sometimes described as a "template"). One technical definition of a schemata is:

> ... a configuration within the brain, either inborn or learned, against which the input of the nerve cells is compared. The matching of the real and expected patterns can have one or the other of several effects. The schema

> can contribute to a person's mental 'set,' the screening out of certain details in favor of others, so that the conscious mind perceives a certain part of the environment more vividly than others and is likely to favor one kind of decision over another. It can fill in details that are missing from the actual sensory input and create a pattern in the mind that is not entirely present in reality. In this way the gestalt of objects -- the impression they give of being a square, a face, a tree, or whatever -- is aided by the taxonomic power of the schemata.

The schemata plays a decisive role in human cognition, particularly with respect to such analytic functions as interpretation, recognition, and extrapolation, and hence seems an appropriate level within human cognitive operations with which to draw a correspondence in designing a functioning extrasomatic memory of signification. From the imputed correspondence between the schemata and the extrasomatic memory of meaning, configured as it is in models which are themselves a kind of schemata, we develop a possible basis for a realistic and useful record of analytic meaning.

One major prospect is that the imputed correspondence offers hope not only of at least some initial realism in the structual design of the extrasomatic memory, and hope not only that the analyst has no fundamental behavioral aversion to the structure (that the "human factors" issue is not overriding): it also offers hope that the extrasomatic memory will quite naturally improve over time, be refined, made increasingly more compatible for human usage, and hence become more powerfully reflective of signification, since one might reasonably expect that continued interaction between the analyst and the extrasomatic memory (in practical terms, of course, a man-machine interaction) will naturally lead to a convergence, a humanizing of the extrasomatic memory.

There remains, however, the question of incomplete signification. Ordinarily we will not be able to record signification operations in the brain on a microsecond-to-microsecond basis. Ideally should we monitor signification at such levels? Since we cannot, what is the effect on the utility of the signification measurement? In our judgment we are very probably not losing enough to impede important measurement. A grasp of the microprocesses of signification may not lead to rapid improvements. Assuming that we someday understand them, these microprocesses are likely to reveal considerably more detail about an important fact of which we already are only too well aware: human fallibility. We can now estimate fairly accurately storage and processing capacities of the mind. Without knowing fully its cognitive microprocesses, we can also recognize beyond any doubt that the progress of the human mind in understanding reality has been painfully slow. We do not need to know more at this point in order to pursue signification usefully.

There are other aspects, such as the nature and role of the collective extrasomatic memory, which we will discuss below. But we may interrupt the discussion of signification for now with the observation that obviously it will be necessary to collect empirical data over time to assess the utility of the specific signification measurement points chosen in the design. In later sections dealing with the IWAMS design, key nodes are identified in the analytic process believed important in capturing signification, and the design of these nodes is exemplified in some detail. A simple example is certain types of information filters existing in threat models by which input information may be associated with preestablished meaning. In this type of signification node, input data may be clustered around certain nodes which model events hypothesized likely given the activity of certain indicators.

The Measures and Variables as a System

We have considered the measures and variables individually but their full definition resides in their linkage, interrelatedness, and interdependence. We must now explore how the basic analysis measures -- maintenance, readiness, estimated effectiveness and real effectiveness -- connect to the key variables of backlog, relationality, and signification; and how this creates linkage among the measures, thereby meeting one of the IWAMS design goals.

Table 4 is a matrix summarizing these interrelationships.

Commentary on Table 4. As shown in the table, maintenance is associated with four variables: standard preventative maintenance (PM), backlog (BL), relationality (R_T), and signification (S_T).

The maintenance measure depends, first, on monitoring the time that support systems are used versus the vendor repair/downtime schedule, which provides preventative maintenance measures. Second, it requires measuring backlog, derived by determining what data in given areas (e.g., the North Korean problem) has not been analyzed within given analytic stages.

Third, maintenance entails measuring relationality. In relationality one factor taken into account is the time spent by analysts in relating given data to given models, in following procedures, and in employing other analytic techniques. For a number of reasons managers and analysts possibly might wish to monitor and compare such values. One reason can be suggested by drawing an analogy to the analysis of intelligence imagery. In some analysis of aerial photography, the objective may not be to do detailed, painstaking review of various photographed scenes, especially if the photography does not give adequate resolution for extremely fine analysis. The purpose of analyzing such low resolution imagery might be to enable

Table 4. Interrelationships Among Measures and Variables

Analysis Measure	Variable	Data To Be Monitored	Calculation
Maintenance (M) (an activity)	Preventative maintenance (PM)	Time used versus vendor schedule	$PM = \Sigma\ ts$
	Backlog (BL)	Data on given geographic areas (or other problem categories) not analyzed at given stages in analytic process	$BL = \Sigma$ area BL
	Relationality (R_T)	Analytic models/ procedural routines involved versus total available data. Time spent on each model (T_i)	# models $R_T = \Sigma\ T_i$
	Signification (S_T)	Changes to variables at analytic nodes. Account taken of analyst skill (A_j)	$S_T = \Sigma\ S_i \cdot A_j$
Readiness (R) (a state)	NA	NA	Scaling based on PM, BL R_T and S_T measures (ideal M versus real M) Objective/subjective reference points on scales
Estimated Effectiveness (EE) (a result estimated *a priori*)	Forecast probabilities as determined by analyst	Forecasts in projection stage of analysis	$EE = \Sigma\ R$ + forecast probabilities

Table 4. -- Continued.

Real Effectiveness (RE) (a result sought to be determined in post mortem)	Forecast probabilities as determined by analyst	Forecasts in projection stage of analysis. Subsequent real events in projected period [via post mortem (PT)]	$RE = \Sigma EE + f\ (PT)$

search of areas to determine possible targets which subsequently should be monitored in higher resolution imagery. The analytic time spent on a single frame of high quality imagery of a significant target ordinarily would be greater than on a lower resolution image of the same area. Similarly, different stages in the progressively more difficult challenges over the sequence of warning analysis from monitoring to projection should result in variations in times reflected in relationality. With enough data, basic trends and characteristic time patterns might, within certain constraints, begin to emerge as a set of analytic norms. Such data might be very important for diagnostics: for example, in operations analysis and research and development activities designed to afford analysts more time to do the more difficult parts of analysis and to reduce time delays in parts of the process which should be done more quickly. Another purpose in examining comparative times is to build in a safeguard against attempts to reduce backlogs by skimping on conducting the relational aspect of analysis. Moreover, the time factor ultimately could more sharply delineate for managers dilemmas created by limited analytic resources. But obviously caution and empirical wisdom are needed since there are not necessarily ideal times for performing various portions of analysis. Clearly, analysts will differ in ability, problems will differ in complexity, and data will differ in their applicability. In the final analysis, the inclusion in the software design of the capability to monitor times spent in relationality and in reducing backlog might aid in the general effort to ensure that a variety of questions of a diagnostic nature, many not now fully anticipated, could be answered in the future.

Signification values are also determined for the maintenance measure. Note that the calculation of signification includes a value, A_j, which refers to the estimated skill of the analyst(s). This is an experimental factor. "Skill" could be derived from experience, training, demonstrated interpretive success, etc. Empirical data and a period of testing the practicality and utility of this factor are required. It would prove interesting in later research to attempt to determine correlations between different analyst profiles and signification. In later discussions of the operation of IWAMS, we will explore the approach of developing IWAMS specialists who largely (but not exclusively) operate the system. The A_j factor would be of interest here.

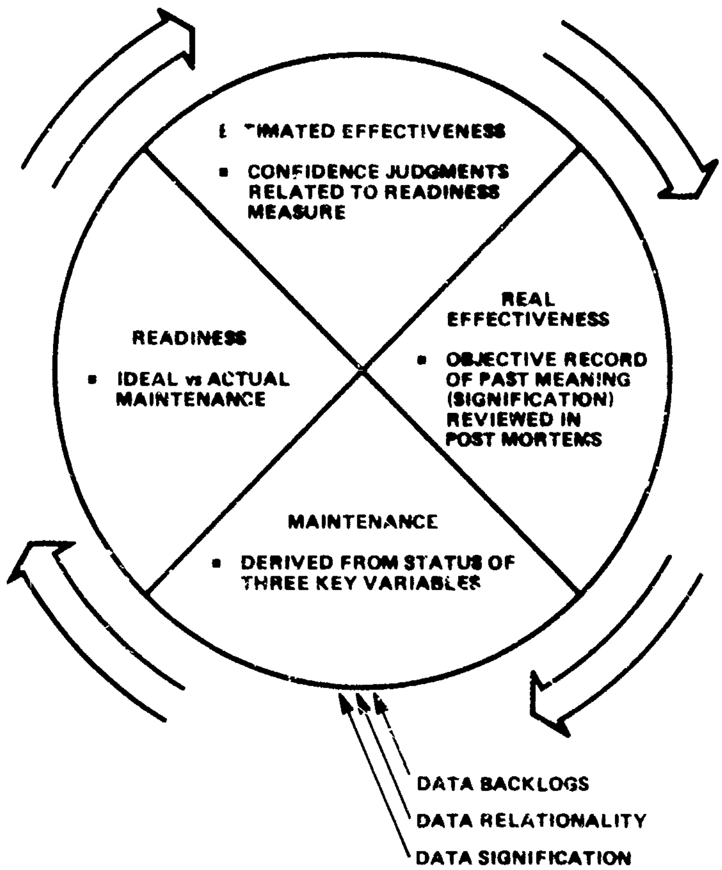
Readiness, an analytic state, is expressed in the form of scaling based on PM, BL, R_T and S_T. Readiness is basically derived by comparing ideal maintenance to real maintenance. Note also that under the calculation of readiness there is mention of objective and subjective reference points on the readiness scales. Managers of analytic centers must allocate limited analysis resources to a wide range of monitoring responsibilities. Managers may assign different goals of readiness to different problem areas and different cadres of analysts.

Under estimated effectiveness, it is seen that the analyst will determine projection probabilities (this is illustrated in considerable detail in succeeding sections) and that the projections will have readiness factored in as a means of determining estimated effectiveness. In sum, current readiness should qualify projection probabilities and produce estimated effectiveness.

Real effectiveness, as discussed above, is ultimately determined through post mortems. In subsequent sections, the problem of measuring real effectiveness is considered in detail. It is necessary to consider analytic procedures, forms, and methods in more substance before appropriately addressing real effectiveness.

The diagram shown below indicates our present level of conceptualization of the full system of analysis performance measures and the relationship to the key variables

WARNING ANALYSIS MEASURES



RELATIONALITY — MEASURE OF EXTENT TO WHICH INPUT DATA IS ANALYZED BY RELATING IT TO SYSTEM OF ANALYTIC PROCEDURES, MODELS, METHODOLOGIES

SIGNIFICATION — MEANING ASSIGNED TO DATA BY ANALYSTS. CAPTURED BY RECORDING CHANGES AT CERTAIN NODES IN ANALYTIC PROCESS (e.g., CHANGES IN VARIABLES IN THREAT MODELS) AND ASSOCIATED RATIONALE

The definitions that now appear in the wedges within the diagram under the four basic measures are explicitly related to the key variables. In addition, the four arrows positioned at different points along the circumference of the circle are meant to indicate the linkage among and across the measures and variables.

Table 5 makes more explicit the linkage between maintenance and readiness, and between readiness and estimated effectiveness.

Table 5. Measures Linkage

From	To	Calculated By
Maintenance	Readiness	Measured readiness times a function* of maintenance activity/effort required to bring maintenance up to 100 percent for specific problem area or stage of analysis. R · f (M100% - Mcurrent)
Readiness	Estimated Effectiveness	Measured estimated effectiveness times a function* of the differential between measured readiness and optimum readiness

*Functions will be refined on the basis of empirical data.

Note that the link from maintenance to readiness is based on the concept that a certain degree of effort and activity in the form of maintenance will be identified that would be required to bring maintenance up to 100 percent for any analytic area or stage of analysis at any given time. (Empirical wisdom is again essential here.) This perspective would be important for the manager who must allocate limited resources in order to respond to problems of varying and variable priority.

Subvariables. Many perspectives can be gained by collecting data on the three major variables. For example, a number of subvariables relate to the major variables. Examples include:

- Types of data. One can consider the different categories of information and how they are being analyzed at the different analysis stages. We can consider product types of intelligence -- SIGINT, COMINT, IMINT, HUMINT, etc. We can additionally consider content categories such as political, economic, military, etc. In short, information may be categorized by various criteria and monitored thusly.

- Percentages. It will be important to determine percentages of information at different levels of the analytic process. In turn, percentages can be related to types of information, or can be related to other parameters.

- Capacity. Such values as data capacities in various levels of the system memory, or data capacities with respect to throughput capabilities at various nodes, can be of interest.

- Time. One can monitor time variously: variables include durations of certain processes; speeds of certain functions; rates of certain activities, for example, rates of backlog reduction; and accelerations.

- Forms. The forms that certain types of data tend to take and then lose during different processes within the analytic model could be of interest.

- Gaps. Data gaps and activity gaps in the process of analysis could be of considerable interest in terms of various measurement problems.

States and pathologies. We can think of a warning analysis system as exhibiting different states. Measurement data may eventually allow us to explore acceptable steady states. To define such states, we would need to determine heuristically relationships between input, throughput, and output capabilities and factors such as the number of analysts, the state of the technology support, etc. Such studies might eventually provide considerable insight into technological solutions for problems in readiness and effectiveness.

Pathological states in information systems occur when one or more variables remain for a significant period beyond their ranges of stability; or when the costs of adjustment processes required to keep them within their ranges of stability are significantly increased; or when the changes from an efficient state are caused by either malfunctioning of subsystems and components or unfavorable conditions in the environment.

Major categories of causes of pathological states in information systems include the following:

WARNING ANALYSIS MEASURES

- Excesses of information input. The problem of excessive information is, of course, highly germane to warning analysis. Adjustment procedures on the part of analysts would be of key interest to management. Excesses in information input could cause delays, loss of focus, and create inappropriate emphasis on certain portions of the analytic process to the relative neglect of others. All this in turn relates closely to the epistemological and cognitive problems which beset analysts in any event.

- Lack of information input. Lack of information input is also very relevant to warning analysis. We have discussed this problem in terms of epistemological and cognitive obstacles to effective analysis; one can see the relationship to the analytic process as a system. Indeed, the lack of information could increase the risk of bad information decisions.

- Inputs of erroneous or mischievous information. The effects on the warning analytic system of the input of deceptive data, erroneous data, and data of relatively poor credibility obviously could become serious obstacles to effectiveness.

- Abnormalities in internal information processes. Such abnormalities must be identified and corrected in a system of warning analysis. Specific pathologies could involve the transmission of information, the coding of information within the system, the associating of information, decisions concerning the meaning of information, and other activities of information processing subsystems. Examples could include semantic problems;

errors in routing of information; and information that is poorly stored in memory, forgotten, not readily retrieved.

In relation to such pathologies, there is a set of classic hypotheses about the likely behavior of information-related systems under varying conditions; for example, when changes are introduced in volume, type of information, stress, etc. The authors are confident that the measures data to be generated by the IWAMS system would facilitate useful research into such hypotheses.

We shall return to the discussion of measures and pathologies later. For now we may conclude the present discussion by making some preliminary comments on the uses of the kinds of measurements we have been exploring.

Preliminary Comments on the Uses of Measurement Data

The previous sections discussed the nature of the measures developed for IWAMS. We should consider also the limitations on the measures data and explore appropriate uses of the data. Of course, full answers to both questions -- utility and constraints -- must await the collection and analysis of empirical data.

It does seem appropriate, however, that managers would utilize backlog and relationality as aids in day-to-day managing of resources and evaluation of operations within warning centers and groups. With respect to signification, the perspective of the authors is somewhat different. Intelligence difficulties caused by problems in backlog and relationality, which in turn are caused by factors such as resource shortages, constitute one type of difficulty, one where management responsibilities for remediation are clear. However, the roots and causes of a warning failure might be shown to derive primarily from problems in epistemological and cognitive aspects of analysis, reflected in a system of analysis whose procedures, models, and techniques were inadequate to the situation. Among other things, the signification measure is designed to illuminate these kinds of problems. Solutions to such problems will in part require conceptual and technical innovations and improvements rather than the sort of adjustments typical of every-day management. Although sharp distinctions among the sources of warning problems are not always likely, it would be useful to differentiate the relative importance of various sources of difficulty. Different problems will have different solutions, some of which will be possible given simply a decision (and the requisite support) to make a change; others will require further conceptual insight. The real purpose of the signification measure, then, is to provide a a basis for more productive inquiry into classes of subtle problems in warning analysis. (Presumably it has been clear that the intent behind the signification measure is not the second-guessing of analysts.) Knowing about the problems, we must, of course, proceed to the formulation of solutions.

We will extend these comments in a later section dealing with analysis management.

Transition

We must now turn to the implementation of the system of measures. For reasons explained below, we have found it necessary to design a system of analysis procedures and techniques whose enactment by analysts will create the measures data. It is not entirely a new system, for some of its parts derive from current operations. But one point is very significant: our system follows our model of warning analysis, builds on it, depends on the assumptions behind it.

There is, as we have been saying, an essential connection between the way analysis is done and how it is measured. The key is that analysis be carried through from monitoring to projection. The measures are intended to determine the degree to which this is done and not done and the consequences.

We have discussed pathologies in information systems and the importance of measures to diagnose them. We can close for now the discussion of measures and proceed to analysis as a method by thinking about the symptoms of incomplete warning analysis in the individual and the system. The chief symptom is memorably suggested in these passages by the writer, Joan Didion, on an illness she has suffered. Referring to certain organic disorders of the central nervous system, Didion writes:

> What happens appears to be this: ...the lining of a nerve becomes inflamed and hardens into scar tissue, thereby blocking the passage of neural impulses ... During the years when I found it necessary to revise the circuitry of my mind I discovered that I was no longer interested in whether the woman on the ledge outside the window on the sixteenth floor jumped or did not jump, or in why. I was interested only in the picture of her in my mind: her hair incandescent in the floodlights, her bare toes curled inward on the stone ledge.
>
> In this light all narrative was sentimental. In this light all connections were equally meaningful, and equally senseless. I was meant to know the plot, but all I knew was what I saw: flash pictures in variable sequence, images with no 'meaning' beyond their temporary arrangement, not a movie but a cutting-room experience.

4

WARNING ANALYSIS METHODS

We must now turn to the act of warning analysis itself. The analytic process is what we seek to measure, manage, and improve. So far we have modeled warning analysis and defined measures of its performance. At this point we must design means of implementing the measures in warning analysis operations.

Stated very simply, this is our basic approach:

1. We have designed the structure of a working context for warning analysis. By context we mean essentially a memory of accumulated analysis against which new data is analyzed to determine meaning. The structure consists of twelve <u>forms</u>. The forms, highly changeable, may be thought of as a language for various kinds of modeling. The forms are comprised of classes of flow diagrams, various types of mapping, and other diagrammatic structures. As such, they are especially well-suited for computer-driven display. IWAMS includes a configurational language by which the analyst can use the machine to change, recreate or develop forms rapidly. Hence there is flexibility <u>within</u> the internal structure of the forms: idiosyncratic, subjective aspects of analysis are accommodated. Further, new meaning and rationale may be registered easily. Within the language of the forms, then, the individual analyst can perform, record and display his particular analysis.

2. The twelve forms each pertain to a different point in the model of the warning analysis process. For example, four of the forms are used in the threat recognition stage; several others are used in the projection stage. Further, the forms are sequential: one leads logically to the next, and so on, through the full process of warning analysis. They are, in short, an interrelated, progressive

series, a chain of outputs of different analysis steps and procedures. Therefore, the language of the forms has a syntax.

3. Together with the forms we have designed an analytic routine, an itinerary of interrelated analysis steps whose results are localized, focused, recorded and displayed in the context of the forms. The routine is designed to insure that the process of analysis as we have modeled it is followed appropriately. Thus there is an overall grammar of analysis.

4. The forms and the routine comprise the IWAMS analysis system. It has been designed to enhance analytic effectiveness; for example, it incorporates the use of anti-bias techniques and other effectiveness-sponsoring procedures described in Section 3.

5. The entire system has been designed to be highly applicable for computer-based support. The extrasomatic memory based on the forms, and the analytic routine, are designed to work against the psychophysiological problems discussed above. The approach is designed to foster the vital heuristic tendency. In short, the system gives the analyst the means to change the system.

6. The performance measures are implemented simply by using the system. When forms are changed in certain ways, signification is evidenced. Signification is recorded and displayed by recourse to the memory of forms. The memory of the forms becomes the data base for post mortems. By following the routine, and evidencing this by computer operations such as calling up forms, relationality is pursued, automatically monitored and recorded for derivation of measurement data. By a system of identifying and tracking the flow of specific input data through the routine and in relation to the forms, backlog values are generated. Hence the objective of managing analysis, is served by the overall process.

WARNING ANALYSIS METHODS

The remainder of the present section describes the IWAMS analysis system in detail. The discussion is organized around the stages of analysis: monitoring, threat recognition and projection. Each is discussed separately. For each stage, the following topics are stressed: the analysis forms; the analytic routine; the development of signification values; and philosophical aspects of machine support. Following that a description is given of an informal test at a U.S. warning center of a preliminary mock-up version of IWAMS. In part the test is described in order to progress beyond the static nature of the system description given to that point and convey a sense of how IWAMS would function operationally. The description of the test, which is focused on the North Korean warning problem, includes sequences of analysis steps and procedures, the times over which they occurred, the signification, relationality and backlog values, and a number of other aspects. Figure 7 shows the areas of emphasis in the discussion of methods with respect to the overall IWAMS concept.

Before proceeding to a description of the IWAMS analysis system, however, it is essential that we consider two fundamental subjects: the role of the warning analyst and the contemporary crisis of interpretation. Without fully appreciating these, it becomes more difficult to grasp the IWAMS analysis system.

Profile of the Warning Analyst

The warning analyst watches some part of the world. He receives information of many kinds and levels of credibility from many sources on events and situations in his sphere. He researches

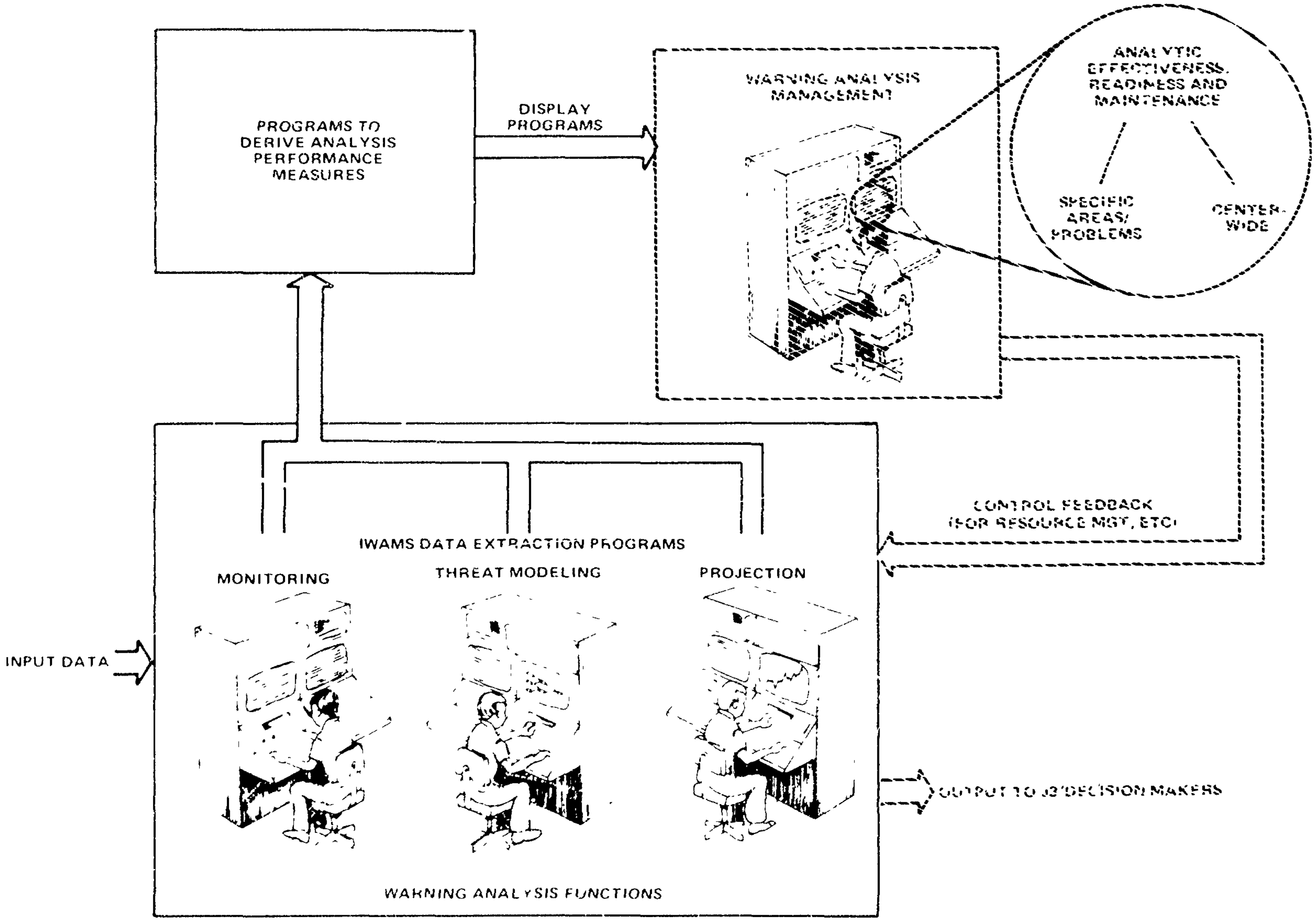


Figure 7. Methods Emphasis in IWAMS

problems and prospects of leaders, countries, alliances, and regions. Perhaps he has visited his assigned part of the world. He may have learned one or more of the languages of the area. He has undergone selected training.

The warning analyst is supposed to do no less than this: understand the dynamics and prospects of change in the area he watches; recognize signs of change, particularly threatening change; assess its significance; make projections; and carry out warning as appropriate.

He strives for literal realism but properly warns on the basis of probabilities.

Through modern communications technology, he encounters on the job (and off the job, too) an unprecedented, growing, vast amount of information, much of it individual facts, isolated events. He is one of the people most caught up in the information revolution. The myriad data provides diverse, sometimes conflicting views of parts of reality.

He is within the realistic tradition of philosophy. He is an empiricist. His operational epistemological assumption is that in some sense "reality" is objective. It is knowable. There are at least some correspondences between his experience and the facts of reality. Moreover, the world in its change has an order, governed by sets of laws, some of which are now known and can be understood and recognized by humans in their perception of reality.

His chief impulse is interpretive. The analyst will be seeking to order the chaos of experience, much of that experience being second-hand, its objects removed like echos from the scene of his interest. He will seek to discover as much certainty and necessity within the reality he watches as possible. To some extent, he must believe that changes in the area of the world he watches are approachable in terms of explainable cause and effect. If change is perverse, it is also consistent within some bounds; it is similar to some degree across different times and places. This basic logic of change derives from the assumptions of purpose and of reality governed by laws recognizable by the rational mind operating on current and past information. Hence factual data are taken as reliable cognitive elements.

Perhaps most fundamentally, he will believe implicitly in the authenticity of models organized by "plots"; models in which experience is ordered in chronological, causal forms. This is not to exclude other perceptual and analytic modes such as mosiac techniques.

Analyzing input data with his models and analytic techniques, perhaps he can be said to have two modes of interpretation:

- To extract a pattern of significance from information
- To impose a scheme of meaning on reality.

The Crisis of Interpretation

In the view of some, there is now an epistemological crisis which throws into doubt our interpretive ability, our success in making sense of events, our ability to project outcomes. Two of the sources of the crisis most frequently cited are, first, certain discoveries in twentieth century physics; and, second, the impact on humans of advances in communications and electronics technology.

Within the present scope, we can do no more than briefly suggest some of the epistemological impact of twentieth century physics. With considerable arbitrariness, we can think of historical stages, beginning before the century and dating back to Newton:

Stage 1: The physics of Newton produces a new model of reality, a new epistemology. A scientific view of the real world emerges in which there is a coherent system of predictive principles. In the eighteenth century, Laplace claims that now the universe can be described with confidence; that it is predictable with certainty. Concepts of man in his perceptual and cognitive relationship to reality tend to hold that there are "facts", and that these are epistemologically reliable.

Stage 2: In our century Einstein throws into question Newton's gravitational theory and its perspective on temporal and spatial constraints, its reliance on laws of classical mechanics. If "facts" were previously considered reliable, Einstein's counter-intuitive revolution in physics now creates uncertainties. In addition, the concept of the elementary particle is developed. Quantum physics, which revises the principles of classical mechanics, alters the older notions of a universe ordered in a predictable system of cause and effect. Heisenberg's concepts of uncertainty further undermine the perspective of the older physics, creating a concept of a microworld of particles characterized by probability and randomness. Niels Bohr's concepts of "complementarity" justify an accommodation with ambiguity. Bohr argues that opposing theories of the nature of matter are valid and coexist in a complimentary way.

Stage 3: The scientific realization grows that there is a world underneath obvious causality which is not graspable by current means of information; that earlier deterministic views have become suspect at the very least; and that the appropriate attitude seems to be a possibility oriented attitude toward reality. In the final analysis, the new theories affect man's confidence in broad terms. As one observer has written:

> The behavior of the particle is uncertain and therefore the behavior of the atom is an uncertainty. The behavior of the atom can be predicted to a degree of probability. The behavior of an aggregate of atoms is therefore only a probability, and not a certainty. And it is no use saying that the degree of uncertainty is too small to effect events on the ordinary scale, for the notion of determinism is similarly based on the fundamental determinism of the individual molecules, multiplied many times to become the world of nature.

> (George Smiley) hated the Press as he hated advertising and television, he hated mass media , the relentless persuasion of the twentieth century. Everything he admired or loved had been the product of intense individualism.
>
> John Le Carré
> Call For The Dead

Perhaps of even greater significance is the impact of the modern communications media. The following is a typical view:

> The new communication technologies make the formulations of any encompassing authoritative visions increasingly more difficult, since they produce an information overload which gives such diverse and disparate views of reality that no single interpretive frame can contain them all and still present a coherent vision of experience. The information revolution also expands the range of the probable to the extent that it blurs the boundaries of fact and fiction ....

The warning analyst obviously is victimized by the information deluge. Modern communications media have created a sort of huge collagé added to daily but perversely discontinuous. It is a collagé of facts, images, events, and "stories," large and small: beyond doubt it is an information overload of diverse and disparate views of reality.

The human neurological and psychological responses to this information explosion, particularly in professional observers and interpreters such as journalists, intelligence analysts, and writers, is sometimes described as a kind of pathology. The specific problem becomes the inability to connect things, to impose order, to narrate process. On emotional and motivational levels, the result can be a variety of inappropriate adjustments: indifference; escape through reduction of the interpretive impulse to the trivial; demoralization; and paranoia. In sum, the symptoms of a crisis of interpretive confidence.

Here we must ask the reader's indulgence, for the impact of media on the interpretative impulse is so important to our discussion that we must briefly explore it. Probably the most dramatic (if among the most extreme) symptoms of the crisis are some recent developments in American literature, developments whose significance is not unrelated to the warning analyst. In the last two decades, we encounter some novelists who blur the distinction between "fact" and "fiction." There has been a change in narrative forms: nonfiction novels, transfiction, surfiction, and other new forms designed to mix the real and the fictional. The chief reason, as one literary observer suggests, is the view that "the official level of reality is so weird that what passes for realistic fiction is totally anachronistic, like an old road map" (essentially a variant of the old adage, "truth is stranger than fiction"). Thus some novelists view their role differently now: they want to be "directly involved" with reality. "Purely imaginative" works can no longer compete with reality. In this sense, then, the writer is becoming more like both the journalist and the intelligence analyst.

A dominant source of these new perspectives is taken to be the modern communications media. The media have amplified the fictive or fantastic quality of reality. Because the major media are driven by economic considerations -- are, in fact, in showbusiness -- the news tends greatly to emphasize "stories" such as Vietnam, the America of 1968 (assassinations, urban ghetto fires, campus wars, etc.), Watergate and Iran of 1978 and 1979. There is judged to be a circus quality about the major media reporting. Through the mass media we are used to seeing images -- usually disconnected and random -- of spectacular events and people caught up in the centers of power, which in turn are the standard stages often of what strike many as rather fantastic and bizarre situations and behavior. Because of time, space and economic constraints on reporting and analysis, the output of media remains a collagé whose meaning is difficult to determine. Worse, the long-term effect is to condition one to the present and to the superficial explanation.

Among some contemporary writers, the reflective tendency has been to reduce the interpretation of reality. Hence even though they are becoming more "journalistic," these writers are becoming far less interpretive Writers working in the new forms tend to approach the world "as it is" without imposing a framework of meaning. The French writer, Robbe-Grillet, has said that reality as experienced by us is "neither significant nor absurd. It is, simply." Some modern literary heroes tend t end up either having lead ambitious expeditions to explore reality which fail to yield much meaning, or simply having decided not to set off on such journeys at all. Writers frequently cited as working in the new forms include Thomas Pynchon, nald Barthelme, John Barth, and Steven Katz.

Such writers depart the tradition of classical novelistic models written on the assumption that it is possible to have an integrated view of existing realities. Instead, they attempt a neutral registration of experience, rejecting the concept of art as the creation of order from chaos and the writer as an interpreter. Such writers do not approach experience in search of cause and effect; they do not organize experience linearly, with logical development and the striving for resolution. Techniques of collagé are more likely, since the writers are opposed to more traditional novelistic forms which seek to perceive and interpret a whole from the parts of reality experienced. In a recent study, Mas'ud Zavarzadeh has interpreted Thomas Pynchon's novel, V., as an expression of the mood, the feeling, of such writers in their pessimism about meaning:

> Mistrust and even fear of totalization not only inform the attitudes of innovative American narratists today but also serve as their immediate subject matter. Such dread is the basic thematic motif of Thomas Pynchon's V., in which the protagonist, Herbert Stencil, ostensibly seeks a literal synthesis of the numerous confusing manifestations of V., but actually fears any solution to 'the V. jigsaw.'
>
> (Stencil wishes to avoid) the false assurance of having obtained the harmonizing principle behind the manifold reality. Stencil's fear of piecing together the hints, clues, and signs he has come across during his search - caused by his suspicion that these are all planted in his way by some conspiracy to mislead him and prove that his integration of V. is no more than merely a scholarly quest for a synthetic wholeness - is opposed by the equal weight of his anguish in not being able to locate V. and separate her from various V.-like appearances. His conflicting feelings ... are indications that, while he has a strong yearning for a unifying belief, the norm in his life has so unmistakably become the fragmentation and chaos of experience that even the thought of reaching a cohesive vision of the wholeness beneath the scattered surfaces is not only suspect but also phony. This agonizing impasse is characteristic of contemporary man's compulsive attempt to identify a solid core of trustable reality distinguishable from fictitious appearances and his mistrust that the pattern he comes up with may be a mere projection based on no more than recurrence of an initial and a few dead objects thrown in his way by cabals. As one character in V. states: 'In a world such as you inhabit, Mr. Stencil, any cluster of phenomena may be a conspiracy.'

Ultimately, reality is viewed as

> ... a form of organized chaos, resisting interpretation and inherently indeterminate to such an extent that a paralogic of conspiracy is the only kind of reasoning which can account for its strangeness.

Most importantly, a profound tension arises because one of our strongest impulses is the interpretive impulse.

Whether we can say that today's history is really any more bizarre than earlier times with their plagues, religious wars, ironic expeditions and rapacious colonizations, is perhaps uncertain. But surely twentieth century technology has made the world smaller, more dangerous. And clearly the "age of information" and "the data market" have resulted in an information overload that is peculiarly perverse. It seems beyond question that the interpretive impulse has been blunted. Confidence in the power of the imagination to simulate reality and lead to und rstanding has diminished.

It suits our purpose here to take account of the interpretive crisis, to recognize it as a major obstacle to be overcome. Certainly the warning analyst does not live in a vacuum; he also is affected by the general environment. Thus while we have been reviewing some developments in literature to suggest quickly the general crisis of intepretation, we should note that symptoms may sometimes appear in the world of the warning analyst as well, such as:

- Skepticism (really, pessimism) at the prospects for more sophisticated analytic methods and approaches.

- Extensive emphasis on indicators and monitoring to the neglect of modeling and projection. This is sometimes referred to as lack of proper emphasis on the estimative, longer-term aspect of warning analysis.

- Narrow _de facto_ perspectives on warning as essentially a very short term activity with virtually exclusive emphasis on military dimensions.

- Less than adequate funding for warning operations and R&D.

The Psychophysiological Basis. There is another view of the interpretive crisis, one that implies a technological response. Let us consider that the information deluge, which is here and must be dealt with, is an opportunity. The warning analyst stands to benefit if through conceptual and technical means we become able to exploit the unprecedented information available today for analysis. It is most important, however, to consider some of the reasons why we have not done so. We can attempt an explanation as follows:

1. At least in a time-critical sense, the unaided human mind seems unable to process, and then conduct extensive interpretive cognition on, the massive modern information input. With reference to our model of warning analysis, the analytic process is truncated; there is a tendency not to achieve follow-through, not to complete the full interpretive thrust.

2. If the information input is accurately described as an overload, perhaps this is largely _in relation to the unaided mind_.

3. For reasons given above, in the cognitive process of analysis we forget as we learn. Therefore we have great difficulty

in establishing continuity and accuracy in the memory, the reconstruction through post mortems, of meanings and rationales. This condition is continuously exacerbated by the intensity and peculiar features of the modern information input.

4. The mind must have recourse to models -- schemata -- through which it filters the input data in order to make sense of it. But the problem described in item 1 has resulted in a failure to build sophisticated analytic contexts for analysis and interpretation of new data.

5. The schemata arising in the mind are both inborn and learned. Learned schemata are the major analytic tool, a major response of the brain, in operating on indirect and second-hand data, which are the classic inputs to the warning analyst who typically receives reports, messages, and visual data on remote places, persons, and events.

6. Three additional problems now ensue. The first is a problem in time. In the face of persistent input overload, there may be insufficient time -- literally no pause -- for the unaided individual human analyst to develop and, more importantly, refine appropriate schemata. Schemata are required that are refined enough at least to give promise of dealing with some effectiveness with the awesome challenge of warning analysis: the interpretive task of attempting to understand remote parts of the world with literal realism, recognizing threats (including novel threats), and at least warning appropriately on probability. This is not to broach the more fundamental problem of the constraints on the unaided brain of reconstructing variations in past schemata.

7. The second problem is this: even if there were time, the unaided human mind, no matter how heroic and endowed with genius,

probably would not invent numerous great schemata, for all the reasons given previously, all the constraints on schemata preservation and storage, and hence refinement, which arise from the nature of the mind's operation on data.

8. The result of these problems is a specific shortfall: the unaided mind has difficulty achieving a certain kind of stasis. As we have said, hindsight analysis and post mortems are key to analysis and its measurement and management. Management of analysis begins with the individual analyst managing his own analysis; post mortems and hindsight analysis should not be the purview only of committees exploring intelligence failures but should be part of analysts' day-to-day attack on the warning problem. For this there must be stasis, a freezing of past situations of signification, those occasions when the analyst (or analysts) assigned meaning by operating cognitively on the data through specific rationales. But as we have seen, signification capturing will not be adequately performed by the unaided mind.

9. The third problem, which we will cite here and discuss below in a more suitable context, is the difficulty of the mind in rapidly perceiving the far-reaching ramifications (or implications) of judgments which initially change single elements or a few elements in complex warning problems whose modeling involves many elements interrelated in a coherent framework. Initial changes to single elements may many subsequently cause shifts in likelihoods at various locations in the model structure. In the case of a complex set of interrelated schemata, the shifts could create structural changes at many points.

This brings us to what the authors believe are the beginnings of a resolution for these problems: the IWAMS analysis system and its associated analytic performance measures. Both were summarized above. We will now undertake a detailed discussion. In doing so it is important to note several points.

The IWAMS analysis forms and routine take into account existing operations at warning centers as observed by the authors. For the threat recognition and projection stages, however, the authors have themselves fashioned forms and a routine. A number of methods of analysis developed in fields outside intelligence, but believed highly adaptable and useful for a first generation methodology, have been used. It is strongly emphasized that the analytic forms and routine are considered a first generation approach that would be changed and refined by analysts during operational use. One of the major premises in IWAMS is the progressive improvement of analysis through the warning heuristic. The main reason for the analytic routine is the presumption, active at every point in the present research, that rigorous analysis requires a system of warning analysis based on the model of warning analysis Against this background, we may now discuss the IWAMS analysis system in terms of the individual stages of warning analysis.

Monitoring Stage

In conducting the day-to-day watch on an area, the warning analyst monitors the activit levels of numerous indicators. Typically there are preestal shed lists of indicators of military, political, economic, and cul ral events. These are judged to be necessary and significant events in processes leading to the enactment of threats. For example, indicators may be developed and organized to show increases in the readiness of military forces to launch an attack. Political indicators may be developed and monitored to provide early warning of potential crises through detecting the emergence and character of political hostility between or among nations or factions.

Indicators are generally categorized. For example, military indicators may be subdivided into such categories as: unusual deployments of military forces; intensive logistics activity; military exercises conducted at atypical times; and similar examples.

There has been considerable indicator research in warning and crisis management over the past decade. The research has led to definition and development of indicators and to design of computer-based analysis-aid systems. The analyst might use computer-based aids which operate on large volumes of indicator data and produce quantitative output on activity levels, for example, the number of adversary ships in or out of position by specific geographic area. Given the input of indicator data from a variety of sources, the basic purpose of such aids would be to determine to what extent, based on the norms inherent in accumulated data, there are unusual activities present; and the likelihood of various threatening trends developing. Judith Ayres Daly of the Defense Advanced Research Projects Agency describes one monitoring aid now under development which involves political indicators:

> The Early Warning and Monitoring System is a computer-based interactive global I&W system. It is based on quantitative political indicators which, along with probabilistic forecasts, are displayed in graphical or tabular form. (The system) is being improved by the addition of rigorous forecasting methodologies and automation of many of the necessary but time-comsuming tasks which must be performed by an I&W analyst. These include automatic generation of hotspot, alert, and monitoring lists which are designed to supplement the analyst's other sources of information and save him time by focusing his attention.

Clearly such approaches and technology tend to mitigate problems of information overload and to enable analysts to realize the opportunities inherent in the availability of large volumes of data.

Indicators are never very far from threat models. This is no surprise since the analyst eventually will seek to make sense of the activity of indicators within some context. If indicators are listed in a sequence believed to represent a probable chronology of necessary and significant adversary preparations for attack, the indicators in effect have been assembled into a model. In the present research, threat modeling, which occurs in the threat recognition stage, should incorporate indicators associated with the monitoring stage. At this point, we should proceed to a consideration of the threat recognition stage and discuss it together with monitoring. The close relationship between the two will become clear.

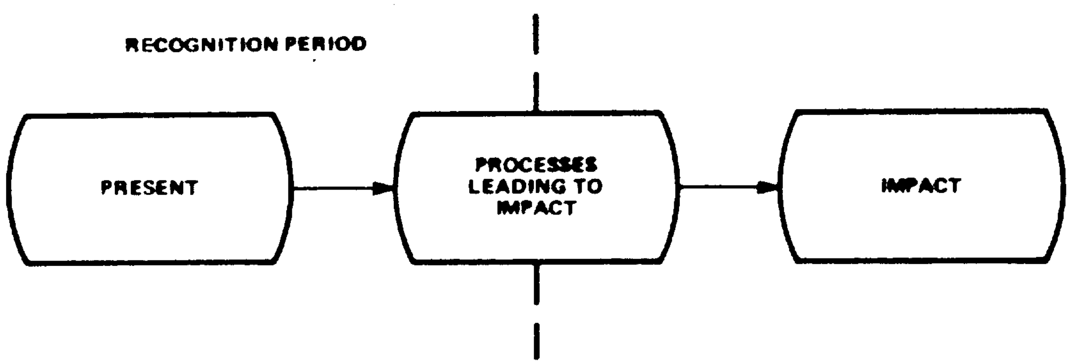
Threat Recognition Stage

As the anthropologist, Edward T. Hall, has said, "Man is the model-making organism *par excellence*." In the threat recognition stage, the analyst now faces a much greater challenge to his imagination and general analytic ability, for he is attempting to model potential courses of action by various countries, entities, and decisionmakers in his area of interest. These models act as filters through which he reviews input data, particularly data on the activity of indicators from the monitoring stage.

The most frequently used term for such models is *scenario*. The warning analyst is indeed a scenarist. He must imagine hypothetical situations as an essential part of the process of analysis.

He must use his experience captured in his memory, and the experience of others in a variety of forms, in creating the situation.

The analyst must be a model builder because the situation (not the event) is the most meaningful unit of warning analysis. The major goal of warning analysis is to recognize a potential threat situation prior to the full onset of the impact. The term, situation, is of special importance. Situations are considered as "things" to be recognized by analysts. Situations may be defined as consisting of three stages: (1) the present; (2) processes leading to an outcome or situation result; and (3) the result itself (which can be an adverse impact on a given U.S. asset). The analytic process should result in recognition of a specific threat situation in advance of the full outcome. The process can be shown as follows:



It follows from the primacy of the situation, itself a complex arrangement of components, that the analyst becomes a model builder, a scenarist: it is how he must envision and analyze situations. Here the concept of forms becomes important.

Analysis Forms. We now turn to specific examples of analytic forms. As a hypothetical case, we will focus on the problem of warning of hostile activity directed against U.S. interests and assets by

North Korea. A set of four interrelated analysis forms believed useful in monitoring and threat recognition have been developed as follows:

- Projected Alternative Major National Courses of Action (PAMNACS). This form is a structure for expressing what are believed the most definitive national policies/courses of action of a country such as North Korea with respect to key warning aspects, such as "reunification" of the Korean peninsula and the international position of North Korea *vis a vis* ROK, Japan, U.S., Europe, PRC, U.S.S.R., and other countries. Figure 8 shows an example of the PAMNACS form used for projection of some alternative major courses of action by North Korea. Several possible courses, ranging from negative to positive impact, are identified. Certain courses can be considered as leading to possible crisis situations. Note that the PAMNACS form is compatible with a system of computer-driven displays.

The PAMNACS should be as comprehensive as the analyst (or group of analysts) believes necessary. Thus PAN MACS are *always and readily changeable*. Figure 9 is a further example in which two alternative courses of action by North Korea are expanded beyond the first version of PAN MACS. The two alternatives are, first, that North Korea attempts to unify the peninsula by war prior to any U.S. military withdrawal (a withdrawal, say, of the scope contemplated early in the Carter adminstration); and, second, that the North Koreans seek to unify the peninsula by war after such a withdrawal. Let us imagine that a study has been made of the various forms such eventualities might take. These forms could include: a protracted conflict; a quick strike by the North against key targets in the South and the seizure of these targets, leading presumably to eventual demoralization of the ROK and its capitulation; and a

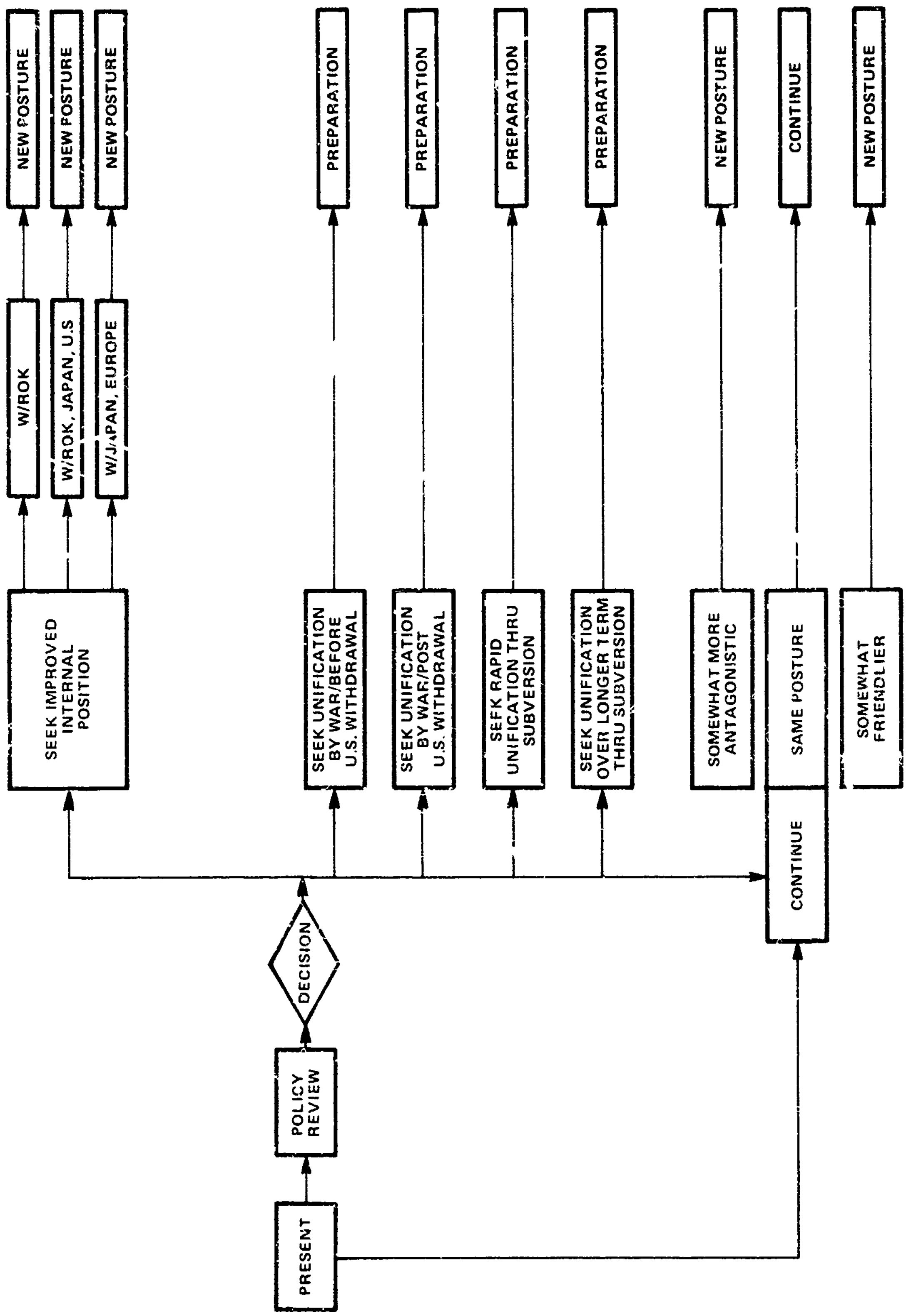


Figure 8. Example PAMNACS

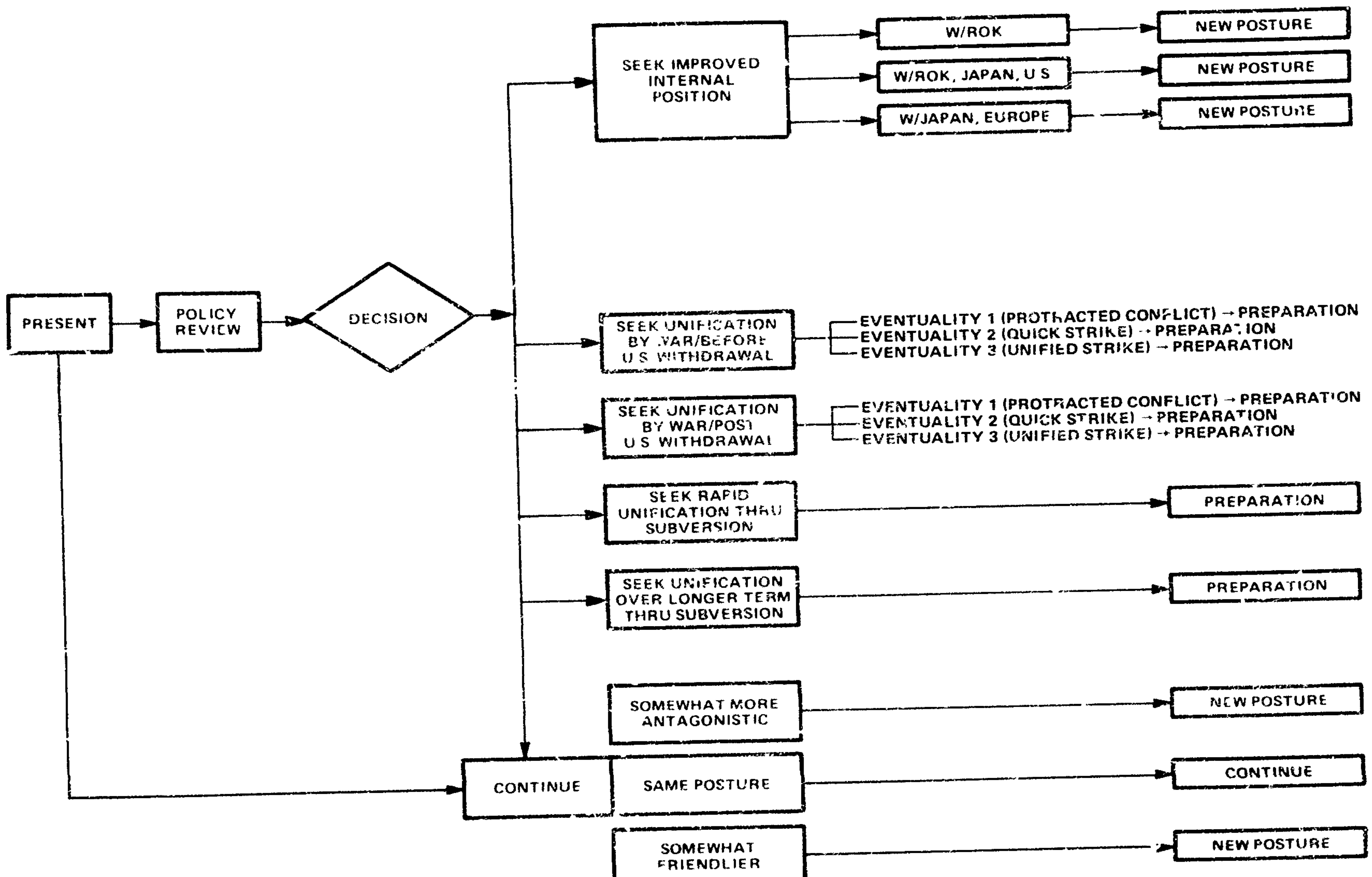


Figure 9. Second Example of PAMNACS

limited strike by the North, for example, against off-shore islands, designed to foment tension and unrest in the ROK which leads to a new government in the South willing to consolidate with P'yongyang. The specific examples given here are not as important as the principle that PAMNACS must be flexible; that it must accommodate new analytic perspectives as they arise.

- Decision/Event Networks (DEN). Figure 10 shows an example Decision/Event Network, the second type of form. DENs are extensions of the PAMNACS. For each of the possible major national courses of action shown in the PAMNACS, a DEN is developed and serves as a means of further modeling the possible activity that North Korea might exhibit in implementing that particular course of action. Figure 10 refers to a specific course of action by the North in which it seeks reunification with the South by military means after a U.S. withdrawal; and plans to do so by means of a protracted, all-out war. Figure 11 shows a DEN for the same course of action but under a different military plan: the quick strike option. Similar DENs would be developed for remaining elements in the PAMNACS. Of course, DENs are always changeable.

The events and activities in the DEN are developed on the basis of the indicators from the monitoring stage of analysis. One of the major purposes of the forms in the threat recognition stage is to provide a context for the indicators.

The numbers shown at the nodes of the DENs are for purposes of indexing and referencing the next type of form, the critical event filter.

- Critical Event Filters (CEF). Figure 12 shows an example of a CEF that applies to the PAMNACS. Similar examples

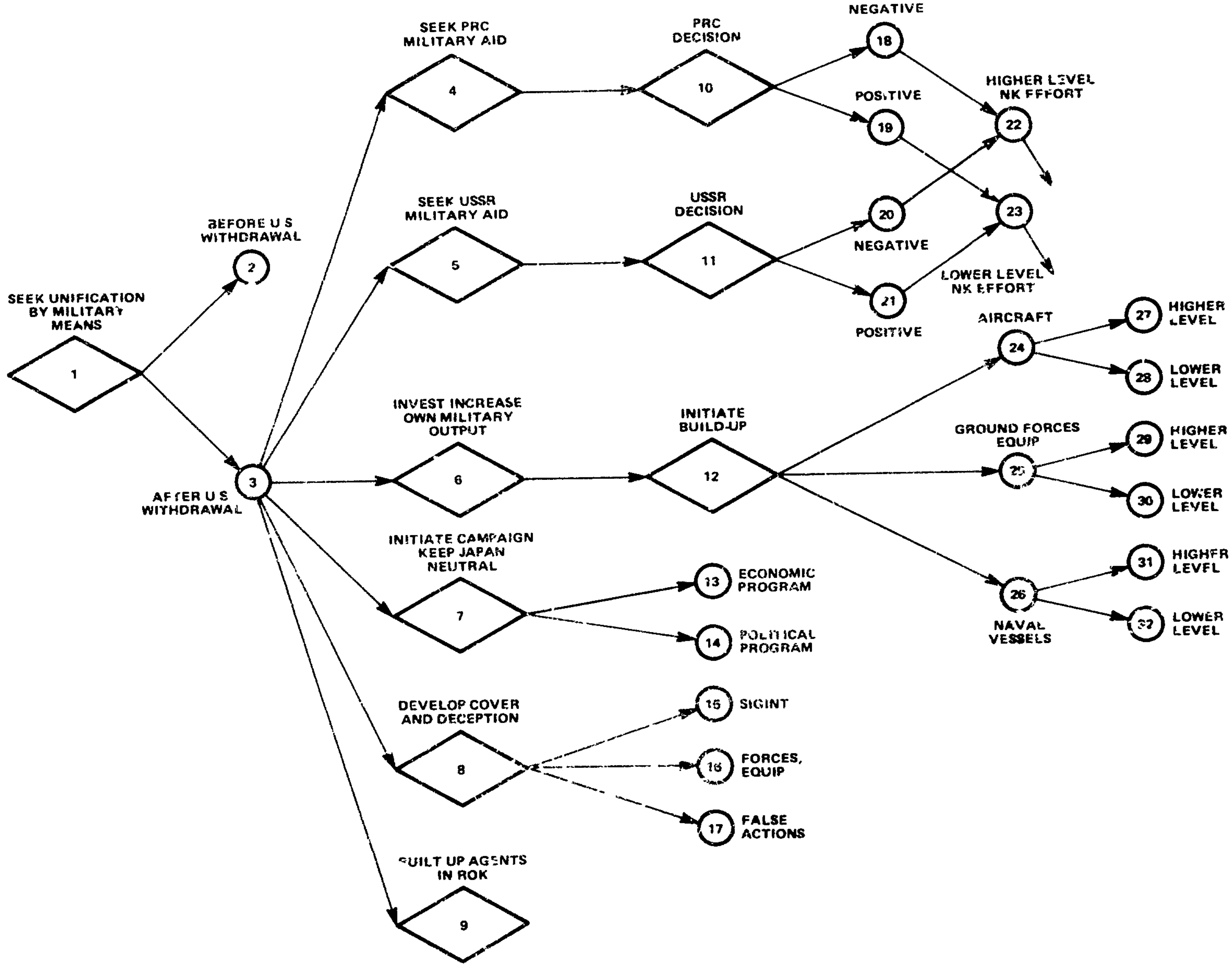


Figure 10. Example DEN

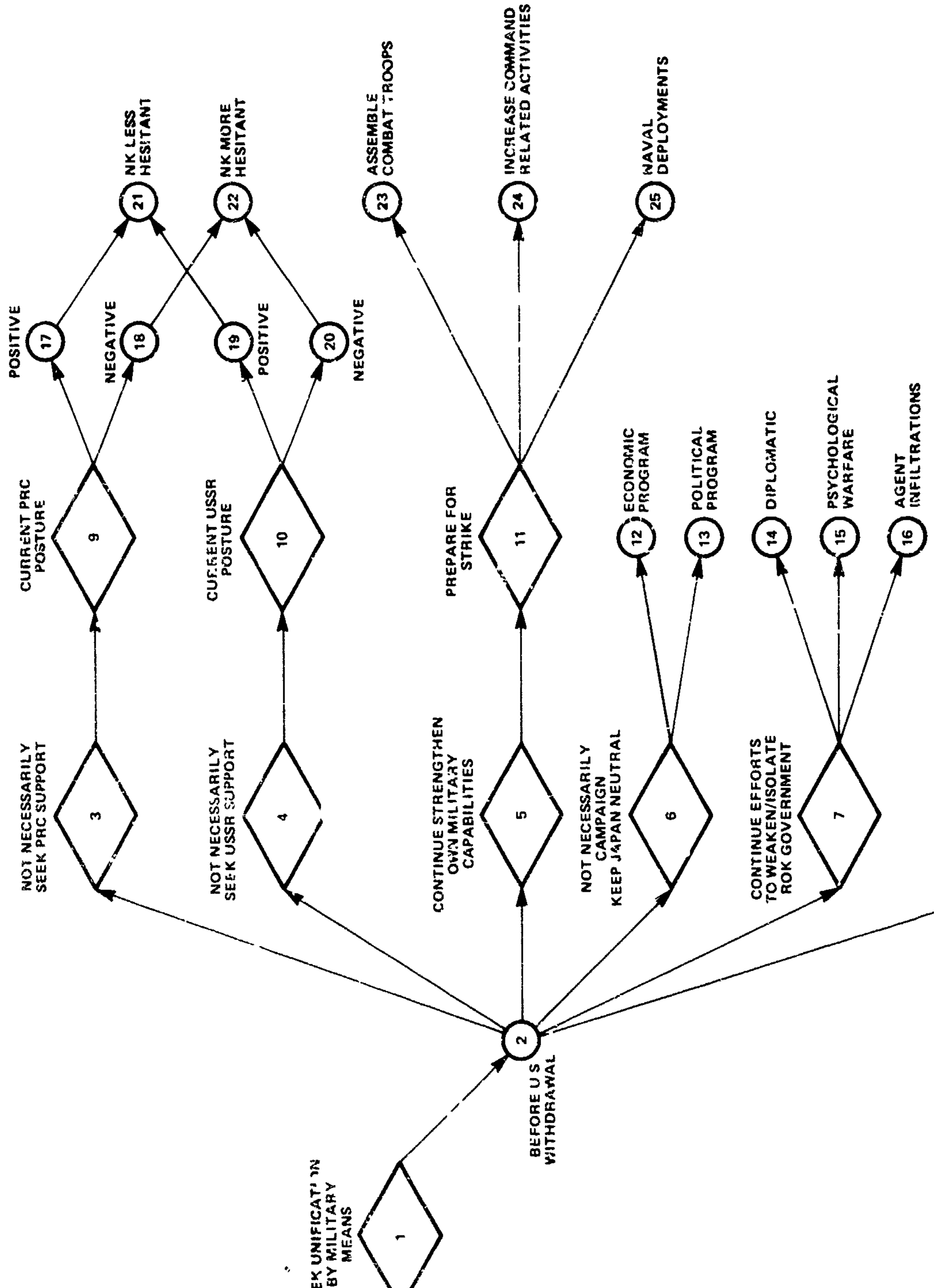


Figure 11. Second Example of DEN

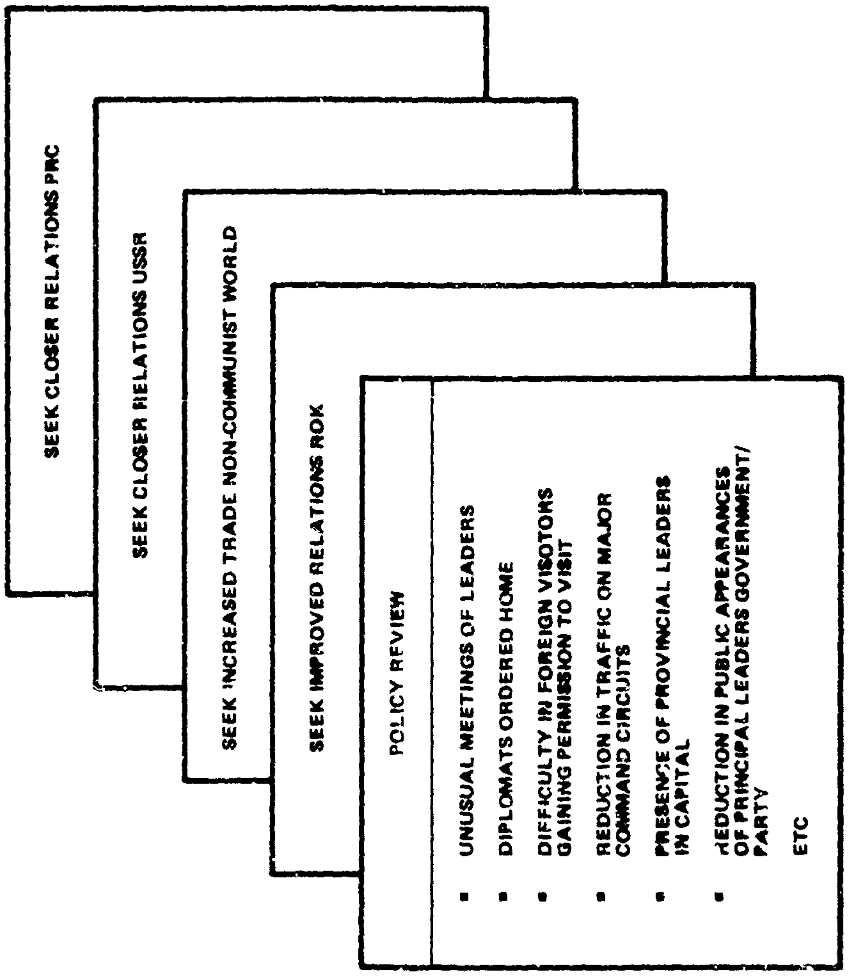


Figure 12. Example CEF

would apply to the DENs. CEFs may be thought of as containers for holding data that are judged to signify that the activity modeled at given nodes in the PAMNACS and in the DENs is occurring. For example, with reference to Figure 11, Node 23, input data on the convergence of North Korean ground units in areas outside their garrisons could signify the assembly of combat troops and hence render that node active. In a computer-based memory, the CEFs could be considered a portion of the memory in which such input data would be stored.

- Anomalous Event Matrix (ANEM). Although always a goal, obviously it will not be possible to model all threat contingencies in advance. We have discussed the reasons for this. We know that novel situations will develop and that recognizing them is one of the major challenges to warning analysts.

It is important to be alert to those cases in which incoming data does not match well with the preestablished context. In these cases, the analyst should have learned that he must take the precaution of formulating new (or novel) threat parameters in order to detect any situational patterns developing in the data. Procedures for developing new threat parameters will generally follow those for designing threat models per se. The analyst should be particularly sensitive to his limitations in knowledge and expertise, and insure that appropriate technical consultation is obtained if there appear to be "abnormal" or inexplicable relationships in the data.

The analytic form denoted, Anomalous Event Matrix, is one approach to aiding in the difficult task of recognizing novel threat situations and of dealing with new data. The technique involves special examination of input data which does not relate satisfactorily to established filters. The examination consists of developing a simple matrix in which input data is compared against new hypotheses; possible changes in technical capabilities; possible new policies in a foreign country; etc. The intended result is to develop new perspectives which tie the input data together better then the existing ones. In turn, these new perspectives can be used to modify or expand the existing models or to create new ones. This analytic process is of enormous significance in several dimensions, as discussed below.

Analysis Routine. The forms and associated modeling involve an analysis routine. The routine is ultimately based on the functional model of analysis in the threat recognition stage as described in Section 2. That stage consists of four major analytic steps and 17 distinct analytic procedures with the input data. We must now relate the modeling to the routine.

We should begin in general terms by considering the basic thrust of the analysis itself. That thrust is to search for, and discover, meaning in input data by relating it to a context of models through the use of certain procedures. Here the analyst is embarked on the analytic adventure, a difficult mental expedition taxing his full powers and demanding that he try to overcome human tendencies that work against his analysis. In theory the analyst should not be satisfied until he can account for data, can assign it meaning. Perhaps the pervasive benefits of full analysis pursued systematically and with rigor -- in short, using a routine -- can best be suggested by looking at the problem of novel threats.

We said above that the analyst must be alert to those cases in which input data does not match well with the system of preestablished models. Conceivably these cases may signify a novel threat situation. At the very least they may signify that the present versions of PAMNACS, DENs, and CEFs are too narrow to account for the perceived events and activities. Therefore, the effective assignment of meaning <u>cannot be accomplished until the models, and perhaps procedures as well, are expanded or modified</u>. Put another way: the analyst cannot effectively analyze such data all the way through the full process until he invents new structure and analytic strategies to do so. In the regenerative process of doing this -- of responding to a problem of signification -- the analyst may discover a new threat, a new dimension to the problem, a new indication, and so on. This will create analyst-inspired change to the structure of the analytic system itself. Through the changes he makes, the analyst will tend to mitigate problems of entropy and to refine methods of analysis. He will tend to stay more current on the problem area he is responsible for. In sum, if the interpretive impulse is facilitated, not blunted, the analyst has the chance to be, and to become increasingly, effective. The paradox, profound and subtle, is this: only by working systematically and hard to create a set of imperfect models does the analyst create the basis for improving his effectiveness. His chance to improve his effectiveness lies in his interpretive impulse which causes him to worry the new data against the imperfect models, out of a mixture of skepticism and excitement, and to make refinements. The analytic routine helps him to be thorough. The context of models helps him to see when he knows something and may be right; and when he does not and must create ways to do so. As we have said earlier, he must, because of the ways in which his mental capabilities have evolved, rely on extrasomatic memories and extrasomatic analytic support in accomplishing these goals.

We should consider briefly certain other aspects of the modeling process in warning analysis, for when the analyst follows the threat recognition routine he does much more than is expressed in the individual steps and procedures outlined in the model. Indeed, among the unique aspects of warning analysis are the special roles of memory and imagination. In warning analysis there is a crucial requirement for effective memory. An analyst must recall associations and relationships, past behaviors, and past events in order to understand current information as a basis for projecting the future. We remember by recourse to our information base of actually sensed events. Further, memory is colored by imagination: given that the mind simulates reality from the abstractions of sense impressions. it can equally well simulate reality by recall and fantasy, creating stories and playing imagined and remembered events back and forth through time. Obviously these powers apply to the modeling of hypothetical threat situations (as well as to projections) in the process of warning analysis. It may seem a grimly humorous question in light of certain history, but is the analyst doing anything fundamentally different when he makes such projections as against when he daydreams? In purpose and mental direction, the answer is (or should be): yes, he is doing something very much different. But in terms of essential mental processes, he is not.

Hence we must distinguish various kinds of imaginative activity. With some wariness, we might consider <u>disciplined</u> versus <u>undisciplined</u> imagining. If one is fantasizing a pleasant and personal future situation -- and all fantasizing ultimately implies the future -- then one is likely to be in a kind of meandering, free-association mode. In some psychology this process is exploited for therapeutic purposes. In some literature it is modeled in what is called the "stream of consciousness" tradition in an attempt to convey the sense of a human being by showing the patterns and tendencies in this ruminating use of the imagination. If there are problems of mindset, bias, wishful thinking, distortion, mirror imaging, and all the rest of the catalog of pitfalls in human perception and cognition, it is good that the problems arise and are evident, both for the therapist and for the writer who is trying to dramatize a particular human personality.

But man the analyst must do directed threat modeling and projections, which of necessity must be done through "disciplined" imagination. They must be done imaginatively because, as we have said, the human being has no other way of challenging the future except by going back through the data base of remembered images, scenes, hypotheses, convictions, etc. and creatively putting together that future. The sobering aspect is that warning analysis has as its basic thrust the Sisyphean attempt to understand the future with literal realism, with great specificity across all the information categories: who, what, when, where, how, and why. It seeks under tremendous constraints to model and project what will happen both in an unimpeded sense and an influenced sense. Warning analysis thus becomes a uniquely demanding, creative act. Hence the routine becomes essential for disciplined approaches.

When a novelist or playwright or movie director creates an idealized world full of people, events, conflict, and, ultimately, meaning (even if it is the view that there is no meaning), a projection of sorts has been made. An enormously complex, sophisticated body of technique and narratology -- all of it highly disciplined -- has grown up around the making of novels and plays and movies. On a different level, the warning analyst is also a narratist. There are general techniques of narratology highly germane to warning analysis in modeling and projection.

The warning analyst undertakes to develop scenarios. What are the techniques and stylistic features of the scenario? The ability to construct realistic and plausible scenarios presupposes not only a comprehensive knowledge of an area and its possible trends, but also demands varying degrees of relatively specialized literary skills. The basic problem is to take the essential ingredients of a hypothetical situation and order them into a coherent, realistic sequence of events. Existing scenarios will require periodic refinements to lend them greater impact and credibility on the basis of new data. This process is also, of course, part of the dynamic of signification.

The analytic forms described above are designed for flexibility in scenario development. One of the basic advantages of scenarios lies in their diversity. They can vary considerably, both in subject matter and form. However, the essential nature of any scenario is that the situation described is hypothetical. By definition, a scenario is a depiction of a hypothetical series of events that could produce some envisaged situation. Thus the analyst's basic problem is to establish a coherent pattern of events within which the projected situations could plausibly occur. In doing so, he is establishing structures of rationale. These in turn are bound up in signification.

Much has been written about achieving plausibility in writing and in other art forms that are largely imaginative (or hypothetical). In its broadest dimensions, the problem is that of using all the elements of composition effectively: mechanical elements such as narration and description; and conceptual elements such as plot and unity. This challenge entails disciplined approaches However, the great majority of scenarios fall within relatively narrow limits as to the mechanical and conceptual problems they pose and thereby require rather straightforward routines. One reason is that scenarios, though they need not do so, are generally intended to serve as broad outlines of likely processes. Their characteristics include the following:

- Scenarios, unlike dramatic fiction and informal essays, seldom tend to digress. Frequently they will be pure plot in the way history sometimes is reported: event A leads causally to event B, which in turn leads directly to event C, and so on until some final situation or set of prevailing conditions is reached.

- Scenarios frequently consist primarily of visual diagrams designed to condense action into its largest movements. That is, they are intended to depict long-range views rather than highly detailed closeups of actions and individual actors, though the latter forms are certainly not precluded. These types of scenarios often will telescope the events of several weeks, months, or even years into a relatively short space.

- Scenarios are often deliberately employed to incorporate and integrate numerous factors in a situation, including military and political, sociological and economic, and psychological and cultural influences and processes. Thus they may include more frames of reference than ordinarily are found in imaginative writing and analysis.

From these characteristics certain problems requiring special attention by the analyst become apparent. One of these is to ensure that at all stages the coherence of the plot or sequence of events is immediately visible: that an outcome is believed possible because certain earlier events or conditions are believed capable of bringing it about. In turn, it should be clear how this outcome influences other stages in the course of events being described. Again, rationale structures are being developed.

Table 2, page 21, shows the functional outline of the threat recognition stage of analysis. In reviewing the table, the reader will see quickly that there is a close correspondence between the modeling activity -- PAMNACS, DENs, CEFs, and ANEMs -- and the steps and procedures in the analytic functions. Largely through the modeling, the routine is implemented: the indicators are matched against the various models, the correlations identified, and the models as a set compared in terms of their relative levels of activity. Novel threat analysis is conducted, with the steps and procedures implemented through the ANEM. Hence the modeling is a means of facilitating the process. Backlog and relationality measures enable us to monitor the extent of these activities.

Signification. In the threat recognition stage the analyst. according to a chosen rationale, assigns meaning to the input data in association with a series of models. Having said this, we must reflect on meaning and context. We have said that meaning constitutes a change in a living system's processes elicited by an information input. For the individual warning analyst and for a group of analysts pursuing the warning mission, changes that indicate meaning has occurred are any and all changes in the perspective on the likelihood of threat situations. Input data must have more meaning or less meaning -- but definitely some degree of meaning -- in relation to what it is thought to tell us with respect to possible threats which must be warned against. The information may appear insignificant, mildly interesting, or highly indicative. Moreover, this meaning is visible through changes in or to the contextual models used in analysis.

The anthropologist, Edward T. Hall, has written importantly about the relationship of context to meaning Hall explores richly the distinction between high context and low context modes of thought and expression. High context modes have a considerable amount of rationale and perspective already built in and available for the interpretation of input data and the development of outlooks on states of reality. One can think of such modes as involving established models of reality and systems of rationale (and, of course, biases as well) which create a strong context for the assignment of meaning to input data, all hopefully in the interests of perceiving and interpreting reality for purposes of developing policies and strategies of enlightened self-interest and survival. High context systems have the advantage of simplifying the cognitive functions of analysis and decision. They tend to ease problems of information overload and stress. The are intended to incorporate painfully learned lessons of experience which have some proven reliance as continuing guidelines for behavior. They may be stores of collective wisdom obtained over long periods and intended to keep us from repeating tragic history. (They are also deeply involved with culture and cultural identity and integrity.)

High context modes of expression tend formally to incorporate high levels of explicit signification, particularly in terms of capturing rationale. A simple but penetrating example is given by Hall in his description of how the Hopi Indians use their high context language in discussing the weather. Hall begins by commenting on spoken and written contexts:

> ... context ... carries varying proportions of the meaning. Without context, the code is incomplete since it encompasses only part of the message. This should become clear if one remembers that the spoken language is an abstraction of an event that happened, might have happened, or is being planned. As any writer knows, an event is usually infinitely more complex and rich than the language used to describe it. Moreover, the writing system is an abstraction of the spoken system .... in the process of abstracting, as contrasted with measuring, people take in some things and unconsciously ignore others. This is what intelligence is: paying attention to the right things. The linear quality of a language inevitably results in accentuating some things at the expense of others. Two languages provide interesting contrasts. In English, when a man says, 'It rained last night,' there is no way of knowing how he arrived at the conclusion, or if he is even telling the truth, whereas a Hopi cannot talk about the rain at all without signifying the nature of his relatedness to the event -- first-hand experience, inference, or hearsay.

The danger in a high context system is entropy. It is a poor wager indeed to suppose that reality will not eventually change in such ways as to make at least portions of high context systems obsolete.

Low context modes can intensify the interpretive effort, since the human must invent new context in order to assign meaning and hence understand and explain perceived reality. This requirement brings with it all the problems that high context modes tend to mitigate, particularly those of input overload. But it also has the advantage of causing us to look at input data from new perspectives. It tends to help us avoid failing to recognize novel situations because we are too wedded to existing context which may have suffered entropy.

Obviously the ideal strategy in warning analysis is to achieve the appropriate balance between high and low context analysis or some condition of oscillation between the extremes. It is evident that the system of models -- PAMNACS, DENs, CEFs, and ANEMs -- represents a high-context interpretive mode. The models establish a substantial context within which to assign meaning to input data. But we have noted that the crucial factor in warning analysis is the force of the interpretive impulse which causes the analyst to challenge the high-context models when he cannot assign meaning satisfactorily within their current forms. As an analyst begins any given sequence of analysis in the threat recognition stage, he may experience either of these cases:

- Case 1: He finds that the data may be readily associated with a node in an existing model.

- Case 2: He finds that the data is not readily associated. This condition then requires him at minimum to modify or create a new subframework to account for the data. It may even require him to create a new model (e.g., a new major national course of action in the PAMNACS, followed by a new DEN and associated CEFs).

In Case 1, the primary record of signification is held in the CEF. Recall: the CEF is not only a model node (and a carefully chosen one, as we discussed in the earlier comments on the art of scenario building): the CEF is also a kind of signification reference point; it is a container in which we store input data which we associate with the existence of real activity similar to that modeled at that node. The analyst, by associating the data with that particular node, is saying that one of the conditions in a threat situation he believes he has effectively modeled is occurring.

The full rationale behind the assignment of meaning -- that is, behind the signification of the data -- lies in the assumptions and logic that went into the structure of the model itself: assumptions about the time frames required for certain events; the preparations needed; and any and all other conditions believed necessary for the situation to occur. Here we must ask for the reader's indulgence temporarily. We cannot deal fully with the issue of the assumptions in models until we discuss the projection stage of analysis. The place to deal with the assumptions behind models is in the discussion of the analysis of conditions leading to threats, and that analysis is bound up in the process of making projections. Although we are describing warning analysis as a linear process, it becomes a cyclical, iterative process in real operations. Developing threat models is done in conjunction with other kinds of analysis performed in the projection stage.

In Case 2, the primary record of meaning lies both in changes made to the models and changes made in the models. The information input, because it has not appeared to have adequate meaning within the context created by the existing forms of the model, has caused the analyst to search for meaning through the creation of new context. This begins as low-context analysis whose thrust is to create a new high context useful for future analysis.

Machine Support Implications. We have argued that specialized machine support to the analyst is essential. We have said that this is so because there must be extrasomatic memory and analysis aids to mitigate psychophysiological problems which constrain human analysis. Section 5 below describes what we believe to be the specific software requirements of such support: the file architecture, programming needs, display designs, required memory capacities, major man-machine interface requirements and other traditional design considerations.

What we should consider in the present section are some important general implications about the basic nature of such machine support to the warning analyst.

One consideration has an overriding importance. It is speed of operation. The human mind can operate with enormous speed in processing and analyzing data. It may worry a problem for long periods of time, creating and reviewing options, imagining consequences of action, and contemplating problems from many sides. But as it does such analysis -- in the analytical acts themselves -- it naturally operates at great speeds. Any successful extrasomatic support system must allow the analyst to continue to operate at adequate speeds. Ultimately there are two words to describe the problems that otherwise ensue: delay and interruption. If there is interruption of the all-out, speedy processes of cognition in hard analysis, whether the processes be lightening-like associations, a series of associations made over a few seconds, or a general assault for a lengthy session on a puzzling problem, such as the significance of an anomaly, the result can be devastating. Anyone's everyday experience verifies again and again the negative effects of interruption on difficult analysis. No particular expertise in human factors is needed to realize that out of the many reasons why analysts may not depend on a given computer-based aid, one of the primary ones is that it fails to meet the need for sustained analysis at appropriate speeds. Certainly one of the diagnostic goals in monitoring the backlog and relationality variables is to discover such problems anywhere in the analytic process.

There is a serious question about the limits in warning analysis on the effectiveness of any approaches using extrasomatic memories and analytic aids embodied in books, reports, memos, etc. It is, of course, unrealistic to imagine that we will cease to depend substantially on these over the near term. Nor can analysis be conducted entirely in a visual mode using computer-driven graphic displays primarily comprised of geometric configurations and alphanumerics. But the simple fact remains that books, reports, memos, etc. are harder and slower to use in virtually all aspects of analysis: data review, data correlation, interpolation, integration, etc. Because of this, they are more likely to suffer entropy in container drawers. And because of these and other problems, they will not provide an adequate record of analytic operations and processes. Just as a pianist translates his ideas into sound directly through a keyboard controlling sound-producing mechanisms, and from there perhaps into a recorder, so ideally the analyst should have a computer-based support system that directly accepts, records and displays his pertinent analytic functions and results at due speeds. Such capabilities are vital in promoting the analysis heuristic.

Tolerance of delays and interruptions is to some extent dependent on the specific capacities for such in each individual. And, of course, sometimes delays and interruptions may ironically prove beneficial. Furthermore, certainly the written word in paper storage has uniquely beneficial properties as a memory and as a vehicle for sophisticated analysis. Each media has its virtues. But none of them is even remotely as important as the overriding point. It would be foolish indeed not to understand that speed of analytic operations made possible by computer-based support systems, together with the secure memory these systems afford, is directly related to enormous possibilities of increasingly sophisticated and realistic human interpretation of reality. Throughout the present research there is no more important point. Nor is there a clearer imperative than in the fact that all too few manhours doing such analysis on significant scales have ever been expended.

There is no necessary conflict between warning analyst and machine. The machine not only need not constrain the analytic capability of the analysts; it should extend it, increase the productivity of the energy of the human analyst, and enable more, faster and less error-prone analysis.

In terms of the models and modeling in the threat recognition stage, a primary design goal for computer-based support becomes clear: the calling up, comparing, and modifying of models and portions of the models must be capable of being performed quickly and displayed succinctly and effectively. As we shall discuss below, there is remarkable potential in the use of color displays and other devices for such purposes. The analyst must be able to manipulate the extrasomatic schemata readily and speedily to sustain the momentum of the analytic processes in his own mind. In doing so, he will create a record for *post mortems* that also must be reviewable with appropriate speed as the need arises.

Projection Stage

The warning analyst now faces his greatest challenge: the projection of situations. As we have said, he will not be able to anticipate final victories. Indeed, we have discussed in some detail the fundamental limits on projections by human beings.

But what prospects are there for improvement in the projection of international situations? That is the important question. The need to make projections sufficiently trustworthy as to inform enlightened policy simply must continue to become increasingly a recognized priority. Yet until a considerable effort to do such projections is mounted, an effort involving open and intelligence data, computer-based memories and analytic aids, a substantial national community of analysts and thinkers operating with continuity and with constant self-review, and with R&D response to shortfalls, on urgent national problems, we will really have no firm basis for assessing prospects. However, can there really be any acceptable alternative to the determination to improve the national capability?

In the present discussion, the intent is not to recommend a single best way of approaching warning projections. Obviously there are projection methodologies yet to be invented which will better the current inventory. We will discuss a general method believed promising as a basis for evolving more refined methods. It is an eclectic approach, an admixture of various methods. There is no intent to provide a survey of various projection techniques, nor is there an implication that what is included is necessarily more suitable than, or implies a reason for excluding, other available techniques. Such qualifications become less important when we recall that the focus is not really on any current set of methods nearly so much as on a man-machine system whereby communities of analysts may readily and heuristically evolve improved warning projection methods. In short, the projection system described is a start.

Analysis Forms. The making of projections presupposes a set of forms used in conjunction with those in the threat recognition stage. We can conceive of cases in which the analyst, having reviewed input data in the threat recognition stage and detected early signs of a potential threat situation, then proceeds to projecting outcomes. It is at this point that the requirement for additional forms arises. In discussing these forms we must simultaneously touch on aspects of analytic routine; there is also a separate section on routine *per se* following the discussion of forms.

- Translation of Threat Models Into Projection Format.

The first form is referred to as the projection format. As Thomas Belden has pointed out, the warning analyst, whether developing unimpeded or influenced projections, ultimately has the obligation to respond to the basic information categories -- who, what, when, where, how, and why. Each presents a separate analysis challenge or obligation. At the same time they must be combined into warning judgments. This implies that a grand projection methodology must be a synthesis of several submethodologies dealing with various problems associated with the different categories. Similarly, the measures of analytic performance must penetrate each category. In discussing the projection stage in the warning analysis model, we established as the first procedure the translation of individual threat models used in the threat recognition stage into a projection format. The format, first adopted by Belden, is this:

(1) Who (or what)
(2) (Could do) what
(3) (To) whom (or what)
(4) Where
(5) How
(6) When
(7) Why (both to what end and/or because x conditions apply).

Of course this form applies whether we are considering a single statement of a threat or an extended description of one.

The information categories, combined into the English sentence, form a penetrating and elegant way to structure the problem of warning projections. The proper focus on warning projections should be on the essential output to decisionmakers and other users; and, as simply and directly as possible, on each of the major challenge areas to the analyst in developing that output. It is useful to consider briefly the obligations of the warning analyst in developing projections within each information category.

First Analysis Obligation -- Who and What. Who and what are explicitly contained in the sentences formulating the basic warning concern:

Who might do what to whom? and
What might cause what to happen to whom?

For analysts, the problem of who and what referring to initiators or catalysts of threat enactment essentially reduces to identifying countries, political and military groups, leaders/ decision makers, and economic, psychological, and cultural forces which can enact threats or cause threats to be enacted.

The problem of what as denoting a hostile action -- nationalize industries, attack property and citizens, etc. -- and the problem of whom as the victim of the hostile action, are closely related. Any generalized list of types of U.S. interests and assets and the potential threats toward them would include items such as these:

- Attacks against U.S. military/government personnel, facilities, and equipment located outside the U.S.

- Hostile actions directed against other U.S. citizens located outside the U.S.

- Seizure of U.S. overseas commercial investments.

- Denial to U.S. of use of lines of communications.

- Withdrawal of political support in world/regional organizations for U.S.

- Economic activity directed against the U.S., such as formation of cartels to deny combinations of vital resources to U.S.

- Attacks against U.S. treaty allies.

As noted, a major (but not exclusive) principle implicit here is that the proper focus of warning analysis is primarily on threats to U.S. interests and assets. Identifying potential initiators and catalysts of threats, and identifying and prioritizing the U.S. assets and interests threatened, can be considered the first obligation of the warning analyst.

Second Analysis Obligation -- Why. The second issue incumbent on the analyst is: Why. This can be stated as:

Who might do what to whom because -

This need to address why is perhaps the most fundamental and certainly the most challenging obligation of warning analysts. The overall problem of credibility, including credibility with decision makers, obviously is linked to establishing the plausibility of potential threats. In the most cosmic sense, theories of what determines the course of events range from the view of Carlyle that the activities of leaders are the predominant factor; to the cutlook of Tolstoy which views history as an accumulation of accidental events with the element of chance more important in determining its course than the decisions of leaders. Both theoretical positions happen to be useful; either may dominate, depending on the situation. More important to the problem of method and procedure is that the analyst must have succinct, up-to-date information based on:

- The goals, predispositions and characteristic behavior patterns of key decision makers

- Decisive military, economic, political, and cultural forces.

Further these must be tied in with threats to U.S. interests and assets.

Third Analysis Obligation -- When, How, and Where. The third obligation is to consider when, how, and where a threat might be enacted. Each of these presents a different challenge to analysts.

For the problem of when, it is necessary to attempt to take into account all the necessary processes that must occur. It was noted that the warning analyst can focus on a finite (and, of course, prioritized) set of threats. For the problem of when, it is important that the analyst attempt to identify the essential processes -- military, political, economic, psychological -- that must unfold in the enactment of given threats, and then estimate the minimum or worst case as well as other potential timelines involved in the unfolding of these processes. Important items in threat enactment could include such factors as the extent of emergency powers of a government, its command and control capabilities, terrain, and the nature of U.S. assets threatened.

The problem of how requires that the analyst consider the means of threat enactment at the disposal of foreign decision makers and the economic, political, or other forces that might combine to produce enactment of a threat. The objective is to estimate the relative likelihoods of occurrence of plausible processes of threat enactment. Factors such as the size and nature of police/military forces of the hostile government and the political constraints on that government would be significant.

As regards where -- the problem of projecting the geography of threat enactment -- the geography of U.S. assets and interests clearly is a key factor. In varying degrees, political, military, and environmental factors will also be important.

Table 5 provides a very simplified and hypothetical example of the translation of a threat model into the predictive format. Such formats could be used for all threat models and both types of projection, and could accommodate considerably more detail and specificity.

- Specificity Ratings. A prototype Specificity Rating Scale has been developed for use in comparing the specificities of models, predictions, and forecasts across the information categories. Table 6 exemplifies the form, showing the thrust of the approach. Of course, refinements would be developed through operational use of the scale. In computer-based operations, color displays could be used, and specificity levels could be color-coded. In turn, models used in threat recognition and projection (see below for examples of the

Table 5. Example Use of Information Categories With Threat Models

1. WHO (or WHAT): North Korean combat forces

2. (Could do) WHAT: could be directed to launch surprise attack from present positions

3. (to) WHOM (or WHAT): against the ROK, and the U.S. military forces stationed in ROK

4. WHERE: by attacking across the DMZ and into ROK via various routes

5. HOW: by attacking without mobilization or forward movement of reserve forces prior to attack, and by using units now deployed near the DMZ; by flying limited interdiction strikes by NKAF without a major forward deployment of aircraft; and by conducting limited naval operations shortly after ground forces cross the DMZ

6. WHEN: within one week

7. WHY (or because X conditions apply)

    a. Assume North Korea's long-range goal remains the unification of the entire Korean Peninsula under the North's regime

    b. North Korea perceives an anarchic situation developing in ROK via the following: uncontrolled student demonstrations; a coup d'etat; an economic collapse; an ROK government leadership crisis.

    c. North Korea perceives that the ROK is losing its ability to offer determined resistance

Table 6. Simplified Example of Specificity Rating Scale

Quantitative Value	Information Category						
	Who[1] (Identity of U.S. Asset or interest)	Who[2] (Identity of Foreign Actors)	What (Identification of Threat	When (Time of Crisis Accurate to the :)	Where (Location of Crisis)	How (Description of Implementation of Threat	Why
S_{max}	10	10	10	10	10	10	10
INCREASING VALUE OF SPECIFICITY	Unique identity of asset	Unique identity of foreign actors	Specific threat: Confiscate Kidnap Armored Attack	Minute Hour	Unique location identity (i.e., individual structure location)	Exact form, direction, speed of "tactical" threat (i.e., ground, air, sea, etc.)	Specific causes (i.e., economic crisis brought on by crop failure, etc. General causes (i.e., facism, etc.)
	Group or type of asset Sector identity of asset U.S. asset or Allies Interests etc.	Group or organization of foreign actors Country of foreign actors	General threat: Increase Tension etc.	Day Week Month Year	Area within region (i.e. area within populatio: center) Region (i.e., population center) Latitude/ longitude Country Section of Hemisphere Hemisphere	General form of threat (i.e., "military", "economic", etc.)	

latter) could be displayed with use of the color codes as a means of rapidly and effectively indicating comparative specificities for different elements in their structure. Experimentation by the project team with such approaches using a Tektronix 4027 color display have shown considerable promise.

- Recourse to Basic Principles Underlying Projections. We have discussed the imperfection of projections made by human beings. Yet in his obligation to make projections, the warning analyst must assume that there are some reliable rules or principles of change to which he has recourse in attempting to understand the future of social systems, their processes, technologies, behavior patterns and so on. In his very useful book, An Incomplete Guide to the Future, Willis Harman has formulated a wise approach to making projections. Harman's focus is not warning as we are examining it, but portions of his thinking apply here as well. Harman reminds us that although there are few clear cut ways in which the behavior of social systems are dependable, one may usefully distinguish several general principles to consider when concerned with the dynamics of complex systems. These are continuity, self-consistency, similarities among systems, cause-effect relationships, holistic trending and goal-seeking. Ultimately the various methods of projection, from the highly qualitative to the essentially quantitative, are based on various mixes of these principles. It is our contention that these principles should be considered systematically by warning analysts making projections.

What, specifically, do the principles encompass? Here are brief definitions largely adopted from Harman:

Continuity. Large systems show continuity. They tend to flow into new states rather than change in discontinuous jumps.

Potentially a serious trap in threat projections is not to realize that even in civil war and other conflict situations, substantial portions of the class structure, bureaucratic structure, economy and technology of a nation may survive. In making projections, we instinctively and rightly operate on the basis of past experience. The principle of continuity may be invoked in various projections involving economic patterns, military capabilities and postures, etc.

Self-Consistency. A second guiding principle is that such systems tend to be internally self-consistent. For example, the behavior of one social sector typically is not inconsistent with that of another. Large scale industries in consumer luxury items, for instance, are unlikely to develop in a small, relatively poor nation focused on a military buildup. This principle is fundamental to the scenario technique. As Harman notes, the purpose of developing scenarios about the future is to make certain that the future conditions we postulate, no matter what technique of forecasting underlies them, are systematically examined for coherency and plausibility.

Similarities Among Systems. Systems in different places and times will show definite similarities. For example, military juntas will tend to act somewhat alike under similar circumstances. Harman notes that this principle is used in what he calls "anthropological" approaches to studying the future and in cross-cultural comparisons.

Cause-Effect Relationships. The dynamics of nations, organizations, and groups may be partially understood in terms of cause and effect relationships. Assumptions of cause and effect relationships are made, for example, in analyzing economic dynamics: if certain goods become less available, it is often assumed that the price of these goods will go up. This principle is basic to what Harman calls "cross impact analysis," a widely used method of studying the future by modeling the imagined cross impact of various events on one another.

Holistic Trending. In evolving and changing, systems "behave like integrated organic wholes. They have to be perceived in their entirety." There is, therefore, no substitute for human observation and judgment about the future state of a system. Ultimately, no matter what the inventory of machine-based projection algorithms, signification must involve the human analyst.

Goal Seeking. Like individuals, systems such as nations, organizations, and groups have goals. These goals may be more or less "conscious" or enunciated. (Certainly an analyst may observe a system and come to believe that the real goals are not the announced goals.) But the major point, as Harman states, is that "change is not aimless, however obscured the goal."

- Use of Forms Which Systematically Employ the Principles of Projection to Reduce Bias. The key concept is that the six principles should be used systematically. Projection methodologies should be designed to foster the application of analytic energies in systematic considerations of possible change. There are a number of potential approaches using the principles. These may primarily involve quantitative data on economic and political indicators; and hard data on such changes as military technology developments. Or methods might be used which attempt to project qualitative aspects such as shifts in cultural perspectives (such as the resurgence of traditional values). Methods combining these separate approaches might be used which ultimately are primarily holistic.

The difficulty, of course, lies in avoiding bias. We have stressed the difficulty in gaining objective views of the future. As we noted, the analyst runs a high risk of bias when he relies too heavily on one projection technique. As Harman points out, methods that rely essentially on numerical data are subject to bias toward input information that can be readily quantified. Similarly, methodologies which focus narrowly on theoretical issues and rational behavior may lead to analytic failures because irrational and unconscious forces are insufficiently accounted for.

An obvious strategy of the warning analyst in mitigating bias is to use several approaches to projection. The problem will lie in judging which results to stress in the various approaches and which to downgrade in importance for given analysis problems. One tactic is to look for points of similarity and conflict in the results and pursue the latter as needed. More basically, the warning analyst would be prudent to consider several plausible future situations, not a single one, given the perennial uncertainty about the future. In the discussion of threat recognition, this strategy was apparent in the construction of models of alternative threats. The principles of forecasting can be used in a variety of ways to delineate a set of alternative paths to the future. In the authors judgment, little has been done to develop analytic forms which deliberately use all the principles. A few promising ones, some described by Harman and some developed in the present research, and all readily compatible with computer and computer-driven display operations, are as follows:

Sector Comparison. Described by Harman, this form can be used with the threat models and with several projection techniques discussed below. Sector comparison is an analytic technique for examining the plausibility of various projected situations, given differing combinations of military, economic, technological, political, and other conditions. The warning analyst would apply the sector comparison technique as follows:

1) In the case of North Korea, for instance, consider a number of sectors of that nation, such as:

   E = economic performance
   S = economic structure
   M = military strength
   R = military readiness
   B = outlook of decision makers
   A = relations with key nations
   I = political control exercised by current regime

2) For each sector, define alternative conditions that together span a reasonable range of possibilities. The range of possibilities may be as extensive as the analyst judges useful. Table 7 gives simplified examples. The question mark over the last column indicates that continuous review and search for additional categories of importance must occur.

3) Examine plausible sector combinations such as $E_2 - S_1 - B_3$ etc. Use projection principles such as internal self consistency, holistic trending, cause and effect, etc., to analyze plausibilities among these sector combinations.

Probable Futures Mapping. In using projection principles to analyze plausibilities among sector combinations, an analytic form has been developed in the present research and designated, probable

Table 7. Example Sector Segmentation

E	B	M	I	?
E_1 Widespread prosperity	B_1 Near-term takeover of ROK/expulsion of UN forces is considered plausible	M_1 Three-to-one advantage on ground over forces in ROK; AF superiority	I_1 Current regime firmly in control	
E_2 Prosperity restricted to certain groups	B_2 Expectation of takeover of ROK by mid 1980's	M_2 Superiority in AF; rough equality in ground forces	I_2 Current regime in control of most of country	
E_3 Equilibrium, slow growth, general public satisfaction	B_3 Acceptance of ROK as reality over indefinite future period	M_3 Inferiority in forces but good defenses	I_3 Current regime in control of key urban centers only	
E_4 Recession, general dissatisfaction	B_4 Focus on internal North Korean economic and political problems	M_4 Questionable defense	I_4 Current regime in control of capital and few other areas	
E_5 Economic depression	B_5 Non-alignment stance	M_5 Military forces in poor status	I_5 Current regime extremely vulnerable to opposition	

futures mapping. The approach is based on the fundamental concept that over a specified period of time there is a definite range over which sector combinations can vary. For example, it is unlikely that a nation would go from a classic depression to substantial recovery in one year. The probable futures mapping would be done in the following steps.

1) Segmentation of Sectors. The types of sectors described earlier should be analyzed and segmented into discrete states. These segments must be fully described to reduce the ambiguity between levels. The process will be continuously refined as the analyst gains experience and insight into its use in a given problem area.

2) Detailed Probable Futures Mapping for Each Sector. Beginning with a description of the present in terms of the sectors defined in Step 1, the analyst then extrapolates into the future and analyzes, for each sector and for every time period, which segments are probable. Typical single sector mappings are shown in Figures 13-16 with respect to military (M), economic (E), internal security (I), and leadership outlook (B) sectors. The analyst has decided that over specific periods of time the military, economic, internal security, and leadership outlook conditions could change according to various and varying schedules.

3) Synthesis of Single-Sector Mapping. The maps developed in Step 2 are now combined into a probable futures map, as exemplified in Figure 17. Beginning with the present (the center of the concentric circles of time) possible combinations of the sectors are

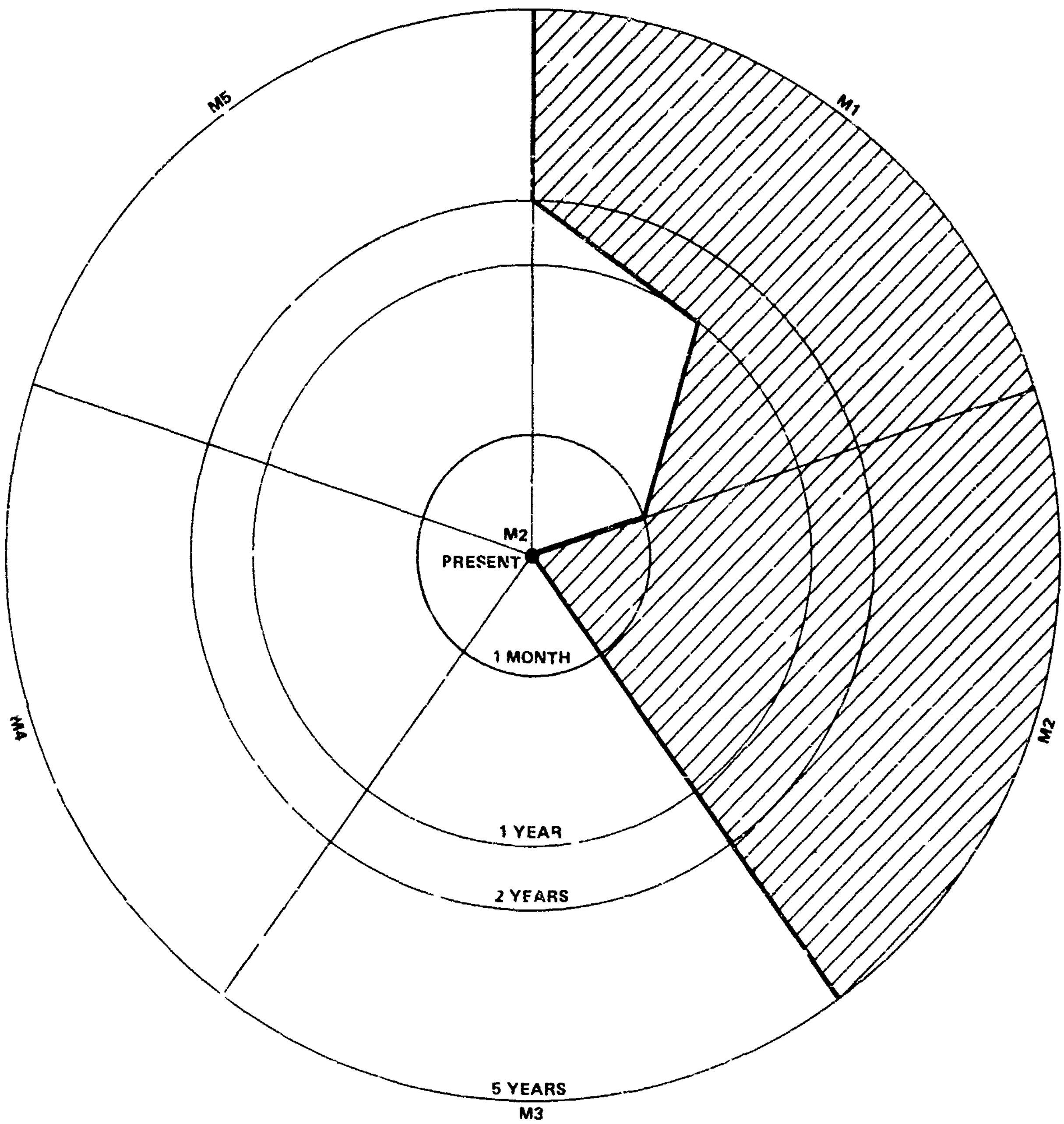


Figure 13. Single-Sector Map -- Military

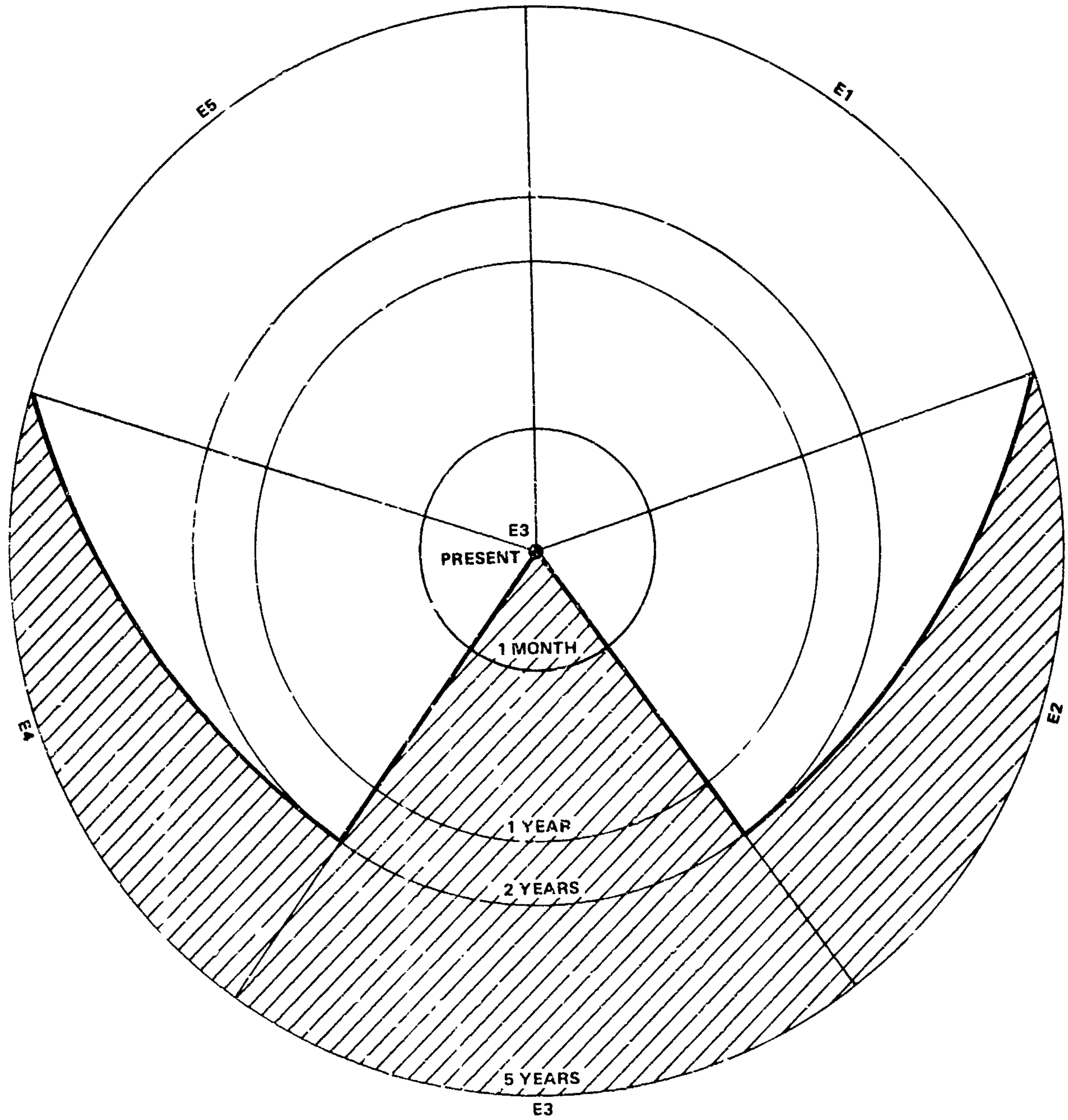


Figure 14. Single-Sector Map -- Economic

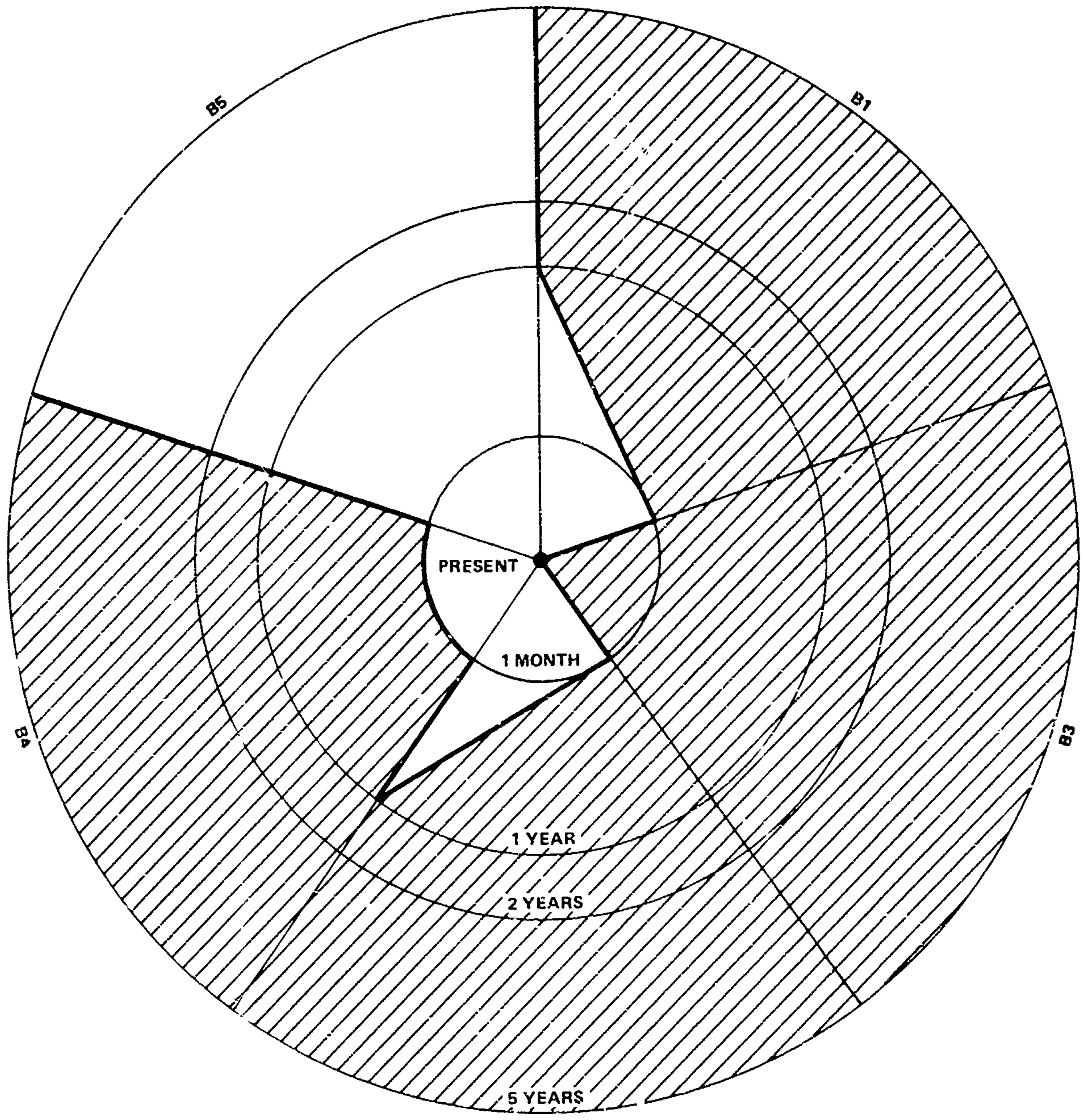


Figure 15. Single-Sector Map -- Leadership-Outlook

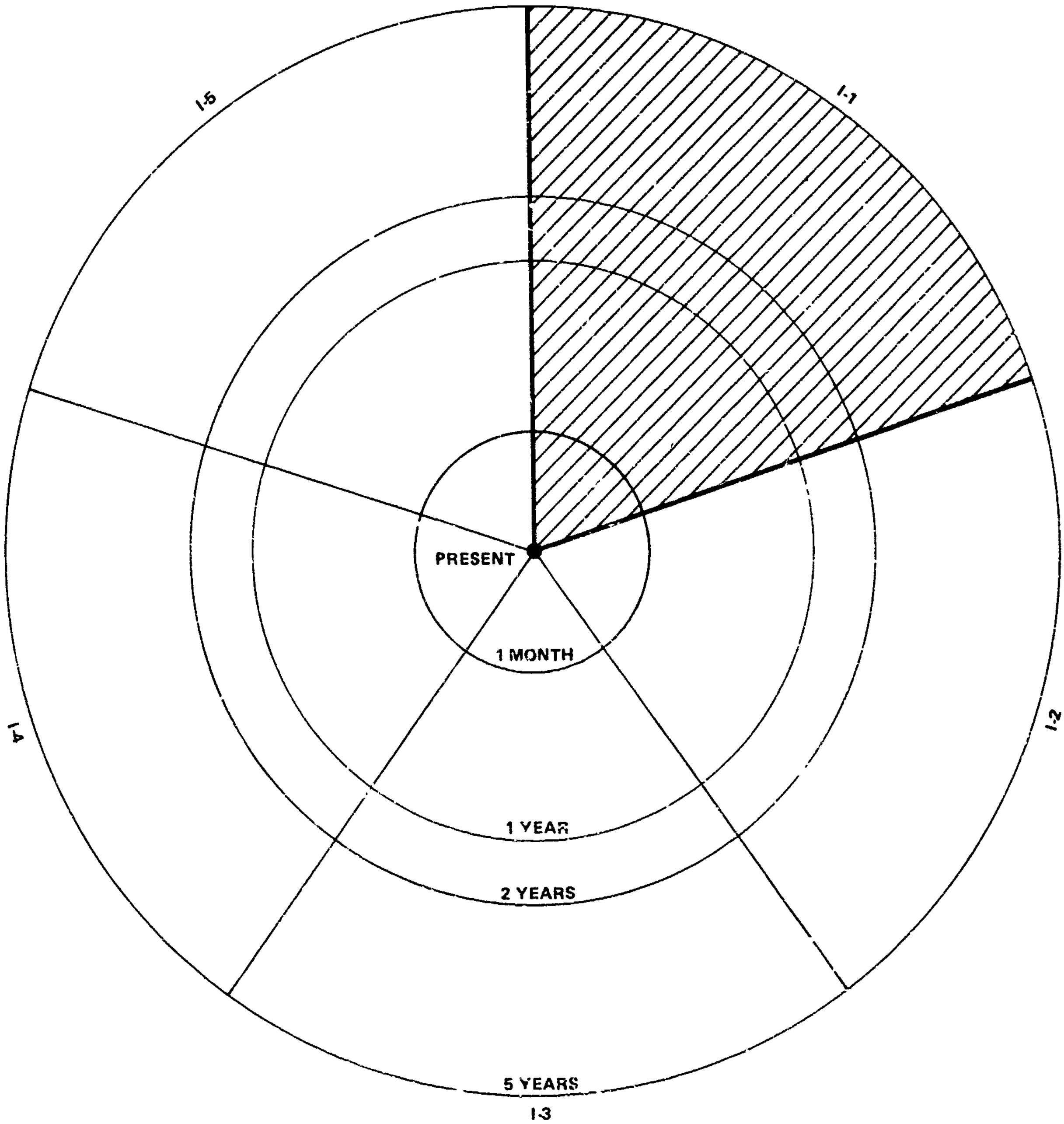


Figure 16. Single-Sector Map -- Internal-Security

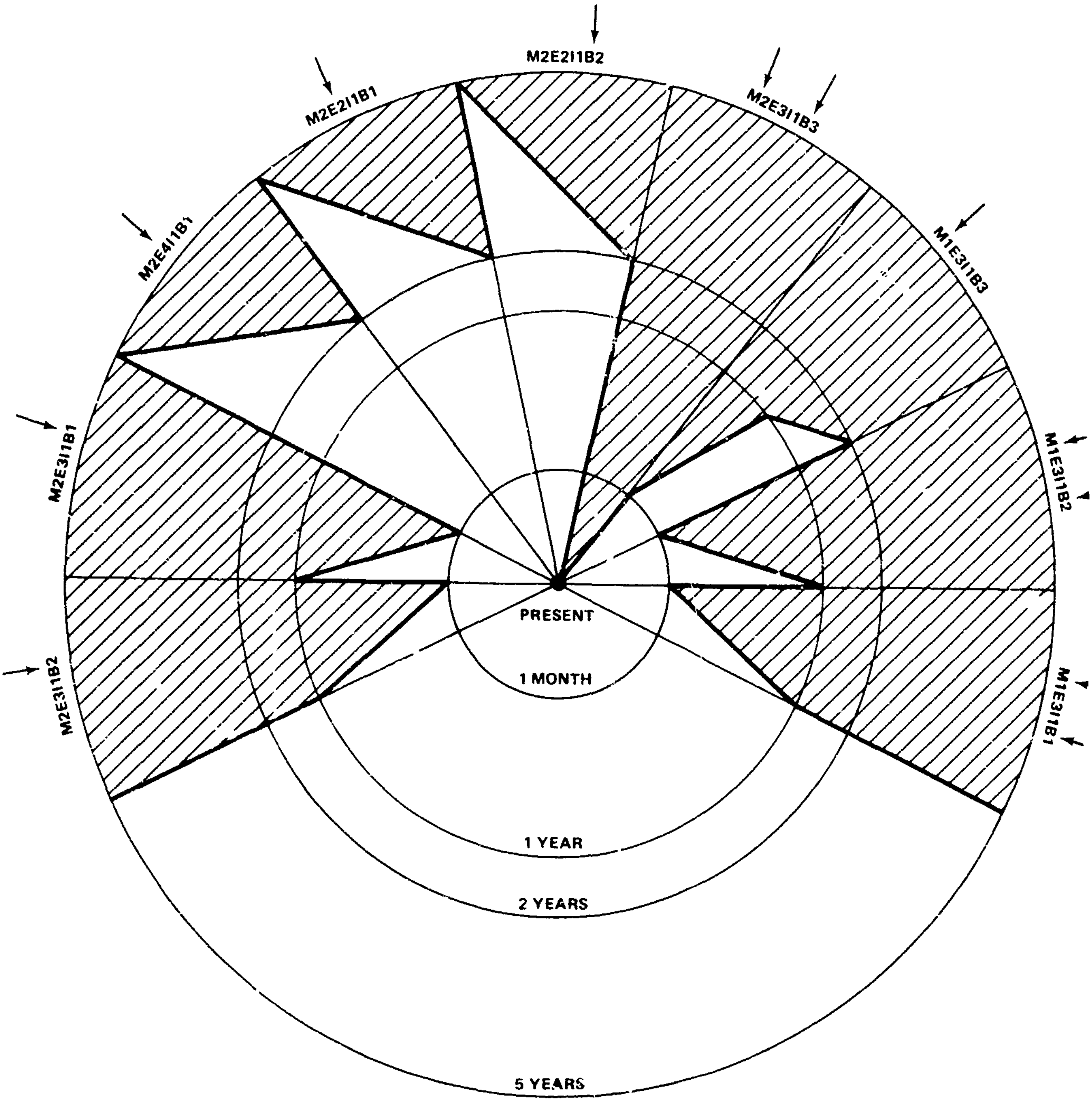


Figure 17. Example Probable Futures Map

displayed along each time circle. The time frames used for the purpose of this example are 1 month, 1 year, 2 years and 5 years. The results of Step 2 are overlaid onto the futures map to achieve a probable futures map. Thus the analyst has decided on a definite range of possible conditions over several time increments. This technique is intended to help the analyst focus on the probable future and not dilute his attention on the vast range of possibilities. The arrows on the map indicate unique conditions for given combinations. As we shall discuss below, such prompting aids as the arrows anticipate a set of computer-based graphic displays.

4) Sector Analysis. To this point we have been concerned with possible conditions, but not explicitly with possible threats. The analyst now uses the results of the sector comparison technique to review all the threats of interest. The result of this step is the identification of a time frame and sector combination associated with each threat. This step connects the analysis of possible and probable conditions to the threat modeling performed previously in the threat recognition stage.

5) Identification of "Hidden" Threats. This brings us to a very important point. The mapping which results from Step 4 will almost certainly display various probable futures described by unique sector combinations not all of which have a previously imagined threat associated with them. The analyst must study each of these probable sector combinations and either identify a new

threat which falls into that sector but had not been analyzed before; or satisfy himself that no threat exists for that sector combination. This step aids the analyst in discovering previously undefined threats that are within the scope of a probable future.

6) Plotting the Unimpeded Threat Line. With the probable futures map completed, and possible threats located, the analyst has the task of plotting the unimpeded threat line -- the path into the future that the subject country will most likely take, given no change in our present day policies and other current constraints.

7) Assessing Impact on Unimpeded Threat Line. Finally, given the unimpeded threat line is not leading to desirable situations, the probable futures mapping technique can serve as a framework in reviewing how changes may be instigated to alter the unimpeded threat line (and thereby create an influenced projection).

Divergence Mapping. Discussed by Harman, divergence mapping is a form of analysis which can be used for analyzing and mapping a number of possible threat situations in terms of their comparative likelihoods. It maintains the thrust of analysis that develops in the sector comparison and probable futures mapping approaches. Development of divergence maps involves the following steps:

1) Review the basic principles underlying forecasting, such as continuity, internal self-consistency, similarities among systems, cause-effect relationships, etc.

2) Consider each threat modeled in the threat recognition stage as a potential situation in the future. Also define non-threatening situations.

3) Title each situation and place it within a block, then graphically arrange the blocks in a plausible sequence on a "map," as follows:

   (a) Identify those situations most like the present, based on systematic recourse to forecasting principles.

   (b) For methodological purposes, initially consider these situations to be located nearest in time to the present.

   (c) Identify the situations least like the present and initially locate them furthest from the present.

4) Complete the divergence map by filling in the intermediate situations. Simplified examples used to show the approach are depicted in Figure 18.

   (a) Extending out over time, there are several tiers of situations. There could be more, of course,

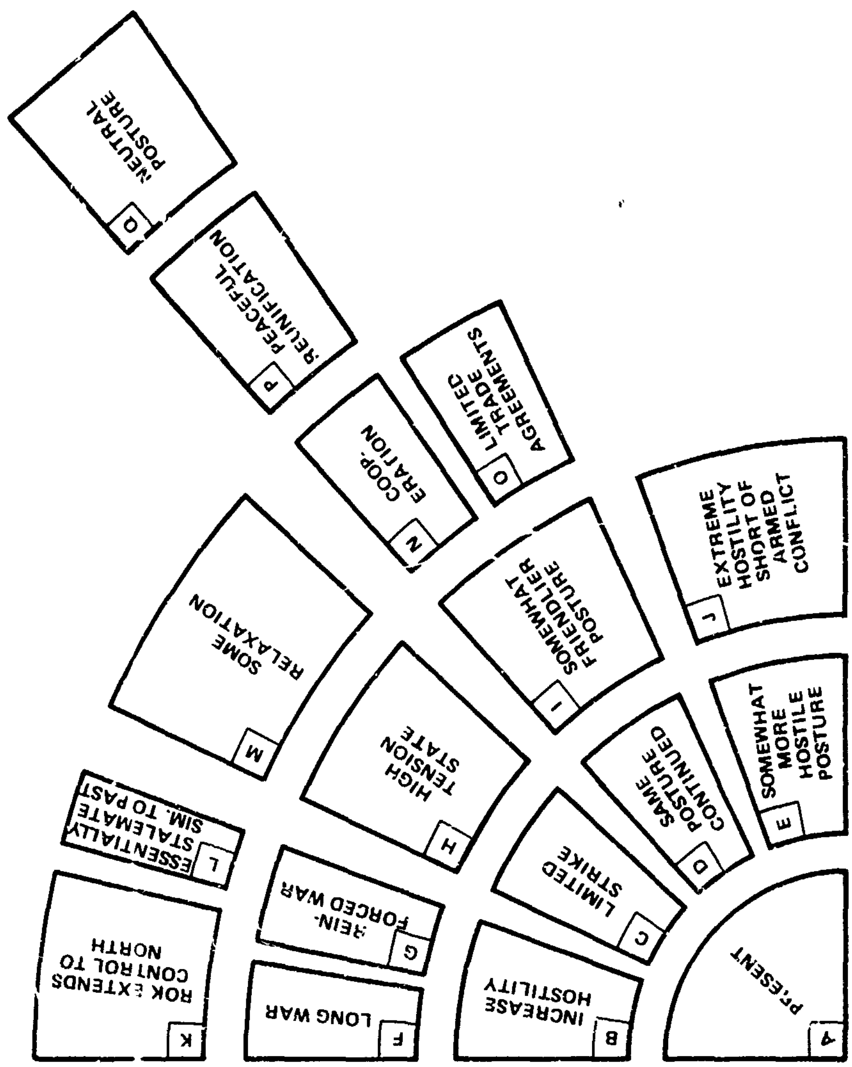


Figure 18. Example Divergence Map

(b) Summarizes the most plausible paths and the associated rationale.

(c) Assigns a time scale to each.

(d) Defines the least plausible paths.

Employment of General and Opposing Projection Methodologies. In order to help mitigate bias problems and consider potential situations in a realistic fashion, the warning analyst can employ two general and opposing projection methodologies which can be described as present extrapolation and future-backwards. These can be used with the other techniques described above.

1) The present extrapolation method of projection extends events from the present conditions to future situations. The description of the time-phased events that comprise these extrapolations are very specific in their details in time periods close to the present, becoming progressively more general and vague further out in time.

2) The future-backwards method begins with a precise description of a future situation, for example, a specific threat. The analyst then works backwards in time via what he considers necessary paths that uncover required pre-conditions for the future situation. Use of the two methods together can be valuable since logical discontinuities in a projection may become more apparent through a comparison of the two projections

Modeling of Interactive Processes. Especially in making influenced predictions and forecasts, the analyst becomes concerned with the decisive interactions among various systems and forces in a situation. The basic concept is that the entities in crisis situations will interact; they will respond to each others' actions. Thomas Belden has modeled this phenomenon as a decision stairway expressed in terms of time (horizontal axis) and probability (vertical axis). To take a simple case, let us suppose that one force is intent on launching a surprise attack on another. The attacker must perform various preparatory logistical, reconnaissance, force mobilization, and other acts before he is ready to attack. One can think of these acts as forming a sequence leading up a staircase toward increasing readiness to attack and, ultimately, the decision to do so. If at some point the potential victim detects such preparations and reacts on that basis (for example, signals awareness), the attacker may be deterred or halted and proceed back down the stairway and away from readiness to attack and the actual decision to do so. In making projections, the analyst must be attentive to the critical impact of such interactive processes on likely outcomes.

Rationale Recording. What we have been describing are some recommended forms of warning projections. We have developed a general framework as follows:

- Projections ultimately channel into the basic information categories

- The state of social systems and other entities may be considered in terms of the status of certain of their sectors. Various states of these sectors are more or less likely in various combinations. These combinations essentially amount to sets of conditions.

- The likelihood of given sets of conditions at various future points should be estimated with recourse to several basic principles affecting societal dynamics.

- Possible threats should be "overlaid" onto the mappings of possible conditions.

- The mappings should be used as an aid in identifying threats not previously considered.

- The mappings should also be used as an aid in postulating the most likely unimpeded conditions out to various future points and the implications for U.S. policy.

But the question remains, what about the specific rationales behind the projections? Exactly what rationales can analysts use in systematically worrying projection from the point of view of the basic principles of societal dynamics? How can they resolve the inevitable tensions among the competing rationales?

There are a number of approaches, ranging from qualitative to quantitative, and sometimes involving a blend of the two. Models of societal change and international conflict are constructed on the basis of paradigms of psychology and sociology. As another approach, argument by historical analogy is made; for example, detailed models of past crises and military surprise are constructed as a basis for recognizing future threats. In still another approach, Bayesian, Markovian, and other methodologies based on statistical approaches involving probability have been developed.

There is, however, little doubt that we are in the infancy of the development of warning projection techniques, a point directly or indirectly implied at every point in the present research. As just one example, the critical need in warning analysis to understand better the psychophysiological constraints on foreign leadership behavior, especially in a predictive sense, is largely unmet. There is no doubt that this is a huge problem with substantial political overtones, but progress has been far too limited. In a report prepared for the Defense Advanced Research Projects Agency, Gerald W. Hopple states:

> ... the elucidation, measurement, and analysis of an array of individual- and elite-level factors should enhance our capabilities for ... <u>estimating</u> and <u>predicting</u> the intentions, preferences, and probable behaviors of other actors in the international arena.

But Hopple must then note that although there has been considerable research in the various relevant fields, the following is reality:

> As is customary in social scientific inquiry, however, the existing work is disparate, uneven, and <u>ad hoc</u> in nature. Few efforts have been undertaken to map out the terrain in more than a cursory fashion.

It is not our purpose here to survey and compare various specific projection techniques currently available; there is considerable literature on these techniques. From the present perspective, what we <u>do</u> say about them is two things: first, they should fit usefully into the basic framework of warning projections; and second, they should be considered as heuristic. For we may be certain that there is now nothing like a fully satisfactory projection technique for the warning problem. Improved techniques must be developed over time. As is being argued in these pages, the key to such development lies in extrasomatic memories and analytic aids.

Regardless, we are concerned with the capturing of whatever rationale is used by warning analysts making projections, no matter how qualitative or quantitative, rudimentary or sophisticated; for rationale must be recorded for purposes of measuring signification (and ultimately for operations research in post mortems to identify technological and methodological needs).

We may consider rationale recording at two levels: the level of conditions and the level of threats. The formats of the rationale records should not differ significantly between the two. At the first level the analyst is recording the rationale behind the conditions he has projected will hold in a given country or sphere of interest at a given time. Table 8 is a matrix relating rationale to the projected conditions and the principles of change. The matrix, which is not in a completed status, is intended as a simplified example. The statements of rationale can be as technical and detailed as warranted and the analyst is capable of producing. In a computer-based memory system with graphics displays, obviously there must be abbreviated rationale statements for quick display and review, with access to more detailed back-up statements, some of which may not need to be computer stored (for example, "fixed" rationales such as those in Bayesian approaches).

Useful supporting statements concerning the basic assumptions behind both levels of rationale recording -- conditions and threats -- should be employed. Very simple formats for such structures are provided in Table 9, Panels A and B. (While the formats are simple, the accompanying statements of rationale can be detailed

Table 8. Example Rationale Matrix (Rationale Record, One Month [M2 E3 I1 B3])

Sector	Internal Self-Consistency	Similarities	Cause/Effect	Goal-Seeking	Holistic Trending	Continuity
M2	Cannot expect large-scale military expenditures over one month given state of economy and political machinery for doing so.		Not enough time to change to M1 or M3 states. Could not purchase/build sufficient military capability.	Goal is to occupy/dominate entire peninsula Therefore, no slackening of military capabilities envisioned.		Has not in past demonstrated capability to make that rapid a jump. Not typical.
E3		Is similar to a number of other communist/noncommunist nations in terms of rate of economic change. Must hold at E3.	Could be nothing in single month likely to cause highly positive or highly negative effect.	Have new 7-year plan, but do not envision much change over one month.		Rate of change not to be very discontinuous in one month.
B3			Nothing being done by U.S. or ROK to cause change in B3.	Given strong goal of reunification, the failure to launch military attack betokens B3.	Visits of PRC high-ranking delegates for most of month. Expect stable posture.	
I1				Goal remains status quo.		

Table 9. Formats for Assumptions Records

DOMINANT SECTOR:

ECONOMIC

ORDER RATING OF REMAINING SECTORS:

S,M,I

DECISIONMAKER PREDISPOSITION:

CAUTION, OPPORTUNISM

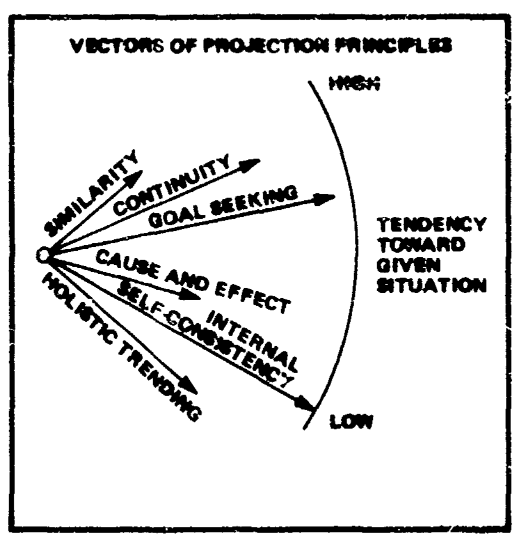
DOMINANT CHANGE PRINCIPLE:

CAUSE AND EFFECT

ORDER RATING OF REMAINDER:

CONTINUITY
INTERNAL SELF-CONSISTENCY
SIMILARITY
HOLISTIC TRENDING
GOAL SEEKING

PANEL A



PANEL B

and substantial.) Jerry Kidd has suggested a vector approach (see Panel B) in which the analyst, by whatever rationale and methods are available to him, develops vectors whose length is a measure of the relative impact of the various (sometimes competing) principles of change and then resolves the vectors and formulates a projection.

To suggest how new projection rationales can be adopted for warning analysis, consider a promising new approach to projecting societal dynamics by the systems theorist, John Sutherland. Sutherland summarizes his paper, <u>A Syncretic Inquiry into Societal Dynamics</u>, as follows:

> The popular paradigms of modern psychology -- biologism, behaviorism and humanism -- have been used to generate constructs of macrosociological significance. But a simple one-to-one mapping from the psychological to the macrosociological domain restricts the richness and variety exhibited in the latter. A somewhat more complete mapping process is perhaps required .... Particularly, we are concerned with the procedures and implications of <u>syncretic</u> model-building. This process appears to have some advantages when the discipline(s) at hand are partitioned into competitive or recriminatory theoretical camps (as are pschology and macrosociology). The basic strategy is to raise the traditional units of analysis to some higher level of abstraction, such that otherwise obscured points of complementarity may become apparent. Syncretic models are thus analytical hybrids -- neither normative nor descriptive -- and thus impose essentially unique challenges to their architects. One way in which these challenges may be met is (summarized thusly).
>
> Particularly, the three dominant paradigms of psychology are used to generate a set of collective behavioral referents that, in concert, are suggested to pretty well exhaust the basic referents required by macrosociology. The heuristic thesis underlying the mapping process is this: at the macrosociological level of inquiry there is a strong <u>clustering</u> effect, such that certain behavioral, social, economic and political attributes will tend to appear in concert (i.e., be highly intercorrelated). That is, certain admixtures of behavioral, social, economic and political properties are distinctly more probable than others. It is the most dominant of these admixtures that serve to define the set of societal ideal-types ... admixtures whose

a priori probabilities of emergence, persistence or reemergence are significant relative to the universe of possibilities.

The dynamic focus of our inquiry concerns an analysis of the conditions under which one or another of the societal ideal-types is expected to dominate over the others. Each of the ideal-types -- in the syncretic framework -- has effectively unique ecological implications as well, these being the nature of its relationships with the environment in which it is resident. It is these unique endogenous and environmental implications that excite both the rise and demise of the various ideal-types. The problem is to deal with the dynamics of societal configurations in a relatively disciplined way, in contrast to the generally optative or normative predilections of mainstream macrosociology. The key here is the apodictical demand of syncretic methodology, the requirement that theoretical, logical or a priori constructs eventually submit to the empirical discipline of normal science.

This study attempts to respond to this dictate by summarizing its essentially qualitative arguments and recasting them into the framework of a Markov model. This reformulation takes us from the static-comparative domain (where we are concerned merely with directions of influence) into a context where we must attempt to add a quantiative or magnitudinal dimension to the study. Particularly the Markov models direct our attention to the computable probabilities of transition between the several societal ideal-types. These transitional probabilities are initially established as a priori (or judgemental) indices, these derived directly from the theoretical content of the study to this point. However, once such indices are established, there are certain statistical instruments (notably variations on the Bayesian theme) that can force the translation from a priori into objective (i.e., a posteriori) transitional probabilities. So, in principle at least, we have met the syncretic methodology's demand for complementation between the two generic arms of scientific inquiry ... deductive and inductive inference.

To the extent that the model's properties emerge satisfactorily from the empirical validation process, the process of macrociological change may be brought a discipline and precision that has largely lacked heretofore. Major configurational changes, such as those recently affecting Iran ... may in some measure become predictable ... and, in that regard, perhaps manageable to some extent. The essential arrogance of this assertion is not lost on this author; but the contention that societal substance must remain forever outside the bounds of scientific rationality is no less arrogant.

And there is a palpable defense for (such an approach). Its essentially syncretic quality means that our models and propositions remain as heuristics only, as constructs whose significance is more methodological than substantive.

Table 10 shows a range of societal types and their respective units of social significance, economic mechanisms and political structures as outlined by Sutherland. Figure 19 is a proposed normative model of societal dynamics developed by Sutherland. The Sutherland concept clearly might prove useful in some dimensions of the projection problem. In terms of rationale recording we may observe that cause and effect, similarities in systems, goal-seeking and especially internal self-consistency are all implicit in the rationale which underlies Sutherland's approach.

Various other structures of rationale are applicable. One further example concerns rules for making probability judgments in warning. Thomas Belden has described some rules as follows:

a. <u>The more precise the prediction, the lower the probability</u>. If one says A will attack B on 16 September, that statement will have a lower probability than, A will attack B in September.

b. <u>The greater the number of information elements within the probability statement, the lower the probability</u>. For example, three of A's divisions at X will attack two of B's divisions at Y on 16 September will have a lower probability of being correct than A will attack B on 16 September.

c. <u>The overall probability of the statement cannot be greater than the probability of any one element</u>. Using the first example, in b. above, if there is only a 30 percent probability that B has two divisions at Y, then the overall probability cannot exceed 30 percent.

Table 10. Cross-Dimensional Clustering of Social, Economic and Political Attributes

Ideal Type	Unit of Social Significance	Economic (Allocative) Mechanism	Political Structure
1. Mechanistic	Tribe	Segmented (e.g., an equal share to each head of household/ proto-Communism	Oracular
2. Proscriptive	Congregation/ parish	Ascriptive (e.g., as with the doctrine of the schoolmen).	Oligarchic
3. Prescriptive	Commune/ extended family	Requisitional (to each according to his need, etc.)/proto-Socialism	Participatory democracy
4. Rationalistic	Nuclear family/ corporate interests	Algorithmic (e.g., via supply and demand or central planning)	Bureacratic (e.g., representative democracy)
5. Instrumental	Ad-hocracy/ bloc	Monopolistic/ preemptive	Autocratic
6. Sapient	Association/ conference	Compensatory	Collegial
7. Existentialistic	Isolated individual	Ascetic (e.g., proto-Bhuddist)	Anarchic

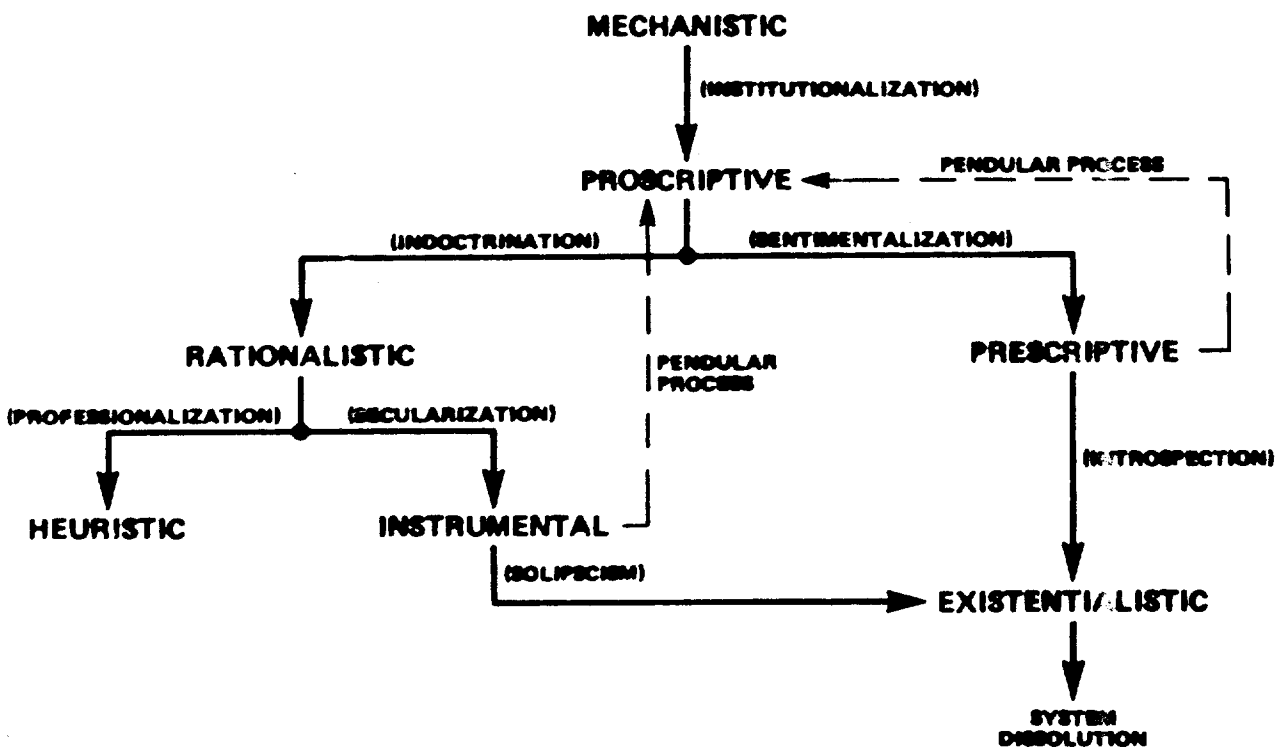


Figure 19. A Normative Model of Evolutionary and Pendular Societal Dynamics

d. In general, the greater the time span of prediction, the lower the probability of its occurrence. This is so because many events can intervene to change the situation. This requires that all probability statements have the date the prediction was made.

Analysis Routine. We should now consider how the methods and techniques of making warning projections correspond to the steps and procedures in the model of warning analysis described in Section 2 (see Table 3, page 26). Upon review it is evident that use of the forms and associated procedures for warning projections will lead the analyst through the full steps, procedures and subprocedures identified in the model. By focusing on the basic information categories, the analyst can translate threat models from the preceding stage into projection formats. Using the Specificity Rating Scale, the analyst can develop and compare the specificities among various threat estimates. There are also approaches by which the analyst can develop rationale for projections. In short, sector comparison, probable futures mapping, divergence mapping and the other approaches represent an integrated analytic routine which assures that the analyst will think very systematically and with considerable mental energies about the prospects for various threats. This routine constitutes a defense against the epistemological and cognitive problems in warning analysis. The backlog and relationality measures are used to monitor the degree to which the analyst pursues the methods and techniques and follows the steps and procedures in the projection stage.

More generally, we may also observe that the system of analysis from monitoring to projection is a coherent analytic routine which culminates in a set of judgments concerning which threats are most likely and least likely at any given time. We can think of the analyst as always confronting a bounded set of possibilities and attempting always to have identified the more probable of these and related them to threats.

Signification. In discussing the threat recognition stage, it was pointed out that signification is indicated when there are changes to and in the threat models, for example, the association of new input data with nodes in the models such as the critical event filters. It was also indicated that the full meaning assigned to input data is bound up in the assumptions underlying the models. A distinction was drawn between high and low context analysis and their interactive relationship in the process of warning analysis. It was also seen that in the projection stage, changes in meaning that indicate signification can be recorded at a number of points, from the specificity ratings through the sector comparisons, probable futures maps, divergence maps, decision stairways, rationale matrices, rationale vectors, and so on. Both changes to and in these analytic structures may be recorded. Further, to the extent that the assumptions underlying the threat modeling in the threat recognition stage are developed in the projection stage, signification involving development of, and changes to, those assumptions cross relate to the earlier stage. In short, there is obviously a considerable structure of signification inherent within the full techniques and methods of analysis from monitoring to projection.

The techniques and methods in all three analysis stages, but especially in the projection stage, culminate in graphic and alphanumeric formats which represent a sort of scoreboard for signification. The outcome is a series of machine-driven display formats used to present recorded signification values at various levels and to varying depth. The potential is there for one to examine the signification values in a small portion of a large analysis or to display in sequence a detailed and extensive summary of a large-scale warning analysis developed over a significant period of time. Here the objective might be to trace the evolution of warning perspectives, showing the impact of input data on the rationale and assumptions of the analysts; and *vice versa*, analysis being an interactive tug of war in which the analyst struggles to fit the data to his analytic structure with mixed success, the failures causing him to review and possibly recast portions of the analytic structure. As discussed above, such a capability gives rise to many measures across a variety of variables.*

Machine Support Implications. In the earlier remarks on machine support implications, we discussed the general need for requisite speed of operation, deferring detailed design requirements to Section 5. In the present discussion another related and extremely important requirement becomes apparent: displays and display techniques.

Warning analysis must include a substantial *visual* dimension beyond oral and written traditions and records. This visual counterpart must be largely electronic in nature. That we need to operate substantially in a visual display mode in warning analysis arises from several considerations we have argued above and which may be summarized as the need for speed of operation both to aid analysis and to aid measurement of analysis.

Implicit is the theme that computer/display technology should be harnessed to allow analysts to operate with extrasomatic support systems designed to complement both the cognitive processes

*There remains a highly technical (and often confusing) argument among theoreticians of interpretation (or "Hermeneutics") over interpretive limits, there being some schools such as the Nietzschean and, later, the Structuralist, which tend to deny that in certain senses we can recover original meanings of past records. See the Notes section for a brief discussion.

of analysis and the measurement of analysis. Analysts must be allowed to create extrasomatic memories in the form of certain models or schemata, and to manipulate them readily through interaction with the machine, for purposes of changing the structures, recording analysis processes and results for measurement, and recalling the analytic memory. Consider the fact that the memory structure we have just described -- PAMNACS, DENS, PFMS, rationale matrices, etc. -- is coherent, considerable in scope, thorough and, most importantly for the present thrust, not readily recalled, let alone manipulated, by the unaided human mind: the machine support is absolutely essential. Yet with the machine, and with quite rudimentary training, the structure becomes readily usable in all dimensions -- analysis, measurement, and management. It is in considering such aspects as these that the basic concept of IWAMS becomes clearer.

One of the obviously essential applications in displays is the use of color, animation, and other cues to highlight changes, lend emphasis to portions of analysis, show threads of continuity in analytic evolutions, indicate varying levels of specificity, assist in memory recall operations, single out unresolved input data, and many other tasks. There is every prospect that color, animation, flashing cues, and other devices that lend themselves to electronic displays will form part of the rhetoric, the style, of the electronic visual tradition. As we review the analysis output formats of models and maps of cognition in the present approach, and imagine future refinements, it becomes clear that such visual devices could become extremely valuable.

IWAMS Informal Test

It is now appropriate to describe an informal test of the IWAMS analytic system conducted at an intelligence center by a member of the project team while in residence for several weeks.

There were various reasons for the test. Primarily it was considered useful for developing software design requirements. Although it was informal the test also broadened the project team's understanding of aspects of warning analysis and management. By informally reviewing basic features of the IWAMS design through dialogs with analysts and managers, the benefits of experienced operational judgments and recommendations were realized. Moreover, if only on a manual basis the full IWAMS methodological procedures were tested.

The basic test procedure was as follows: First, typical backlogs of representative information that might confront analysts over given periods were reviewed and several were assembled.

The second step was to construct a mock-up paper version of the IWAMS analytic system. The types of analytic forms described above were developed. The North Korean problem was selected for focus (hence the specific diagrams and models shown above apply).

The third step was to conduct an informal analysis by analyzing the backlog data through the routine of the IWAMS analytic system. Part of the intent was to simulate a process that would be conducted with a computer-based system. For obvious reasons, of course, there was no anticipation of total realism. However, records analogous to log-in/log-out records on a computer-based system were kept. The time used in analyzing input data with various techniques at the different analytic stages was manually recorded as faithfully as possible. The time spent away from analysis -- interruptions that might normally occur as one worked such problems at an analytic position -- were recorded. In addition, records were kept of backlog at various stages; relationality as the data moved through the system of analytic techniques and methods; and signification. Examples are provided below.

Summary of Results. Since the informal test was designed to review the IWAMS concept in a realistic setting, the summary of results will concentrate on three widely different and representative cases. The cases are considered generic and have been developed on the basis of the extended testing. The three cases are, first, a description of the detailed analysis of a typical single input; second, a general account of the analysis of a substantive estimative report and the changes it introduced to elements in the IWAMS analytic forms (i.e., signification reflected in changes to the forms); and, third, a brief description of potential uses of IWAMS in crisis environments.

Certain constraints should be pointed out:

- The results of the informal test are qualified by the fact that the project team member, although familiar with warning analytic operations, is not a professional warning analyst and was learning his own system of analysis for the first time in the sense of applying it. It must be presumed that anyone first employing an approach, especially one that involves a number of steps and procedures, will become speedier at implementation with increased experience. As we have stressed, use of a computer-based system would increase further the potential for speed. Therefore, one cannot assume that the time frames involved in the test in performing various analytic functions, even though relatively short, are necessarily typical.

- Another important factor is that during the informal test probably more changes were made to the <u>structure</u> of various forms than might occur with a system that had been operational for some time. Intuitively it seems probable that in the latter case a set of models and maps would be developed which eventually would tend to stabilize (though, of course, never completely!) and ordinarily be changed steadily but minimally, once the initial hard work of structuring them on the basis of substantive analysis had been done. (Certainly this represents an interesting issue for examination.)

- Another qualification is that the informal test was conducted by one person over one shift per day for several days. Assuming a fully operational IWAMS system, several analysts might be using it within given shifts. Further, the operation of IWAMS might develop into a relatively specialized job. For example, within a sizeable cadre of analysts -- say, a group responsible for monitoring North Korea and Japan -- a subset of analysts might be responsible for working against backlog and for conducting initial relationality and signification. Subsequently other analysts in the group might impact on the results but not themselves follow the full analysis paths through the IWAMS system. Thus the configurations of usage might differ considerably.

- In short, it is not to be inferred that the informal test should completely define "steady state" conditions within a computer-based IWAMS system.

Case 1

We will begin by exemplifying how a single input was moved through the IWAMS system and the signification, relationality, and backlog measures obtained. Section 5 contains a description of the IWAMS software design features, including the specific man-machine interactions required in moving data through the system. The hypothetical profile of analysis discussed in the present section is a functional description only. Implicit in many of the steps, however, are technical design features of a computer-based system.

The example selected is this: assume receipt of a message concerning the unusual deployment of a single tactical air unit to a specific airfield. Assume that this type of activity is included in the predefined list of indicators to be watched in the monitoring stage.

Table 11 shows the results of the analysis of the message. In reviewing details in the table, the reader should recall the severe expository problem of attempting to convey through prose and static diagrams a sense of speedy analysis by an experienced analyst, taking cognizance of the analyst's background knowledge and the IWAMS high context system, and assuming interaction with computer-based support whose operation the analyst has mastered.

The following discussion applies to the table. Note first that 34 steps or functions were undertaken, some of which would entail interactions between the analyst and the machine component of IWAMS. The sustained analysis time was approximately 21 minutes. Some comments are useful here. First, as indicated above, this time may be lengthier then would be expected ordinarily had the analyst been using an operational IWAMS for some time. Second, let us assume that this

Table 11. Analysis Profile

Stage	Analyst Action	Time	Signification	Relationality	Backlog
	1. Log-on IWAMS	0715			
	2. Complete reading message	0716		Step 1* (P)**	
MONITORING	3. Call-up AIR/AD activity indicators	0716	Signification (N)	Step 2 (P)	PROGRESSIVE REDUCTION
	4. Complete check of data against indicators	0717	Signification (N)		
	5. Determine data applies to indicator C-4	0717	Signification (P)	Step 4 (P) Step 5 (P)	
	6. Assign +1 activity level	0717	Signification (P)	Step 6 (P) Step 7 (P) Step 8 (N) Step 9 (N)	
THREAT RECOGNITION	7. Call up PAMNACS	0718		Step 1, Procedure 1 (P)	PROGRESSIVE REDUCTION
	8. Check data against PAMNACS policy review CEF	0719		"	
	9. Determine no relevance	0719	Signification (N)	"	

*The "steps," "procedures," and "processes" refer to those in the Model of Warning Analysis and comprise the analytic routine.
**P = positive
N = negative
PD = analyst decision not to pursue further analytic steps.

Table 11. -- Continued.

Stage	Analyst Action	Time	Signification	Relationality	Backlog
	10. Check data against PAMNACS decision CEF	0720		Step 1, Procedure 2, Processes A-I (P)	
	11. Determine no relevance	0720	Signification (N)	"	
	12. Tag data for future reference	0720		"	P
T	13. Call-up DEN 1	0721		"	R
H	14. Determine no relevance	0722	Signification (N)	"	O
R	15. Call-up DEN 2	0722		"	G
E	16. Determine no relevance	0723	Signification (N)	"	R
A	17. Call-up DEN 3	0724		"	E
T	18. Determine association with nodes 26 and 31. Give rationale	0726	Signification (P)	"	S
	19. Ask for readout other correlations in DEN 3 with other nodes over past three days	0729		"	S
R	20. Call-up DEN 4	0728		"	I
E	21. Determine no relevance	0728	Signification (N)	"	V
C					E
O					
G					R
N					E
I					D
T					U
I					C
O					T
N					I
					O
					N

Table 11. -- Continued.

Stage	Analyst Action	Time	Signification	Relationality	Backlog
THREAT RECOGNITION	22. Determine none exist	0730	Signification (N)	Step 1, Procedure 2, Processes A-I (P)	PROGRESSIVE REDUCTION
	23. Review inactive nodes	0730		"	
	24. Identify further information needs	0731		"	
	25. Ask for other nodes to which data has correlated	0732		"	
	26. Determine none	0732	Signification (N)	"	
	27. Call-up DEN 3 to which indicator correlates	0732		"	
	28. Explore for possible alternative explanations. No results.	0734	Signification (N)	"	
	29. Decide not to conduct novel threat analysis. Move model forward.	0734	Signification (N)	Step 2 (PD)	
PROJECTION	30. Call-up unimpeded prediction model for DEN 3	0735		Step 1 Procedure 1 (P)	PROGRESSIVE REDUCTIVE
	31. Determine no change in specificities	0735	Signification (N)	Step 1, Procedure 2 (P)	
	32. Indicate rationale	0736	Signification (N)	Step 1, Procedure 3 (P)	

Table 11. -- Continued.

Stage	Analyst Action	Time	Signification	Relationality	Backlog
PROJECTION	33. Estimate no changes in remaining prediction forms	0736	Signification (N)	Step 1, Procedures 4-8 (PD)	PROGRESSIVE REDUCTION
	34. Decide no requirement pursue additional projection procedures	0736	Signification (N)	Steps 2, 3, 4 (PD)	
		21 minutes			

particular report represents activity of an indicator of somewhat more than ordinary significance; the analyst would likely treat the indicator with greater than casual attention. Third, the example chosen is appropriate for illustrative purposes because it involves input data which an analyst would be likely to pursue through a number of steps in the IWAMS analytic procedures. In IWAMS an analyst pursues data through the system as far as he decides it is appropriate to do so. There are decision points at which the analyst may decide not to pursue the data further. The data is removed from the system and measures cease. Of course these cases are recorded within the IWAMS memory. (As seen in Table 11 such cases are tagged in order both to be recalled if other indicators arise and also to be readily identified in post mortems.) In our example, in fact, the analyst does not pursue the input data through all the possible steps.

Note that in Table 11 the points of development of signification, relationality, and backlog measures are shown in parallel with the analytic steps. There were a total of six steps in the monitoring stage, 23 steps in the threat recognition stage, and five steps in the projection stage.

Signification. Several instances of signification occur in each analysis stage. The letter, P, indicates that the signification was positive, meaning that the information was correlated positively by the analyst to particular indicators, model(s), or projection maps. The letter, N, refers to negative signification, indicating cases where the analyst has decided that the information does not signify certain indicators. It is fundamental to determine both types, there really being no such case as neutral signification. Either the information has some degree of positive meaning within the context of the indicators, threat models and projection maps, or it does not. In the monitoring stage, where there are four instances of signification, the first example finds that the analyst predictably has decided that from the inventory of preestablished indicators the message specifically relates to indicators of air and air defense activity. By calling up only those indicators, signification has occurred: the analyst has judged that if there is a positive correlation, it must be with those indicators. By not calling up other indicators, which cover a variety of other categories such as economics, politics, and other military indicators, the analyst has also evidenced negative signification.

As we move down the column of signification entries under the monitoring stage, we find that the next instance of signification is positive. The analyst now determines that the input data applies to a specific indicator (called "C-4").

The next instance of signification occurs at the fifth and final step in the monitoring stage. The analyst now assigns a certain activity level to the indicator out of various predetermined levels. Let us suppose that the analyst assigns a level of +1 on a scale of 1 to 3.

Notice that the four instances of signification comprise a succinct, selective, chronological expression of the analytic decisions made in the monitoring stage by our hypothetical analyst.

We may now review signification in the threat recognition stage. All but one of the signification events are negative. This is not surprising since the analyst is concerned with a single indicator, reviewing that indicator against several diverse threat models. As shown in Table 11, the analyst assigns positive signification at step 18 and with reference to DEN number 3. Within that particular model of a possible North Korean threat, nodes 26 and 31 presuppose the kind of activity that the message indicates is occurring in North Korea. Until the calling up of that particular threat model, the threat recognition procedures had not led the analyst to determine any positive signification.

At this point, we should review some aspects of the threat recognition stage. Recall that the analyst departed the monitoring stage with one indicator judged to be at a certain level of activity. The analyst then moved to the threat recognition stage and called up models of projected alternative major national courses of action (PAMNACS). The analyst then checked the indicator data against the PAMNACS critical event filter (CEF) for policy review and judged no relevance; he also checked it against the PAMNACS decision CEF and judged no relevance. We should suppose that if the analyst had been on the job for awhile and familiar with the North Korean problem, he might have gone straight to the particular model of relevance (called up in step 17). But two points need to be made. First, for purposes of exemplification it was thought appropriate to depict the analyst reviewing the indicator against several threat models. Second, there should always be a concern about too much short cutting, based on "familiarity" with the system of models. (The relationality measure is designed in part to monitor this practice.)

Beyond step 18, there is no futher positive signification in the threat modeling stage. In our hypothetical analysis situation, this fact would suggest that in the absence of other threatening indicators the unusual deployment may be an isolated event rather than signifying the emergence of a threatening situation in North Korea.

In step 21, the analyst asks the system to tell him whether in the past three days there have been other such indicators, perhaps in the ground forces, correlating to other nodes within the particular DEN. Seeing none of them (step 22), the analyst then asks for display of the inactive nodes in the DEN in question and sees that they are numerous. In step 25, he then asks for a call-up of other models to which the data has correlated and sees that there have been none. Therefore, by the time he reaches step 29, the analyst has decided not to conduct a novel threat analysis but to move the DEN in question forward to the projection stage. The analyst still has the obligation to determine whether the activity associated with DEN number 3 would signify any change in the status of projections.

In the projection stage, the analyst undertakes five analysis steps. First he calls up the prediction format for DEN 3. (Recall that the DENs are translated into a predictive format organized around the basic information categories.) In step 31 the analyst determines no change in specificities across the categories, who, what, when, where, how, and why. As is evident in the remainder of the projection stage, the analyst then decides not to pursue the analysis further. He therefore has made the decision not to move from the unimpeded projection to the influenced projection procedures, nor from there to the unimpeded and influenced forecast stages.

The analyst has judged that the situation is essentially "normal" in North Korea, in spite of the fact that there has been an unusual deployment of a single tactical air unit. For the present, the significance of the input -- the meaning associated with it -- is that it does not fundamentally alter any of the current projections and probabilities. The North Koreans appear still in basically the same posture they were in before news of the unusual deployment. Yet the analyst has been alerted because the indicator is deemed potentially significant. Obviously there are variations to this basic case in which the situation might have been viewed as considerably different. In a developing crisis situation, for example, analytic reactions and responses would have been different, particularly in view of the fact that a number of other threatening indicators in political, military, and other dimensions might well have been developing.

Relationality. The relationality measurement is made to determine how fully the routine -- the various steps and procedures of analysis -- is followed by the analyst. The key means of monitoring are the recorded instances of man-machine interactions between the analyst and the IWAMS system as these interactions correspond to and reflect analysis procedures and steps. Hence the data needed to measure relationality develops as the analyst performs certain functions using the machine, such as: calling up lists of activity indicators; assigning levels of activity to indicators and entering them into the system; calling up various threat models; changing the configuration of the threat models; and so on through the full range of procedures which culminate in the projection stage.

Under the monitoring stage, there are seven positive instances of relationality. Steps 1 through 7 of the analysis routine have been followed by the analyst in analyzing the example message. Steps 8 and 9 were not followed and, therefore, show negative relationality. Steps 8 and 9 pertain to analysis of novel threat situations; since the report being examined did not at present seem to signify in and of itself a novel situation, it was not so analyzed. However, the later tagging of the input message (see step 12 under threat recognition) allows it to be reviewed should a significant amount of other information on unusual events accumulate over a short time period. The decision not to follow novel threat analysis steps is also recorded in the memory.

We may now consider the threat recognition stage. Relationality is quite comprehensive until step 29, where the analyst again has decided not to pursue a novel threat analysis. Note that the relationality entry in the table indicates that step 2 has in fact been addressed at that point, but negatively, as symbolized by PD.

In the projection stage, steps 33 and 34 again show a PD status with respect to relationality. The analyst has decided that since he has judged negative signification to that point, it is unnecessary to call up and pursue further projection tecnniques and analytic steps. Specifically, he has determined that the input has no positive signification with respect to the unimpeded prediction models, and therefore that no purpose is served by initiating influenced prediction procedures or unimpeded and influenced forecast procedures. This analytic decision was based on signification and not the result of lack of time or other problems that could reduce relationality. The IWAMS design includes the capability to record in the memory whether relationality was cut short because of signification in an ensuing analyst judgment or whether for some other reason. Hence the PD designation is meant to indicate those instances in which the analyst makes a conscious decision, based on the meaning given the data, not to pursue relationality further.

Backlog. Backlog values would also be shown in the analytic process. Backlog will simply be shifting and reducing as a function of examining inputs through relating them to the analytic procedures. For example, at the end of step 6 in the monitoring stage and at the beginning of the threat recognition stage, which occurs in step 7, the backlog with respect to the monitoring stage of analysis would be reduced by at least one, that is, by the example report. Were an analyst or manager to wish to examine backlog at any point in the process, the information would be there to calculate and display backlog for individual steps and procedures.

Uses of the Measures Data

Before proceeding to examine the other two analytic cases, it is appropriate to discuss potential uses of the measurement data retained in the IWAMS memory. It is useful to imagine that the outputs from the different stages of analysis are recorded in an overall memory consisting essentially of three submemories. The first submemory relates to information that intelligence managers might have the greatest interest in. The second submemory would contain information on the analytic process that might be of primary interest to the analysts themselves. One might designate this submemory as an analytic working memory. The third submemory would consist of the accumulation of data that might be of interest for operations research and R&D aimed at improving the conceptual understanding of, and technological support to, warning operations.

The memory subdivisions are, of course, arbitrary. It is certainly conceivable that all three users -- managers, analysts, and researchers -- would want access to portions of all the submemories. Obviously, however, a certain degree of privacy must be maintained, so that the memory would not be totally open, say, to the R&D community. However, some of the data would serve all three users.

At least some major distinctions can now be made as to what should be provided for various users. For the managers of I&W operations, for example, probably daily and other cumulative displays of backlog should be provided. Managers should be able to detect where backlogs exist, their size, rates of reduction in the past versus resources, and other such data which, when compared to priorities, would help in the day-to-day management of operations. In general (but not, of course, always) managers presumably would wish to monitor operations on a broad scale: for instance, total backlog, backlog by area, relationality trends, and major changes in signification (both within and to the structures and forms of analysis). Often managers will be looking for indications of notable changes from the norm.

When we speak of "management," we must stress that the analyst is a manager too. Analysts will, in a fundamental sense, manage their own analysis. Analysts must be able to monitor the uses they have put data to; the uses it has been put to by other analysts within the group; by analysts on shifts other than their own; and, ultimately, by analysts at other nodes in the national analytic network. Analysts must be able periodically to review the changes in and to models and procedures. The IWAMS system, therefore, is designed to summarize analytic operations, particularly in terms of signification, relationality and backlog, for working analysts. Potential forms of the summaries are powerful and fascinating. For example, the signification changes over a given period could be displayed through the models and cognitive maps already in the computer. Color and other display techniques such as dynamic mapping and flashing could be used to highlight changes dramatically and effectively. Analysts would examine rapidly, in telescoped fashion, the analytic processes for many ranges of time with respect to various problems. This would be highly useful to analysts in such functions as: monitoring their own operations; monitoring the types and impact of data they regularly receive; and monitoring threat dynamics.

Conceivably both managers and decisionmakers being briefed might wish such summaries and demonstrations of signification and relationality. To cite one of many possible examples, the onset of a threatening situation in a given area might lead managers to monitor rapidly the state of analytic judgment and perspective on the threat by utilizing summaries based primarily on sequences of displays, supplemented by discussions with the analysts.

A third use of the IWAMS memory is for purposes of off-line operations research and the development of R&D requirements. We are referring primarily to the measurement of a number of variables representing key points in the cognitive process of analysis. They concern aspects such as the rates of flow of information within the system, the relationship between types of data and types of analytic operations, and many other variables. Data on such variables should be available for research off-line to provide insight into the kinds of technology that should be developed and transferred to support warning analysis operations.

Case 2

Case 1, a very simple, straightforward example involving one message, was chosen as an appropriate introduction to the operation of IWAMS. Another classic case is that in which the analyst must review and respond to a probing, broad estimate of likely developments in his sphere of interest. Intelligence estimates made at the national level which concern possible developments in various world regions are examples of such studies. These substantive, far-reaching estimates, made by various agencies and offices, are prepared periodically and should be utilized by the warning analyst as a source of the development of the high context analytic structure of models, assumptions, etc. In addition, such studies and research conducted outside the government should also be used.

During the informal test of IWAMS, several such studies and estimates concerning Asian affairs, notably centering on the Korean peninsula, were reviewed. As a means of exemplifying how they would be utilized with IWAMS, we will postulate a hypothetical estimate concerning Korean affairs, as follows. Assume that the analyst reviews a detailed analysis of the political, economic, military, and other constraints on both North and South Korea with respect to policy over the near term. The estimate probes the interrelationships among economic problems, political problems (domestic and international), military force shortfalls, and numerous other aspects, particularly those influencing the policy postures taken by the leadership in North Korea. Let us also assume that regardless of the extent to which given analysts might subscribe to the assumptions and judgments in the report, it is nevertheless generally a very comprehensive and useful input.

In such cases (and based on the experience of the project team member conducting the informal test of IWAMS) an analyst typically might spend several hours reading and analyzing one such estimate, breaking out what appear to be the salient points for the warning analytic structure of models, sectors, probability maps, assumptions, etc. Based again on the experience during the test, it appears that _if there is a system of analysis_, analysts _ordinarily_ might deal with daily message traffic in blocks of time during a shift and use other time blocks for review of estimates (which appear only periodically) and other such inputs and for working on analytic structure, methods, and procedures. Of course, functional distinctions between watch personnel and analysts performing detailed review of data are obviously germane here. So is the question of the role of IWAMS specialists.

Regardless, estimative reports will impact most strongly on the threat models and particularly on the structures and assumptions in the projection stage. For example, a new sector might be added to the list of sectors of North Korea. Assume that prior to his analysis of our hypothetical estimate, the analyst had established these sectors: E (economic status); B (perceptions of North Korean decision makers); and M (military force status vis-a-vis South Korea). Assume that based on reviewing the estimate, a new sector, I, the degree of political control exercised by the current North Korean regime, is added to the sectors.

An important point is that the addition of this new sector creates ramifications throughout the remaining structures of the projection stage. For example, a new single sector map must now be created to accommodate the new sector, and this will create a general shift in perspectives. Further, the probable futures maps, which encompass all sectors, must be changed. In turn, the rationale matrices will change, as will the assumptions, and so on.

Ramification in Meaning. We now arrive at, and must digress to discuss, an extremely important aspect of signification (and of warning analysis *per se*). Let us call it the Condition of Ramified Meaning. What we have just described is a process whereby an analyst's decision about signification -- about a change in meaning -- occurs (as it must in the sequential world) at a single point in the analytic system. It is focused on some element in the high context system. These points now become critical:

1. Whether or not it is noticed and recorded, the change at the single point in the structure will to the degree that the whole structure is coherent result in far-reaching ramifications in meaning. New meaning will occur, independently of human recognition of it (various philosophical viewpoints notwithstanding). In effect, then, we can think of an extrasomatic memory as having a coherent set of perspectives, and that this set changes to some extent as a result of a human analyst assigning meaning somewhere in the set.

2. There is a positive relationship between the principle of coherence, as applied to the system and structures of analysis, and the dynamics of the ramification of meaning.

3. Among the specific cognitive problems of the unaided human mind are its limitations in "seeing" the extent of ramifications in meaning, particularly in timely fashion.

4. The real issue becomes that of aiding the mind by using a computer-based system programmed to (a) indicate with color-based or other prompting cues when ramifications are probably consequent, so that the analyst may realize it and explore them; and (b) as feasible, contain algorithms which develop, record, and display the ramifications. Obviously, in many cases it will be the analyst who, once notified, is obliged to confront and resolve as best he can the implications of individual acts of signification.

5. These factors put into better perspective the requirement for computer-based technological support to the unaided human mind attempting to perform complex and extremely difficult warning analysis. We now have additional context for the earlier discussions of signification.

Returning to the example in Case 2, we may consider a procedural question. By what procedures and mechanisms should analysts and groups of analysts change analytic structure, for example, change the number of nodes and indicators in a threat model? The authors have no detailed recommendations, but a suggestion. Analysts at least ought to be able to make such changes informally and store them in working or activity files provided by their computer-based support system. Eventually, through established procedures, decisions on formal changes could be made. Certainly individual warning judgments based on different analytic perspectives should be recorded and available for review. Further, models will, as we have stressed, tend to get out of date. It is important to monitor the status of the analytic structure with respect to the relative ages of various portions of it.

Various inputs to analysts can cause change to the structure of analysis models. Open literature in fields such as political science, economics, forecasting, and dynamic modeling may be used by analysts to change the structure of analysis procedures and models. The same is true of consultation with experts. And we need hardly mention the analyst's own experience on the job.

Case 3

Another important case is the crisis situation. In this instance, a number of indicators such as the unusual deployment of tactical aircraft would presumably be input to the analyst. The process described in Case 1 would be greatly amplified and intensified. A number of analysts would be working the problem, inputting different indicators, for example, from different desks and at different times of the day. A major value of IWAMS would be its ability to accumulate and summarize quickly the multiple inputs and analytic judgments from different analysts.

Transition

We have now reviewed the structure and dynamics of the IWAMS analytic system. This system is designed basically to provide the analytic measures necessary to monitor effectiveness, readiness and maintenance values, and to foster effective analysis. The next section will document the software design of the IWAMS system. This design consists of depicting the file architecture and programming required to bring IWAMS to fruition.

5
IWAMS FUNCTIONAL DESIGN

The present section describes a software system for IWAMS. Figure 20 shows the major emphasis in the description relative to the total IWAMS concept. Portions of the discussions in Sections 2, 3, and 4 bear on the functional design of IWAMS. The definition in Section 3 of measures of warning analysis, and the development in Section 4 of the analysis procedures, forms, and graphic displays of analysis output, apply directly to the present description. Especially pertinent is the informal test of IWAMS.

Figure 21 shows the overall functional design of the IWAMS software. The present discussion is organized around the figure. Design requirements for each of the eight major functions are discussed, together with details on the subfunctions. Writeups are provided on the design requirements for analytical modeling, for developing and displaying measures, for developing and modifying models and projection maps, for providing management access to the status of analysis, for data base retrieval functions, for logging operations, and for operations with input data. In the vernacular of MIL Standard 7935.1-S (Automated Data Systems Documentation Standard), the design description represents a Functional Description document. The design presented can serve as a basis for extended development efforts.

The IWAMS design description assumes the existence of computer-based analysis support systems at major warning centers; IWAMS would be integrated into those systems. Therefore, the design does not include hardware or computer architecture considerations.

The remainder of this section will consider in turn each element in Figure 21.

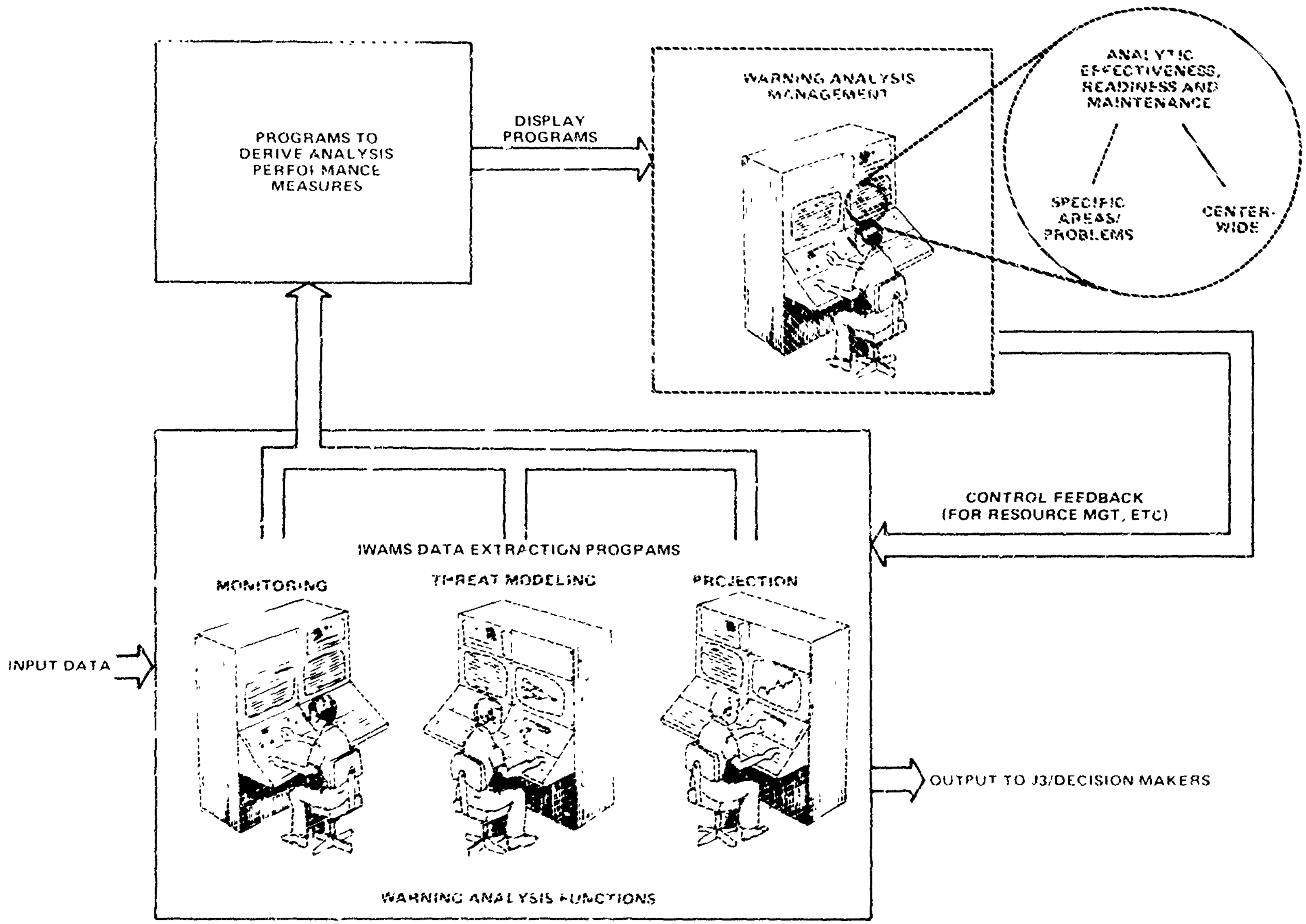


Figure 20. Functional Design Emphasis in IWAMS

IWAMS FUNCTIONAL DESIGN

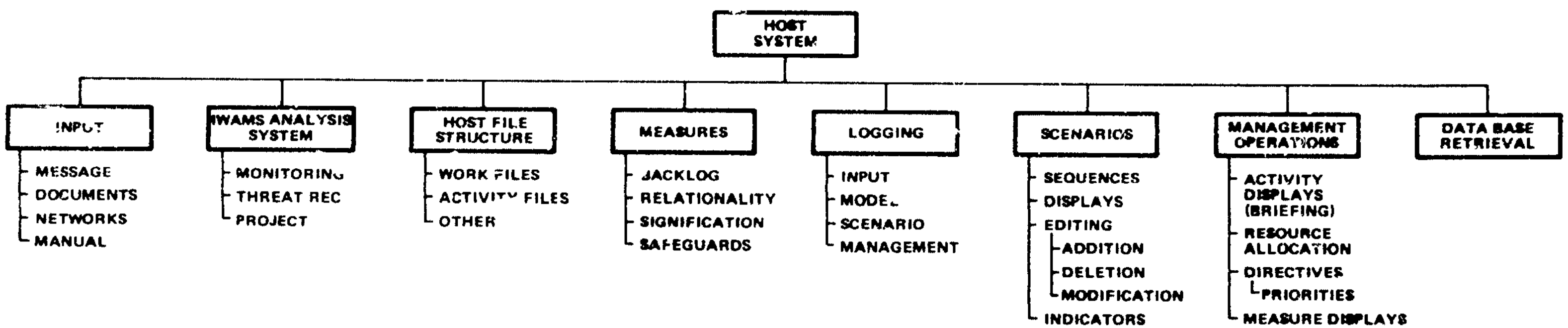


Figure 21. Basic Design of IWAMS

Host System File Architecture

It may be assumed that in warning centers the host analysis support system -- that system into which IWAMS would be integrated -- will include two specific files for use by analysts which also could be used by selected managers. These files are designated activity files and work files. In Figure 21 under the block entitled, Host File Structure, we have listed work files, activity files, and other files. The third category is included in the event that specialized files for IWAMS might be created, particularly for management.

With respect to the format for the two major files, two items are particularly noteworthy: first, a substantial amount of input data will be entered into IWAMS in various forms (to be discussed subsequently); second, all analysis activity and direction is captured either by explicit man-machine interaction, such as analysts logging on the system and interacting with the system in various ways prior to logging off; or by nonintrusive programming, such as recording the lengths of time within the computer over which analysts perform such functions as modifying the elements in threat models (and thereby developing signification). With this background, we will now discuss the specific file structures.

Analyst Activity File. Two types of subfiles are used under this category. The first will hold input data time tagged and listed by type. Input data will be listed under categories such as message, document, daily, weekly, monthly, and/or by subject matter, producing agencies, classification, etc. Further, the file will contain the text of the messages and documents if it is short enough; or the reference number, with an analyst-generated synopsis. Often the information from a document that might be pertinent will be brief; it may consist of an excerpt from a relatively substantial document.

The second subfile under the activity file category will provide a list of the monitoring indicator structures, the various threat models, and the different projection maps and matrices currently used by the given analyst(s). In addition, this subfile will contain references to analytic structures being used by other analysts. These other analysts may be located within the same intelligence center or, depending on the extent to which the system is deployed, resident at other geographic locations.

Analyst Work Files. Again, two subfiles will be provided. One will contain the informal models used by analysts. There is a presumption here that individual analysts should have the capability to work with their own models, projection maps, matrices and other forms, and to store and have access to these within their work files. In addition, it would probably be useful to establish one set of models and other analytic structures which reflect the formal analytic perspective for given groups of analysts. Thus it may be useful to distinguish between informal and formal models, and to include in the design the capability to store and work with both kinds. As suggested above, decisions on changing formal analytic perspectives might follow criteria developed by management.

The second subfile would contain a record of the analytic actions performed on input data as reflected in changes to and within the analysis models, maps, matrices, etc. This particular file would store the signification values, including their rationale, as developed by the analyst. Implicit here is that the analyst provides through manual input some of the rationale descriptions needed. For example, in Section 4 matrices are described which serve as a format for expressing the rationale behind various analytic perspectives. This storage capability applies both in the case of the individual analyst and in the case of files containing the formal perspectives of a given analytic group.

Management Activity File. This file will contain time-tagged measures such as backlog and relationality which have been generated through analytic activity. The manager will have access to a file which ultimately provides to him by appropriate sequences of geometric and alphanumeric displays the data on backlog, relationality, and signification values, together with translations of these to values in effectiveness, readiness and maintenance. This management file will include a measure value action pointer which points to records appropriate for review within work files. Depending on the design judgments made by analytic management, access could be provided to both formal and informal analytic structures.

Management Work File. Depending on the desires of management, it would also be feasible to structure a management work file. The purpose of this file would be to enable management to interconnect with analyst files and convey priorities and directions to given analysts. Whether this should be done in part through computer operations or done simply through verbal means is a design issue to be decided within the operational context.

Data Base Retrieval

The data base retrieval mechanisms to be used in IWAMS will be the same as the mechanisms used in the host system. Obviously it will be necessary to review the host system retrival mechanism prior to IWAMS integration in order to assure that there are no incompatibilities.

IWAMS FUNCTIONAL DESIGN

Input

Both automatic and manual inputs will be provided. Automatic input modes presuppose that portions of certain kinds of input, such as message traffic, are automatically input to the overall analytic support system. The format for both types of input would be the same: header followed by text. The record length would be variable. The header portions would conform to those which are currently used with the various traffic coming into the warning center. The data itself would be stored in the computer as American Standards Computer Interchange (ASCII) data.

Manual Input. Manual input capabilities will be necessary to provide a mechanism with which analysts may interact with, and supplement, automatic input data. More basically, analysts will need the manual input capability because they will need to excerpt and extract information from various inputs. Analysts must be able to tailor the input they wish to store within the IWAMS system since, as indicated in Section 4, there are in many cases special formats for the data entered into the system of models, projection maps, matrices, etc. Given the volumes of input data, IWAMS specialists may provide support for manual input. Moreover, lists of documents received by the library facilities at intelligence centers could be entered into the system by library personnel and routed to the appropriate analytic files.

Automatic Input. Various types of input data would be automatically available to analysts. With respect to the format for automatic input data, some message type traffic might include the actual text. In the case of other kinds of input, a reference to the document number and title might be automatically generated, with the actual perusal of the document made after manual retrieval from the holding office. The synopsized results of that review could be input to the system manually and form part of the record.

Ultimately the analyst would enter some data within the context of the models, projection maps, assumption matrices, and other forms which comprise the overall analytic structure. Thus automatic and manual inputs to the system really occur at several levels, beginning with initial input of information for review, followed by routing the information (in whatever reduced or modified form) for further input to specific nodes and elements within the formal structure of analysis.

IWAMS Analysis System

The IWAMS analysis system was described in detail in Section 4. The present section will describe the computer implementation of that system.

Monitoring. As noted, the analyst may be supported by various computer-based qualitative and quantitative techniques for monitoring indicators. It may be that the analyst is already able to display lists of key indicators through the basic support system. In addition, quantitative analytic techniques which involve assigning priorities and weightings to various indicators and combinations of indicators may also be available within the basic support system. Other quantitative techniques for monitoring indicators may also become available. Whatever the status of such support, the IWAMS system will either have access to existing techniques or provide through its files the capability to store what is required. IWAMS will be designed to assist the analyst in whatever functions are entailed, such as (1) review incoming data applicable to his assigned activity or region; (2) extract the pertinent information; (3) correlate the information against indicator lists; and (4) generate a result in terms of graphics displays of active indicators. Depending on the quantitative techniques available to the analyst, the result generation may involve a statistical presentation.

With respect to the review of input, the analyst, having stored data in IWAMS, can readily extract and display continually updated lists. Analysts can then review these lists, extracting individual data as necessary.

Information extraction with IWAMS would be primarily manual. However, the system does furnish assistance insofar as it provides current activities, indications, or data points that must be verified, checked, or otherwise correlated against. This function gives rise to the important concept that the IWAMS system include the capability to develop prompting and cueing of the analyst, through the use of color and other techniques such as flashing and underscoring on the requisite display formats.

The data correlation activity is also primarily manual. Ultimately the system will assist analysts because it will capture and record the results of previous correlations. The IWAMS system will also include prompting devices to help the analyst determine what steps and procedures in the analytic routine might be followed as a result of correlations made to date.

Output activity would be automated in IWAMS. The outputs could take the form of various lists of indicators; and alphanumeric and statistical renderings of the past and present status of analytic operations in the monitoring stage.

Threat Recognition. Considerable detail was provided in Section 4 on the threat recognition stage. The analyst seeks to account for indicator activity from the monitoring stage by reviewing the activity against an interrelated set of models (or information filters) which address the primary threats believed pertinent to the area in question. These models range from large scale depictions of possible national courses of action for an adversary country through increasing detail as to the specific activities and events that would characterize the unfolding of any of the major courses of action. IWAMS will support the threat recognition functions and analysis in a number of ways, including the following:

- The threats which are modelled in scenario form may be stored and called up.

- The displayed models would include prompting and cueing devices which identify for the analyst the status of the different models, for example, indicating previous instances when certain indicators were linked to different nodes on the models. Also included would be prompting cues which help increase the comprehensiveness of analysis, for example, cues which aid the analyst in conducting a systematic review of the different models against the indicators moved forward from the monitoring stage.

- The analyst can change or modify existing threat models on the basis of input data; he will have the ability to generate completely new models through a configurational language discussed below.

- The system will provide statistical and alphanumeric descriptions of past changes to models; show relative activity levels as well as periods of no change associated with various elements in models; and summarize the changes depicted graphically on the displays of the models themselves. Obviously this latter output capability will provide needed support for summaries for management.

- The above capabilities will provide the basis for graphic indications of the ramifications of signification throughout the series of models. It was noted in Section 4 that when the analyst changes given elements or nodes in a model, often the change ramifies through the logic structure of other related models and carries the implication that changes must be made there as well in order to complete the full meaning that has resulted (and which ultimately brings changes in signification values). IWAMS will at the least prompt the analyst to proceed through a series of review steps in which he examines other structures that might be affected by a change in judgment at a given point.

By providing such capabilities, IWAMS clearly affords a number of significant advantages to both analysts and manager. The IWAMS design reflects the concern that only measurable activities of analysis be stored, recorded and displayed. The analytic structure of models, maps, etc. represents a coherent system of analytic thinking, creating a common thread throughout the system in terms of a visual and alphanumeric language to be used by analysts and management.

Projection. The role of IWAMS in the projection stage is essentially the same as for the threat recognition stage. The difference, of course, is that IWAMS is now providing the same computer-based support for the projection maps, matrices and other structures used in projection as it provided for the threat recognition models. Thus, IWAMS provides in the projection stage all of the capabilities of storage, modification, display, and recording, with respect to these elements of projection:

- Statements of predictions and forecasts in the format of the basic information categories.
- Display of the specificity rating scale, using color and other techniques to emphasize levels.
- All appropriate computer operations on sectors and their comparisons.
- Generation, modification and display of single sector and probable future maps.
- Generation, modification and display of divergence maps.
- Generation, display and modification to rationale matrices and vector formats.

All of these outputs of the projection stage will be reviewable in terms of past status versus present status. Analysts and managers will have access to summaries, using the system of displays, with changes indicated. In addition, the display of ramifications of meaning throughout the different structures will be provided in the same way as for the threat models.

Measures

A detailed description of the development of the measures -- effectiveness, readiness and maintenance -- together with the key variables, was provided in Section 3. In addition, much of the discussion in Section 4 on warning analysis methods directly or indirectly concerns the generation of measures data as an organic outcome of the process of analysis itself, presuming that such analysis involves significant man-machine interactions which themselves indicate the occurrence, duration and other aspects of particular steps in the analysis process. The key information-related variables to be monitored in the analytic process are backlog, relationality, and signification. The description of the informal test of IWAMS indicated the basic mechanics by which the data to provide the monitoring of these variables (and the subsequent derivation of measures) would be developed. In Section 3, the calculations for converting the variables data into statements of measures were described. Against this background, we may examine the computer-based operations within IWAMS required for monitoring the variables and generating the measures.

Backlog. Backlog is monitored for each analytical stage and each step and procedure within stages. To measure backlog, IWAMS must track and monitor a number of elements, including the following:

Stage	Function
Monitoring	Date/time of arrival of data items Time analyst references data items Time indicators generated or identified and declared by analyst.
Threat Recognition	Times in which indicators are related to applicable threat scenarios (i.e., individual nodes and elements)
Projection	Times that the output data from the threat recognition stage are reviewed against the projection structures. For example, the times in which the results of the threat recognition analysis are reviewed for their impact on sectors, the various projection maps, etc. The times in which these activities are completed.

Rather than list them again here in detail, it suffices to point out that all the steps and procedures in the various stages of analysis, as implemented through the methods and techniques, must be recorded in IWAMS with respect to those times during which they were involved in the analysis of data.

Relationality. Relationality will be measured at each point within each major stage of the analysis process. It was shown above that the model of warning analysis encompasses a number of steps and procedures in each of the major stages. Moreover, a series of methods and techniques of analysis have been defined whose enactment results in the analysts carrying out those steps and procedures. The IWAMS approach is to develop recordable man-machine interactions at critical points of activity in these sequences. The analyst logs on and off the IWAMS system and performs certain analytic steps and procedures manifested by the calling up of displays and other activities. By recording these man-machine activities and timing them, the relationality measure is determined.

The activities and items monitored at each stage to determine relationality include the following:

Stage	Monitored Activity
Monitoring	Calling up of input data for review.
	Categorizing of input data.
	Calling up of predetermined indicator lists.
	Identification and display of correlations.
Threat Recognition	Calling up and displaying of preestablished threat models (PAMNACS, DENS, etc.).
	Calling up of displays comparing threat models to which input data has correlated.
Projection	Calling up of threat predictive formats.
	Calling up of specificity rating scale.
	Calling up of sector lists.
	Calling up of probable future maps.

Signification. Signification is also measured at each point of analysis. We have discussed in detail the strategy for measuring signification within IWAMS. The basic mechanism is to monitor and record changes made to the models and other structures (for example, projection maps) as analysts assign meaning to input data. Examples of the items to be monitored are the following:

Stage	Monitored Activity
Monitoring	Changes in the activity levels assigned to indicators.
	Changes in the priorities or weightings given indicators.
	Indicators not called up for review against given input data.
Threat Recognition	Changes to the nodes or other elements in the structures and forms of analysis.
	Association of given indicators with specific nodes of threat models.
Projection	Changes in the specificity value assigned to given projections.
	Changes in the predictive formats.
	Changes in the number of sectors.
	Addition of new sectors.
	Changes in possible future maps.
	Changes in divergence maps.
	Changes in assumptions matrices.

Since IWAMS will determine the relative times spent on various activities, and the nature of those activities, it will be possible to develop a considerable amount of insight, based on determining such aspects as:

- The time since each scenario, model, or other piece of analytic structure has been modified.
- Time spent on various activities.
- The dimensionality of given models.
- Average time between management reviews of analytic status in various problem areas.

Scenarios

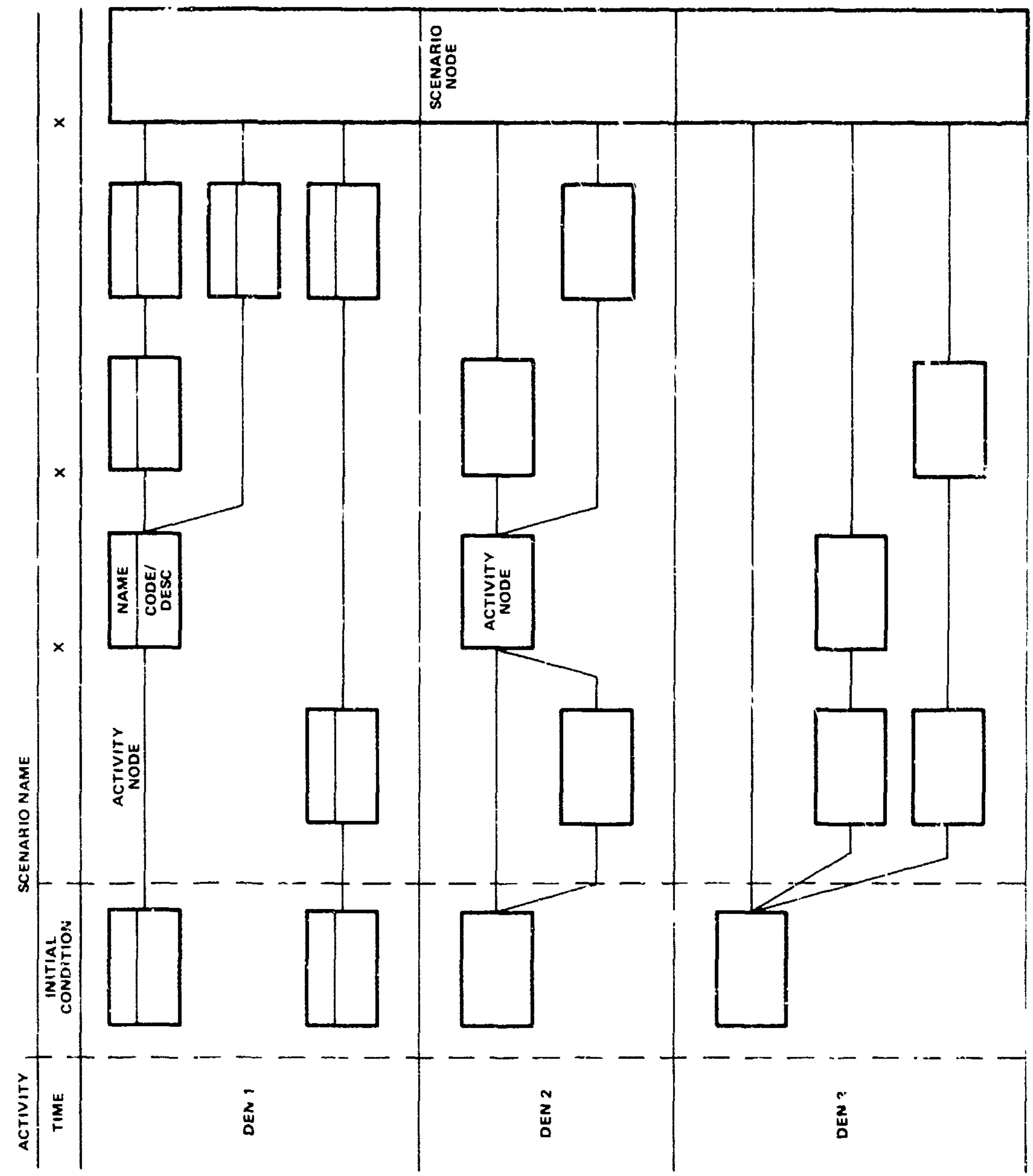
IWAMS incorporates scenario language for use by analysts. The term, scenario language, is used here to include all elements within the total structure of models, projection maps, assumptions matrices, and other forms within the analytic context. The scenario language which will be provided in IWAMS for the analyst may be functionally described as follows:

- Block and node oriented.
- Parallel activities/sequential actions.
- Scenario building blocks provided.
- Scenario editing available -- addition, deletion and modification provided to analysts.
- Scenario display via graphics, with color and dynamic prompting.

Figure 22 is an example display format used by an analyst working on the development or change of a given model. In its full design detail, there would be a similar display format for working up any of the structures, whether in the monitoring, threat recognition, or projection stages. The example shown in Figure 22 is intended to be generic and representative. But it can be seen that an analyst could change the nodes in a model; add or subtract structure; and have indications of activity points and degrees of specificity within the models as indicated by color and other techniques.

Management Operations

The last major function within the IWAMS system architecture is the management operations function. IWAMS provides for multiple levels of management. At each level, provision is made for managers to provide input to the analyst on the IWAMS system and to receive displayed output from that system. Probably a valid assumption is that most of the time higher levels of management will have less concern for the day-to-day details of analytic ctivity than will the analysts and their immediate managers. Communications within the IWAMS structure between analysts and management levels is indeed an important design consideration. As presently configured, IWAMS provides for linear bi-directional communication as follows: from individual analysts to or from level 1 management (immediate supervisor); and from level 1 to and from level 2 management, and so on as appropriate. The table below shows simplified examples of the inter-level communication types. Also shown are displays that would be available to the individual levels.



CURRENT SITUATION – INDICATED BY TIME LINE (VERTICAL LINE)
MONITORED NODES – INDICATED BY COLOR FLASHING ACTIVITY NODES, ETC
SPECIFICITY INDICATED BY COLOR

Figure 22. Example Working Display Format

IWAMS Communication and Displays by Management Level

Management Level	Input Options		Displays
	To:	Description:	
Level 1	Analyst	Query on signication/ rationale	Active scenarios, threats, projections, etc. by "Desk" and activity
		Query on scenario construction	Measures by "Desk" and activity
		Output/activity direction	Rationale (assumptions, etc.)
	Level 2	Display of analytic perspectives for review	
Level 2	Level 1	Activity priority Scenario critique/ approval Resource direction	Measures by center or "Desk" on active threats, projections
	Level 3	Activity Report	

FEASIBILITY AND INCENTIVES

> ...There is no more delicate matter to take in hand, nor more dangerous to conduct, nor more doubtful in its success, than to set up as a leader in the introduction of changes. For he who innovates will have for his enemies all those who are well off under the existing order of things, and only lukewarm supporters in those who might be better off under the new. This ... results ... from the incredulity of mankind, who will never admit the merit of anything new, until they have seen it proved by the event.
>
> Machiavelli

For those responsible for facilitating technical innovation, the problem of developing strategies of successful transfer of technology from the laboratory to the operational world is almost always formidable. This clearly is the case with warning analytic aids. The innovation manager faces a specific dilemma: an innovation should be proved constructive before it is integrated into an operational setting, yet the most credible assessment is provided by usage in an operational setting. Therefore it becomes necessary to design an approach which can be used and demonstrated in an environment that is either within the operations or at least slightly off-line and parallel with the operational setting.

Certainly the user -- the analyst and his manager -- is the essential factor at the concluding phases of transfer of innovations. The chief reason for rejection of innovations appears frequently to be inertia. There will be a tendency for users to block changes to established procedures. With respect to analysts, we are referring to a group now beset with persistent overload conditions. Other obstacles arise from factors such as the frequently high rate of turnover within warning and watch analyst groups.

The authors have sought to design in IWAMS a system which offsets these constraints on the introduction of new technology. One way of reinforcing these points is to indicate that the entire apprach has been designed to commend itself to analysts and managers. We have discussed feasibility with many people and have found especially valuable the perspective of Russell J. Smith, formerly Deputy Director of Intelligence at CIA. Smith has encouraged the view that the analytic routine should combine a broad array of analytic techniques in order to offer substantial assurance of comprehensive thoroughness, sophisticated analysis, and safeguards against bias. Analysts should subject their information and judgment to a series of rigorous steps, thereby gaining confidence in obtaining return from the inputs. Supervisors whose analysts work faithfully with such a system should feel confident that few, if any, avenues have been left unexplored in the effort to derive significance from the available information. Moreover, if the analysts review new inputs against displayed models of previously established guidepoints, and then employ projection techniques, the system should cause the analyst to think the problem through each time, to test the meaning of new information against the array of criteria, and to come to some decisive judgment. The interaction of previously established indicator and threat models with event analyses and policy statements would give considerable assurance that the analyst would be encouraged into modes of thought where meaning may be found.

Certainly the system should be easy and natural for an analyst to use. This is not to say that training requirements must be minimal; yet as vital as warning operations are, training requirements for IWAMS need not be nearly as severe as those for piloting high performance aircraft or for operation of various weapon systems. Analysts should find the warning analysis system invariably supportive, not a burden, and should turn to it enthusiastically with the expectation that it will help them find meaning that might otherwise be missed. Until this feeling exists, aids will be used perfunctorily, or only when there is time to spare -- not, in short, in truly critical situations -- and possibly gradually abandoned altogether.

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In addition, the system should be fairly broad in its application. It should fit the various kinds of intelligence problems the analyst confronts.

The system must also help to mitigate the information overload. Based on field experience, it is our strong judgment that with IWAMS several analysts can normally reduce typical backlogs of input data for the busiest problem areas by working steadily to do so through only parts of their shifts. There will ordinarily be time remaining for review of estimative reports, methodology refinement and research, and experimentation with analytic structure and routine. IWAMS provides what analysts indicate is important: a context, a coherent framework, in which to place data being analyzed. There is a "home" for the data. As we have noted, a high-context system tends to ease problems of information overload.

Moreover, the IWAMS memory, as it is built up, represents an extremely coherent and succinct reference system for the analyst. Experience with the memory will help analysts document and decide which kinds of data are more and less useful. This capability could prove very beneficial to judgments of the value of information and to establishing priorities with respect to the attention given different types of data.

In terms of the memory capacity, there is no doubt that providing ample storage for the <u>selective</u> memory envisioned for IWAMS is quite feasible. Indeed, there are no technical obstacles -- no software or hardware "breakthroughs" -- required for implementing the system.

Beyond these considerations, feasibility reduces simply to the fact that we have met analysts willing to work with IWAMS. IWAMS will require learning and impose challenges. It will mean that the analysts who use it must be able to interact with a computer-based support system and function in the electronic visual medium. It will mean opening up analysis to greater visibility. But it will also mean an extremely challenging and engrossing form of warning analysis, one that confronts some of the most important and adventuresome national problems. It will extend the sense of a community of analysts, with the community linked together in an electronically-based network of conceptualizing. The establishment of measures of performance and conceptual frameworks shared in a community of talented people cannot but produce in the future excellent methodological innovations and new skills. It will inevitably show the way for new technology applications.

But perhaps we can best sum up our views on incentives by relating an experience. A good friend who happened for awhile to be in charge of all analysts at a large warning center recently advertized in the local papers for two analyst positions. Over 400 applications were received. Two persons in their twenties, with PhD's, hard and soft science training, and familiarity with computer operations, were selected after much deliberation over many promising candidates. Warning analysis is clearly a field for especially talented people whose chief incentive is the pursuit of understanding. There are ample numbers of these people. And certainly what will help us most in the long run are not off-line consultants and expert observers but innovative practitioners among the analysts themselves.

As a final thought on the <u>esprit</u> of such analysts, and with only a few reservations (after all, he was "mad"), there is sympathy with an exhortation made by Captain Ahab, one of the great challengers of the world's perversity:

> All visible objects, man, are but as pasteboard masks. But in each event -- in the living act, the undoubted deed -- there, some unknown but still reasoning thing puts forth the mouldings of its features from behind the unreasoning mask. If man will strike, strike through the mask!

SOURCE NOTES

1. INTRODUCTION

(5) Watershed literature of warning: Roberta Wholstetter, Pearl Harbor: Warning and Decision, Stanford, California: Stanford University Press, 1962. Barton Whaley, Codeword Barbarossa, Cambridge, Mass: MIT Press, 1973. Avi Schlaim, "Failures in National Intelligence Estimates: The Case of the Yom Kippur War," World Politics 28 (April), pp.348-380.

(5) A set of writings recently by Thomas Belden: Thomas G. Belden, "Indications, Warning, and Crisis Operations," International Studies Quarterly, Vol. 21 No. 1, March 1977, pp. 181-198.

(6) In particular, Richards J. Heuer, Jr: Richards J. Heuer, Jr., "Cognitive Biases: Problems in Hindsight Analysis," Intelligence Studies XXII/2, Summer 1978, pp. 21-28.

(7) "The brain itself:" Edward Rothstein, "The Dream of Mind and Machine," The New York Review of Books, December 6, 1979, pp. 34-39. A superb review of Douglas Hofstader's Godel, Escher, Bach: An Eternal Golden Braid, New York: Basic Books, 1979.

2. WARNING ANALYSIS MODEL

(13) various organizations and individuals: definitions appear in sources such as Defense Intelligence School textbooks, Joint Chiefs of Staff (JCS) publications, Instructions at

warning centers, and writings by individual authors such as Cynthia Grabo and Evan Davis. Unfortunately, these can be difficult to obtain. We are indebted to Captain Frederick W. Robitschek, Jr., USAF, for providing an informal compendium of some of these definitions assembled for his research. Some definitions simply do not exist in accessible documents. The itemized entries on pages 15 and 16 include elements of several such definitions.

(16) pointing out that warning is <u>not</u>: Captain Frederick W. Robitschek, Jr., USAF, in a compendium of informal working papers generated in the Pacific Command, 1978-79. We are in the debt of Captain Robitschek, an expert on warning operations, for a number of useful discussions and research materials.

(21) We distinguish four types of projections: these distinctions are not new, though the terminology and rationale are. The difference between unimpeded and influenced projections bears on theoretical aspects of the nature of international crises, for example, the concept that such crises and their management involve significant -- perhaps decisive -- <u>interactions</u> between and among parties. (Se [illegible] iden, <u>op cit</u>. and Charles McClelland, "Anticipation of Crises," <u>International Studies Quarterly</u>, Vol. 21, No. 1, March 1977, pp. 15-38, for representative discussions.

(22) For each of the four types of projection: we are indebted to Thomas Belden for insightful discussions pertaining to the uses of the information categories for formatting warning reportage and, more basically, for warning analysis itself. See also Belden, <u>ibid</u>.

SOURCE NOTES

3. WARNING ANALYSIS MEASURES

(30) In analysis essentially we associate different data and assign meaning: we will have much more to say about the dynamics of warning analysis in Section 4. There we explore the interpretive impulse and its dynamics in some detail.

(32) Portions of James Grier Miller's work: see James Grier Miller, Living Systems. New York: McGraw-Hill Book Company, 1978. We are indebted to James Miller for discussing with us portions of his work and their utility in the present research.

(34) "Meaning represents": Miller, Living Systems, p. 11.

(38) Skeptics of post mortems: See Heuer, op. cit.

(39) These include the assumption that usually multidimensionality is good in warning analysis: this well-founded assumption is pervasive in the warning community.

(39) Another major assumption (concerns) safeguard procedures: this too is pervasive in the warning community. A fine discussion of the safeguards issue may be found in Avi Shlaim, op. cit.

(40) Chan's work on warning failures: see Steve Chan's excellent article, "The Intelligence of Stupidity: Understanding Failures in Strategic Warning." The American Political Science Review, Vol. 73, 1979, pp. 171-180.

(40) "We tell ourselves": See Joan Didion, The White Album. New York: Simon and Schuster, 1979, p. 11.

(41) "Even though human behavior": See Edward O. Wilson, On Human Nature, Cambridge, Mass.: Harvard University Press, 1978, p. 73.

(42) classification of the specific obstacles to analytic effectiveness: we are indebted to Shlaim, op. cit., for his fine discussion of some of the pitfalls in warning analysis. Relevant perspective also exists in a book by the Soviet authors, V. Druzhinin and D. Kontorov, Concept, Algorithm, and Decision, translated and published under the auspices of the United States Air Force, U.S. Government Printing Office, Stock # 0870-00340.

(42) In Soviet Literature: see Druzhinin and Kontorov, Ibid.

(43) As Shlaim im particular discusses: see Shlaim, op. cit.

(45) Belden, op. cit., p. 191.

(45) learning from "ambiguous" and "incomplete" information: a concept discussed broadly by Druzhinin and Kontorov, op. cit.

(46) Procedures and techniques for weighing opposing hypotheses: several writers on warning discuss briefly this fundamental strategy of warning analysis. See Wholstetter and Shlaim.

SOURCE NOTES

(46) Procedures that foster systematic use of a mixture of analytic approaches: Willis W. Harman has written valuably on this analytic strategy in the context of forecasting. See Willis W. Harman, An Incomplete Guide to the Future, New York: W.W. Norton and Company, 1979, pp. 9-19.

(51) To derive real and estimated effectiveness: the overall discussion of information-related variables draws in a very general sense from some of Miller's conceptualizing in Living Systems, especially those sections dealing with information subsystems in the individual and the group. See particularly Chapters 8 and 9.

(53) The relationality variable: insofar as we know, this variable is unique to the present conceptualization of the warning analysis process. That is, it is a new concept with respect to measurement of warning analysis. Of course, the notion of organized procedure is hardly new.

(54) The most important of the three variables, signification: insofar as we know, this variable also represents a new conceptualization with regard to warning analysis. The persisting problem of meaning, of course, is essentially bound-up with the signification variable.

(54) Signification is captured by: There is awareness of the long-standing quarrels among theorists of interpretation of "narrative": what is it we do, and what is it we can learn, when we attempt to interpret records of previous outlooks? Indeed, there are those who argue that recovery of an observer's (say a writer's) original "intentions" is impossible. In the present context, as the ensuing

discussion will show, the signification measure involves this theoretical aspect. However, we shall postpone discussion of it until we have concluded a portion of the discussion in Section 4 below (Methods of Warning Analysis) for the signification measure requires also a system of signification which would foster interpretation of previous meaning.

(54) The Soviets distinguish: see Druzhnin and Kontorov, op cit.

(55) As Richards J. Heuer, Jr., has written: The discussion of hindsight problems draws on Heuer, op cit. Sources Heuer draws on include: Fischhoff, Baruch and Beyth, Ruth. "I Knew It Would Happen: Remembered Probabilities of Once-Future Things," Organizational Behavior and Human Performance, 13 (1975); Fischhoff, Baruch, The Perceived Informativeness of Factual Information, Technical Report DDI-1, Oregon Research Institute, Eugene, Oregon, 1976; Fischhoff, Baruch, "Hindsight ≠ Foresight: The Effect of Outcome Knowledge on Judgment Under Uncertainty," Journal of Experimental Psychology: Human Perception and Performance, I, 3 (1975).

(57) Carl Sagan (has) stressed: see Carl Sagan, The Dragons of Eden. New York: Random House, Inc. 1977. See especially Chapter Eight.

(59) appointed committees who explore an intelligence failure: A review of some post mortems conducted in relation to the U.S. Intelligence Community is to be found in Richard W. Shryock, "The Intelligence Community Post-Mortem Program, 1973-1975," Intelligence Studies XXI/2, Summer, pp. 15-28.

SOURCE NOTES

(61) "a configuration within the brain": see Wilson, op. cit., pp. 75-76.

(63) We can now estimate: see Sagan, op. cit., especially Chapter 2.

(71) SIGINT: signals intelligence (SIGINT); communications intelligence (COMINT); imagery intelligence (IMINT); human-source intelligence (HUMINT).

(72) pathological states in information systems: see Miller, op. cit., pp. 81-82 for a general discussion; see also pp. 473-480 for a discussion bearing on the individual human; and pp. 581-592 for consideration of these states in groups. See also pp. 121-202 for an extended consideration of the problem of information input overload, including a survey of related research, a study of the pathological effects of information input overload, and the results of experiments conducted by Miller and associates.

(74) there is a set of hypotheses about the likely behavior of information-related systems under varying conditions: see Miller, Ibid., for an extremely detailed treatement of such hypotheses, related to his structure of information-processing subsystems in living systems. The individual discussions appear at many points in Living Systems.

(76) "What happens appear to be": Didion, op. cit., p. 44.

(76) "I was meant to know the plot": Didion, Ibid., p. 13.

4. WARNING ANALYSIS METHODS

(83) The physics of Newton: Mas'ud Zavarzadeh, in a superb study of newer forms of American literature, has discussed the impact of recent and current physics, as well as modern communications media, on the novelist. See Mas'ud Zavarzadeh, The Mythopoeic Reality, Urbana, Illinois: University of Illinois Press, 1976, pp. 3-49. The general epistemological impact of both physics and the media has been considered by a number of observers, but Zavarzadeh addresses its specific effects on contemporary American literature illuminatingly. The discussion of these subjects in the present study (see pp. 83-88) unashamedly has drawn for some of its points from the fine study by Zavarzadeh.

(84) "The behavior of the particle": see Cecil Schneer, The Evolution of Physical Science. New York: Grove Press, 1960, p. 364.

(84) "(George Smiley) hated the Press": John LeCarre, The LeCarre Omnibus: Call for the Dead and a Murder of Quality. London Victor Gollancz Ltd., 1967, p. 126.

(84) "The new communication technologies": Zavarzadeh, op cit., p. 7.

(85) "the official level of reality": see Cutting Edges: Young American Fiction for the 70's, ed. Jack Hicks. New York: Holt, Rinehart, and Winston, 1973, p. 537.

SOURCE NOTES

(86) reality ... is "neither significant nor absurd.": see Alain Robbe-Gillet, For a New Novel. New York: Grove Press, 1965, p. 19. Cited by Zavarzadeh.

(87) In a recent study: Zavarzadeh, op cit.

(87) "Mistrust and even fear": Zavarzadeh, op cit., pp. 7-8.

(88) "... a form of organized chaos": Zavarzadeh, Ibid., p. 9.

(93) "The Early Warning and Monitoring System": see Judith Ayres Daly, Command, Control, and Intelligence: R&D for Decision and Forecasting Systems. Arlington, Virginia: Cybernetics Technology Office, Defense Advanced Research Projects Agency, 1979, p. 12. For related and expanded descriptions, see the following: S.J. Andriole, Progress Report on the Development of an Integrated Crisis Warning System, Decisions and Designs, Inc., McLean, Va., December 1976; J.A. Daly and T.R. Davies, The Early Warning and Monitoring System: A Progress Report, Decisions and Designs, Inc., McLean, Va., July 1978.

(94) "Man is the model-making organism par excellence": see Edward T. Hall, Beyond Culture. Garden City, New York: Anchor Press/Doubleday, 1976, p 10.

(95) Situations are considered as "things": V. Druzhinin and D. Kontorov, op cit., p. 103, agree that situations are of primary importance to the intelligence analyst. See also Hall, op cit., pp. 113-123.

(95) We now turn to specific examples of analytic forms: Don R. Harris and Frances M. Calloway, two colleagues, have contributed significantly to the design of some of the analytic forms described and discussed in the present study. Harris, formerly a CIA analyst, has been involved primarily with forms used in the threat recognition stage; Calloway with forms used in the projection stage.

(108) The warning analyst undertakes to develop scenarios: see Albert Clarkson, "Writing and Editing Scenarios," Journal of Technical Communications, Volume 16, Number 2, Second Quarter, 1969, pp. 20-21. Clarkson's article is drawn upon for the present discussion on scenarios on pp. 108-110.

(111) The anthropologist, Edward Hall, has written importantly about the relation of context to meaning: see Hall, op cit., especially Chapters 7, 8, and 9 (pp. 91-123).

(112) "... context ... carries varying proportions of the meaning: Hall, Ibid., pp. 75-76.

(114) The full rationale behind the assignment of meaning: various theories of interpretation exist and reflect profound arguments on the limitations of ad hoc understanding of meaning recorded in texts and other forms. In later discussions of signification (see section below on the projection stage) we will consider the "hermeneutics" of signification as it is being considered in the present context.

SOURCE NOTES

(118) There is no intent to provide a survey of various projection techniques: for an excellent examination of the literature, see Richard W. Parker, Crisis Forecasting and Crisis: A Critical Examination of the Literature. McLean, Virginia: Decisions and Designs, Inc., 1976.

(119) As Thomas Belden has pointed out: Belden, *op. cit.*

(126) In his very useful book ... Willis Harman: see Willis W. Harman, An Incomplete Guide to the Future. New York: W.W. Norton and Company, 1979. We are indebted to Harman, and shamelessly draw from, his excellent discussion of the methods of futures research, especially pp. 9-19. As indicated in the text of the present discussion on pp. 126-130 and 139-143, portions of the consideration of projection methodology are drawn exclusively from Harman and rely extensively on his perspective on methodology. All references to Harman in these pages refer to An Incomplete Guide to the Future and are part of the discussion therein on pp. 9-19.

(130) Probable Futures Mapping: A technique largely developed by a colleague, Frances M. Calloway.

(144) Thomas Belden has modeled this phenomenon as a decision stairway: Belden, *op. cit.*

(145) There are a number of approaches: see Parker, *op. cit.*

(146) "the elucidation, measurement and analysis": see Gerald W. Hopple, Mapping the Terrain of Command Psychophysiology.

McLean, Virginia: International Public Policy Research Corporation, August 1978, p. 2.

(147) "As is customary in social scientific inquiry": Hopple, Ibid., p. 3.

(150) "The popular paradigms of modern psychology": see John W. Sutherland, "Towards a Middle-Range Theory of Societal Dynamics," forthcoming in Human Relations. The material quoted is from a draft of the forthcoming article.

(152) "a. The more precise the prediction": Belden, op. cit.

(153) Table 10: Sutherland, Ibid.

(154) Figure 19: Sutherland, op. cit.

(157) See the Notes section for a brief discussion: It is interesting to view the problem of interpretation with respect to post mortems and the determination of real effectiveness. In Section 4, we discussed the crisis of interpretation in terms of the analyst attempting to monitor and project activity in the international arena. But given that a record of meaning would be created in IWAMS, we may also consider interpretation from the traditional standpoint of textual interpretation. The IWAMS memory is based on a system of signification that will produce a "text" of historical meaning. There is a long-standing debate among theorists of textual interpretation concerning how much objective meaning (the original intended meaning of a given author) is recoverable by later interpreters. Obstacles to such interpretation derive in part from the passage of time which causes new readers to

review the work through their own (new) perspectives, thereby (it is maintained) obscurring the original meaning. Taken to its extreme, this view results in the position that all such interpretation is endless, futile (in terms of recovering original meaning) but perhaps important (and certainly fun) if you concede that new generations of readers should use significant literature of the past at least as a vehicle for viewing the reality of their own times. While few would not concede that some meaning in past records, especially very old ones, is probably irretrievably lost, a set of formidable observers stress the common sense approach that there is obviously a great deal of objective meaning readily recoverable, particularly if the system of signification fosters the recovery. We have, however, barely touched here on the complexities of this topic. For extended discussion, see especially: E.D. Hirsch, The Aims of Interpretation and Validity in Interpretation; Frank Kermode, The Genesis of Secrecy: On The Interpretation of Narrative; any number of works concerning New Critics and New Criticism, a powerful movement in the literary world influential especially in the 1940's; Hirsch's review of Kermode's Genesis, "Carnal Knowledge," The New York Review of Books, June 14, 1979, pp. 18-20; and Gerald Graff's review of Genesis, "The Genesis of Secrecy: On the Interpretation of Narrative, by Frank Kermode," The New Republic, June 9, 1979, pp. 27-32.

5. IWAMS Functional Design

(183) Mil Standard 7935.1-S: refers to specifications and requirements for computer-based systems.

(186) Input data will be listed under categories: see description in Section 2 of typical categories of data incoming to warning centers.

(189) Moreover, lists of documents received by the library facilities: assures IWAMS access by library personnel as well as analysts and managers.

(200) level 1 management: an arbitrary designation, not an official term for specific management echelons in warning centers.

(202) "Desk": term is sometimes used to refer to geographic area (e.g., North Korea) undergoing intelligence watch.

(203) "There is no more delicate matter": see Niccolö Machiavelli, The Prince. New York: The New American Library of World Literature, Inc., 1952, p. 55.

(204) the perspective of Russell J. Smith: the remarks on acceptance criteria are based on an informal memorandum by Smith.

(206) "All visible objects": from Moby Dick.

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UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A084 189	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) INDICATIONS AND WARNING ANALYSIS MANAGEMENT SYSTEM A DESIGN STUDY. IWAMS		5. TYPE OF REPORT & PERIOD COVERED Final Technical Report Oct.26 1978 - Mar.31 1980
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Albert Clarkson, Laurence Krasno, Jerry Kidd		8. CONTRACT OR GRANT NUMBER(s) MDA903-79-C-0011
9. PERFORMING ORGANIZATION NAME AND ADDRESS ESL Incorporated 495 Java Drive Sunnyvale, CA 94086		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS DARPA Order Number 3571
11. CONTROLLING OFFICE NAME AND ADDRESS Defense Advanced Research Projects Agency 1400 Wilson Boulevard Arlington, VA 22209		12. REPORT DATE March 1980
		13. NUMBER OF PAGES 225
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) Department of the Army Defense Supply Service - Washington Room 1D245, The Pentagon Washington, D.C. 20310		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release, unlimited distribution.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

9) Final rept. 26 Oct 78-31 Mar 80

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Indications and warning, warning, warning analysis, crisis, crisis management, analytic methodology, measures of warning analysis, computer-based analysis aids

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This final technical report summarizes the design of an advanced computer-based system for the performance and management of indications and warning (I&W) analysis. In addition to a preliminary software design, the report summarizes work in these areas: development of a model of warning analysis; measures of warning analysis performance; and methods of warning analysis.

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

404 171