The Timeliness of a NATO Response to an Impending Warsaw Pact Attack

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THE TIMELINESS OF A NATO RESPONSE TO AN IMPENDING WARSAW PACT ATTACK

DECISIONS AND DESIGNS INCORPORATED

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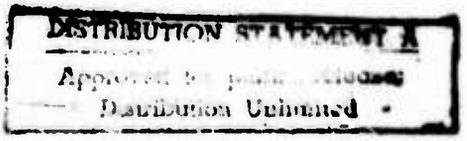

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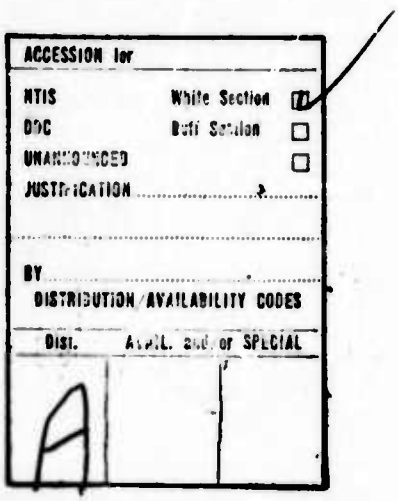

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by

Rex V. Brown, Clinton W. Kelly III
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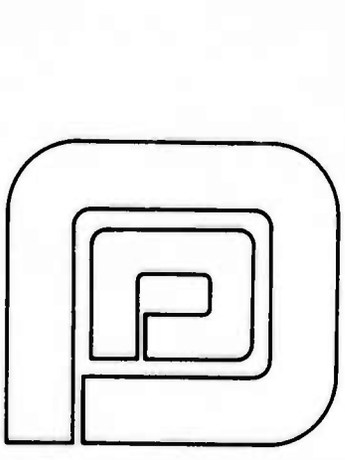

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this study was: "If the Warsaw Pact were to attack at the end of a 30-day mobilization cycle, at what point in time after the Pact begins to mobilize would NATO initiate a state of reinforced alert?"

An answer to this question can serve as an input for determining the most likely state of NATO readiness on Warsaw Pact D-day. Obviously, there may be as many answers to questions about NATO reaction time as there are experts with plausible scenarios. However, since there is no one set of correct answers, the development of new techniques and insights to assist military planners in making more realistic, defensible estimates of NATO mobilization time is perceived to be of considerable value with respect to U.S. General Purpose Force Planning and in Mutual and Balanced Force Reduction (MBFR) negotiations.

SUMMARY

Introduction

The study which is reflected in this report was performed for the Studies, Analysis and Gaming Agency (SAGA) of the Office of the Joint Chiefs of Staff (OJCS). It focused on an assessment of NATO readiness in the event of a Warsaw Pact attack. The primary purpose of the study was to develop a methodology for understanding the NATO decision-making process during periods of rising tensions involving the increasingly strong possibility of an attack by the Warsaw Pact countries. The particular question addressed by this study was: "If the Warsaw Pact were to attack at the end of a 30-day mobilization cycle, at what point in time after the Pact begins to mobilize would NATO initiate a state of reinforced alert?"

An answer to this question can serve as an input for determining the most likely state of NATO readiness on Warsaw Pact D-day. Obviously, there may be as many answers to questions about NATO reaction time as there are experts with plausible scenarios. However, since there is no one set of correct answers, the development of new techniques and insights to assist military planners in making more realistic, defensible estimates of NATO mobilization time is perceived to be of considerable value with respect to U.S. General Purpose Force Planning and in Mutual and Balanced Force Reduction (MBFR) negotiations.

Approach

A major portion of this study was devoted to the application of decision-analytic techniques to model quantitatively the continuing decision processes of the Supreme Allied Commander Europe (SACEUR) in a situation involving Warsaw Pact mobilization. The result was a SACEUR "rational-choice" model wherein the term "rational" denotes a decision process which ensures that the conclusion is logically consistent with judgmental and other given inputs. The term implies nothing with regard to the nature of those inputs.

In the SACEUR rational-choice model, conclusions that SACEUR might reasonably reach on the basis of a plausible sequence of incoming intelligence reports concerning Pact preparedness actions are quantified in terms of probabilities. Value judgments, such as assessment of the relative value of avoiding a false alarm versus the value of full readiness at the time of a Pact attack, are quantified in terms of utilities. The point in time when SACEUR should rationally opt for NATO mobilization is calculated from these inputs. Certain factors affecting NATO readiness, such as unilateral actions taken by NATO members in consultation with NATO, were excluded from the scope of this study. Results from the model were

combined with experienced assessments of organizational delays within the North Atlantic Council (NAC) and other factors in estimating the total mobilization lag.

Substantive Implications

The methodology developed during this study did, of course, determine specific estimates of NATO mobilization time for the selected scenario. More importantly, it promises to provide new insights into NATO decision processes and new techniques for the military planner who is responsible for making new assessments pertaining to strategic planning and negotiations.

The study alerted the SAGA staff to the fact that forecasts of NATO mobilization actions are critically sensitive to SACEUR's value judgment of the relative costs of a false alarm versus unpreparedness for an attack as well as to the diagnostic value of incoming intelligence. The model is sensitive to values assigned to various potential outcomes of a decision to mobilize NATO forces. Varying these values permits the effects of a particular nation's aversion to war or an individual's concern for the impact of a premature NATO decision to mobilize to be systematically examined. In a similar vein, varying the intelligence-dependent probabilities in the model allows the impact of changing such factors as the timeliness and quality of early warning information to be examined. This is a complex issue, for the final estimate at the Supreme Headquarters Allied Powers Europe (SHAPE) of the probability of a Warsaw Pact attack and the number of days until the attack occurs is likely to be largely dependent upon SACEUR's personal interpretation of events. In this context, the nature of the evidence collected (e.g., photographic evidence versus communications intelligence evidence) may well be more important than the staff's interpretation of it.

Although the use of the model was limited to providing an improved prediction of the NATO mobilization lag for a specific 30-day confrontation scenario, a succession of comparable analyses could be readily performed to permit generalization beyond this particular scenario. These analyses would include scenarios with different Warsaw Pact mobilization cycles and, more importantly, scenarios in which the Pact's behavior may be influenced by NATO's behavior.

When findings about NATO mobilization lag are incorporated in an analysis of NATO readiness, it must be realized that, in reality, SACEUR would implement certain military actions to the extent of his authority in order to improve the readiness and security of NATO forces, even though a decision to mobilize had not been forthcoming from NAC. Other NATO countries might respond similarly, and the degree

of this independent action would markedly affect NATO's state of readiness. However, this factor can be reflected implicitly in the model (for example, by the assignment of values for potential outcomes) or it can be modeled explicitly. Formal inclusion of this factor can be of value in determining the extent to which certain authorized SACEUR military actions could compensate for the anticipated NATO lag and, additionally, how certain new authorities might further improve the situation.

Methodological Implications

This study was an interesting and unusual application of decision analysis in several ways. First, it was concerned with predicting actions rather than prescribing an optimal course of action, which is the classical application of decision analysis. Second, the study addressed the problem of how to compress a complex decision tree into a more compact one. Since in this case a more complete complex model required literally millions of assessments, it was necessary to simplify the model while retaining its essential characteristics. Third, this study developed techniques for modeling subsequent acts and identified important areas for further research, notably the modeling of bureaucratic processes to relax the assumption of an organization's being a single rational actor.

The decision-analytic model created during this study represents a reasonable first step in developing a structured methodology for studying the NATO decision-making process in a crisis situation and, in particular, the NATO mobilization lag problem. Although the SACEUR rational-choice model has a number of limitations--for example, the model assumes that SACEUR will think the way it prescribes and that SACEUR's judgments will be those attributed to him--the model is sufficiently flexible to accommodate different judgments about SACEUR's intelligence assessments and value system. In order to exercise this inherent flexibility, an obvious extension to the present study would be to implement the model using interactive computer graphics so that it can be utilized by military planners to:

- Rapidly examine the effects of changing assumptions, scenarios, intelligence inputs, estimates, and value judgments; and
- Conduct sensitivity analyses on the results of their studies.

Other extensions of this study might include:

- Refining the analysis of components within the study, such as organization delays within NAC or intelligence estimates;

- Broadening the focus of the study to cover richer measures of military readiness; or

- Addressing directly a current decision in which NATO mobilization lag is relevant.

CONTENTS

FIGURES

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THE TIMELINESS OF A NATO RESPONSE TO AN IMPENDING WARSAW PACT ATTACK

1.0 INTRODUCTION

The study which is reflected in this report was performed for the Studies, Analysis and Gaming Agency (SAGA) of the Office of the Joint Chiefs of Staff (OJCS). It focused on an assessment of NATO readiness in the event of a Warsaw Pact attack. The primary purpose of the study was to develop a methodology for understanding the NATO decision-making process during periods of rising tensions involving the increasingly strong possibility of an attack by the Warsaw Pact countries. The particular question addressed by this study was: "If the Warsaw Pact were to attack at the end of a 30-day mobilization cycle, at what point in time after the Pact began to mobilize would NATO initiate a state of reinforced alert?"

An answer to this question can serve as an input for determining the most likely state of NATO readiness on Warsaw Pact D-day. Obviously, there may be as many answers to questions about NATO reaction time as there are experts with plausible scenarios. However, since there is no one set of correct answers, the development of new techniques and insights to assist military planners in making more realistic, defensible estimates of NATO mobilization time is perceived to be of considerable value for U.S. General Purpose Force Planning and Mutual and Balanced Force Reduction (MBFR) negotiations.

1.1 An Overview of the Problem and Setting

In this study, a specific objective was the development of a prediction, conditional upon a single, specific confrontation scenario, of the number of days which might elapse between a Warsaw Pact M-day and a NATO M-day. As reflected in Figure 1-1, this scenario specifies an attack by the Pact countries following an irreversible 30-day mobilization cycle. Furthermore, it assumes, somewhat restrictively, that the Pact is in no way influenced by NATO actions; that is, it excludes the possibilities that the Pact is encouraged to attack or deterred from attack by NATO action in response to Pact mobilization.

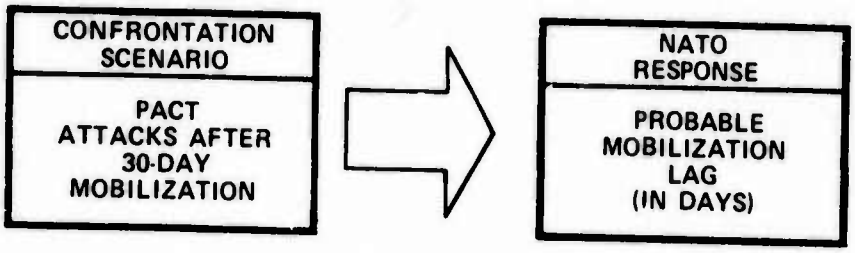

Figure 1-1
OVERVIEW OF THE PROBLEM

Although the scenario selected may not be the most likely one, it is one which, nevertheless, provides plausible and rich input data for the formulation of a SACEUR "rational-choice" model. The term "rational" is used here to denote a decision process which ensures that the conclusion is logically consistent with judgmental and other given inputs. It does not imply anything with regard to the nature of the inputs.

Although not addressed here, the methodology which has been developed provides a rapid means of examining the impact of revised input data from other scenarios as desired, for example, more covert or more accelerated confrontation scenarios or scenarios wherein Pact actions are influenced by NATO actions.

For a 30-day Pact attack scenario, three different levels of activity might unfold over a 35-day period from M-4 to M+30, which are represented as t=-4 to t=30 for later analytical purposes. First, the Warsaw Pact would build up, possibly clandestinely, toward the planned attack on D-day, selected hypothetically as March 7th. This activity would generate some daily sequence of intelligence reports and other visible manifestations upon which SACEUR and other NATO parties would base their daily estimates of the situation, which possibly are fallible. It must be emphasized that SACEUR does not know the Pact scenario, only the intelligence data resulting from the sequence of intelligence reports. In response to this sequence of intelligence reports, various SACEUR and other NATO actions would take place. The timing of two of these actions were of particular interest in this study, namely, SACEUR's recommendation for NATO mobilizaion and actual NATO mobilization. As may be observed in Figure 1-2, the point in time at which SACEUR recommends mobilization divides the total mobilization lag period into two components, which are designated as SACEUR lag and NAC lag.

The general setting of the problem is represented graphically in Figure 1-2.

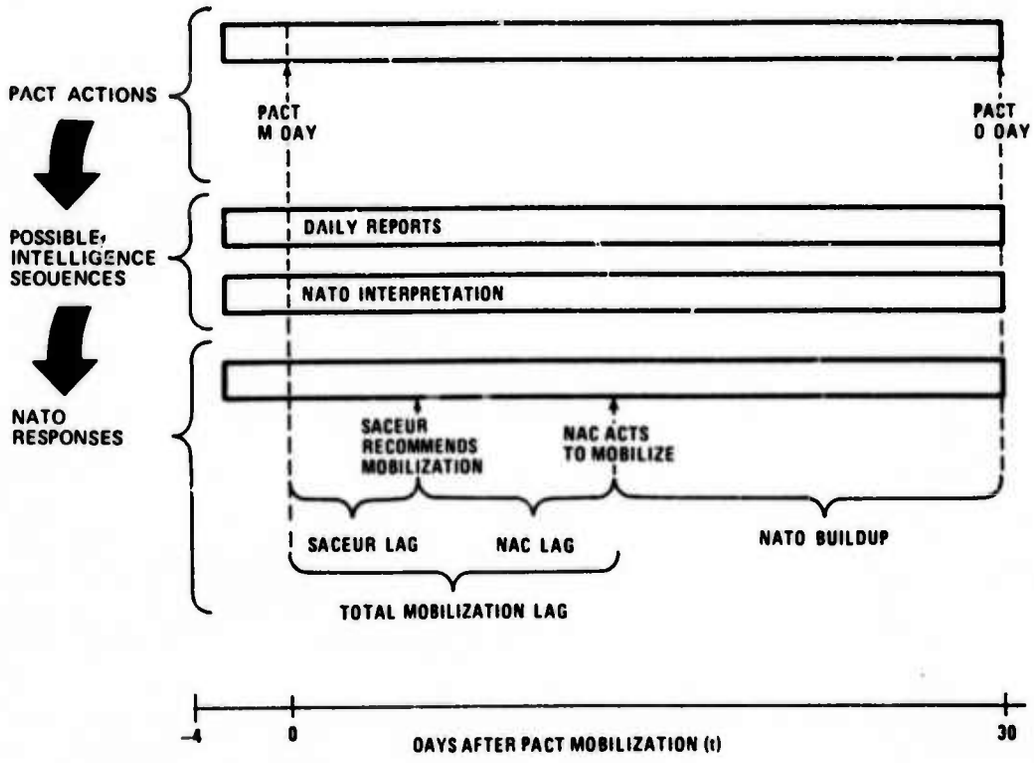

Figure 1-2
GENERAL SETTING

Specific NATO activities leading up to a state of reinforced alert are reflected in the form of the flow chart shown in Figure 1-3. The key role of SACUER's intelligence evaluations and recommendations in the total NATO decision process may be readily observed in this figure. Basically, the objective of this study was to model the process shown in Figure 1-3 in such a way that the model can be used to predict the total mobilization lag in response to the situation described in a particular scenario.

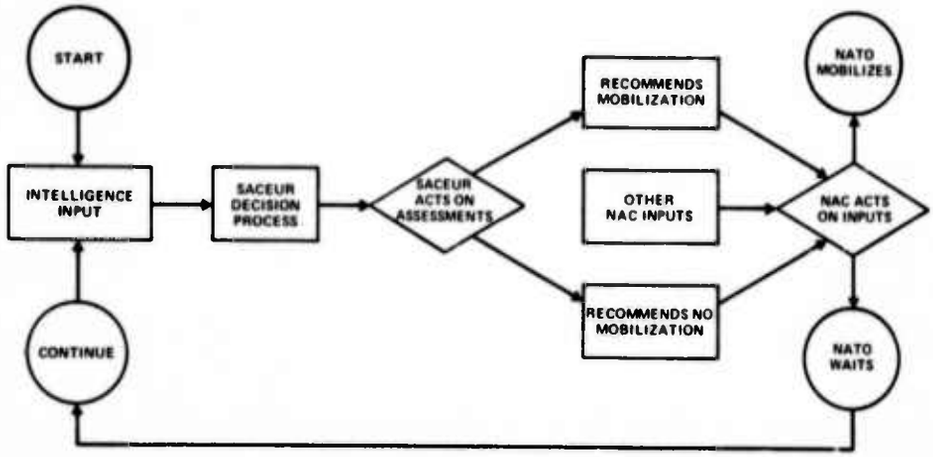

Figure 1-3

OVERVIEW OF NATO MOBILIZATION–RELATED ACTIVITIES

1.2 An Overview of the Technical Approach

The following summary of steps in the technical approach to the problems affords the reader an overview of the more detailed, analytic description of the models and how they transform input data into useful insights concerning the NATO decision-making process:

- Select a specific daily sequence of intelligence reports that might plausibly be generated by the selected confrontation scenario;
- Predict SACEUR lag in probabilistic terms by using a formal rational-choice model of SACEUR's behavior. SACEUR lag is the delay until SACEUR's estimate of the situation, based upon the foregoing intelligence, would lead him to recommend NATO mobilization;
- Predict NAC lag in probabilistic terms by using informed judgments about NATO organization processes. NAC lag is the additional delay until the NAC actually initiates mobilization;

- Take into consideration additional uncertainties about SACEUR lag and NAC lag because the availability of intelligence is uncertain; and

- Assess a probability distribution for the total NATO mobilization lag associated with the 30-day scenario.

1.2.1 Selection of a representative intelligence sequence - A representative intelligence sequence or script was developed and, for the purpose of predicting SACEUR and NAC responses, was initially assumed to have occurred. Later, this assumption of a fixed intelligence sequence was relaxed.

The intelligence script creates a hypothetical situation in which an Intelligence Staff can review daily the available evidence about unusual military-related activities taking place in the western Warsaw Pact area. From this evidence, the staff can continuously estimate, for example, the probability of a Pact attack against NATO and, if an attack is probable, when and after how many days of mobilization it is likely to occur.

The postulated intelligence sequence illustrates the type of evidence generated by Warsaw Pact pre-attack actions and assumed to be available to the SHAPE Intelligence Staff. As such, it reflects a typical development of intelligence during a period of political tension characterized by steadily deteriorating East-West relations. During this period, Soviet naval activity and the opportunity for a U.S.-U.S.S.R. naval confrontation increases in the Baltic Sea and the Eastern Mediterranean. In the central Warsaw Pact area, unusual activities at various military installations are in evidence; as D-day approaches, the movement of ground force units is detected; and finally, a break in U.S.-Soviet diplomatic relations occurs.

The intelligence sequence or script is reasonably representative in terms of its diagnosticity about Pact actions and intentions. However, certain dimensions of intelligence, such as the status of Western sentiment (revealed in part by editorial comments in European and U.S. newspapers), are not given, and there are no provisions for feinting and deception on the part of the Warsaw Pact.

1.2.2 Assessment of mobilization lag - As indicated in Figure 1-4, total mobilization lag, which is the interval

between Pact mobilization (defined as day t=0) and NATO mobilization, consists of two major components, SACEUR lag and NAC lag, which are separately assessed.

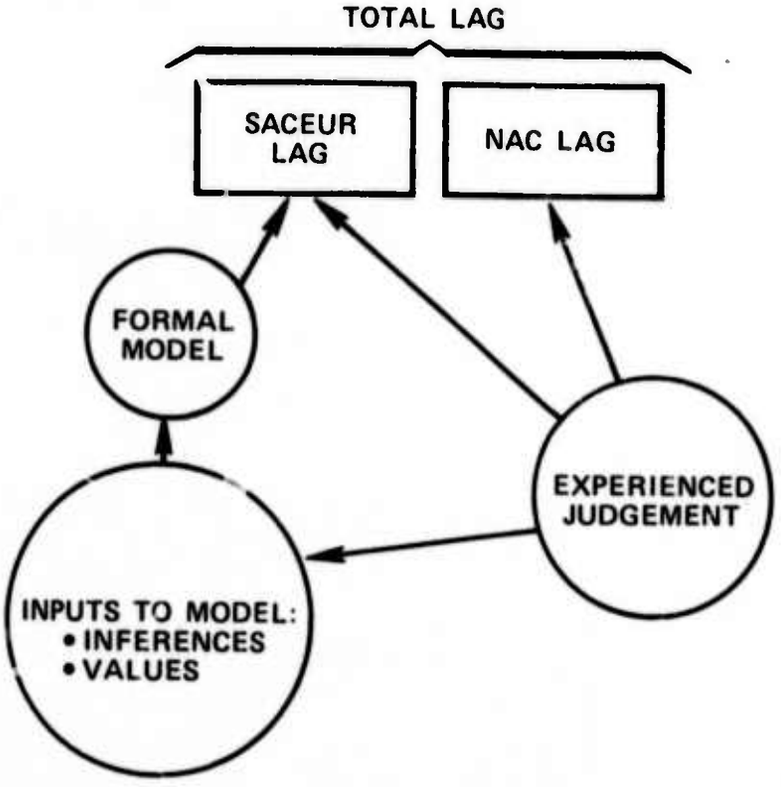

Figure 1-4
OVERVIEW OF THE ASSESSMENT OF MOBILIZATION LAG

The first component, termed "SACEUR Lag," is the delay from Pact Mobilization until the point in time when SACEUR recommends a Reinforced Alert. Although direct assessment of this lag by experienced military sources was also used, the primary approach to this assessment was the construction of a formal rational-choice model for SACEUR. This model attempts to calculate the point in time when the assessments, judgments, and values that might reasonably be attributed to SACEUR would indicate that NATO should mobilize. The methodology used is that of modern decision analysis. The inputs are based upon the informed judgments of intelligence analysts and individuals with military command experience in this area, who made quantified daily estimates of the situation in response to the given intelligence and provided quantified value judgments about possible outcomes.

The other component of total mobilization lag, termed "NAC lag," was that attributable to organizational delays occurring in the NAC after the SACEUR presented his recommendation. Although conceptual models for addressing this issue are available in principle, they require further technical development beyond the scope of this study. For this reason, informal military judgments about the organizational processes involved, based in part upon Graham Allison's bureaucratic process model,[1] were used during this portion of the study. A reasonable extension of this study would include the development of the requisite technology to model formally the NAC decision process.

1.2.3 A formal rational-choice model for SACEUR - The major part of the research effort in this study was directed to the construction and quantification of a formal rational-choice model for SACEUR. The model was used to deduce at what point in time SACEUR should favor NATO mobilization in terms of a quantified representation of his perceptions. These refer to the probable implications of "mobilize today" or "wait" on each successive day covered by the intelligence sequence and to his personal evaluation of the possible consequences.

SACEUR's optimal rational choice can be determined from these value and probability inputs by using decision analysis. However, what SACEUR's actual probabilities and values would be can only be a matter of informed conjecture.

Playing the role of the Supreme Headquarters Allied Powers Europe (SHAPE) Intelligence Staff, six experienced intelligence analysts were used to generate the probabilities of a Pact attack and the probable timing of Pact mobilization and attack on a daily basis. Value judgments, such as the relative costs of a false alarm (mobilizing when the Pact is not attacking) and of a surprise attack (being completely unprepared when the Pact attacks), were supplied by senior military officers with command experience in this area. These officers also supplied quantified predictions of whether and when NATO would mobilize if it did not mobilize on the day in question. All these judgments were then treated as if the SACEUR subscribed to them.

The formal model with the assigned inputs was analyzed for each successive day in the scenario to determine

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[1] Graham T. Allison, The Essence of Decision: Analysis of the Cuban Missile Crisis (New York: Little Brown and Company, 1971).

whether or not mobilization were preferred to waiting and to determine thereby the first day on which the rational choice of SACEUR would be to prefer and presumably to recommend NATO mobilization.

Such an analysis indicates a single SACEUR lag for a single set of inputs. Uncertainty about what SACEUR's inputs would actually be, combined with any uncertainty about whether or not the SACEUR would, in fact, recommend mobilization at the point in time indicated by a decision-analytic model, leads to a probability distribution instead of a point estimate of SACEUR lag.

1.2.4 A summary of the assessment - The numerical output of the analysis, based largely on the formal rational-choice model, indicates that SACEUR would recommend NATO mobilization approximately 7 days after the Pact started to mobilize and that the NATO countries would approve his recommendation roughly 8 days later. On the basis of this analysis, which should be considered illustrative of a methodology and certainly not definitive, NATO would thus have 15 fewer days for mobilization than the Pact. When uncertainties in the intelligence data are informally applied to the inputs, NATO could have from 9 to 21 days for mobilization.

Although a specified numerical result was developed, the principal output of the study was the development of an analytical tool for exploring key factors bearing on mobilization lag rather than any specific estimate of its magnitude.

2.0 A SACEUR RATIONAL-CHOICE MODEL

The rational-choice model described in this section of the report uses decision-analytic techniques to predict when SACEUR would recommend full NATO mobilization. Decision analysis is a recently developed technique of which the essential property is that, if a decision maker's judgments of probability and utility have been accurately measured, the best decision is logically implied. A fuller discussion of decision-analytic techniques employed in the study is presented in Appendix A.

While the primary use of decision analysis is to help individuals make reasoned decisions, the technique may also be used to predict what decision a rational third party would make. In the case of this study, decision analysis is used to predict how a rational SACEUR would act in the event of a confrontation by Warsaw Pact countries.

2.1 Structure of the Model

2.1.1 Essence of the SACEUR rational-choice model - The essence of the SACEUR rational choice model is shown in Figure 2-1.

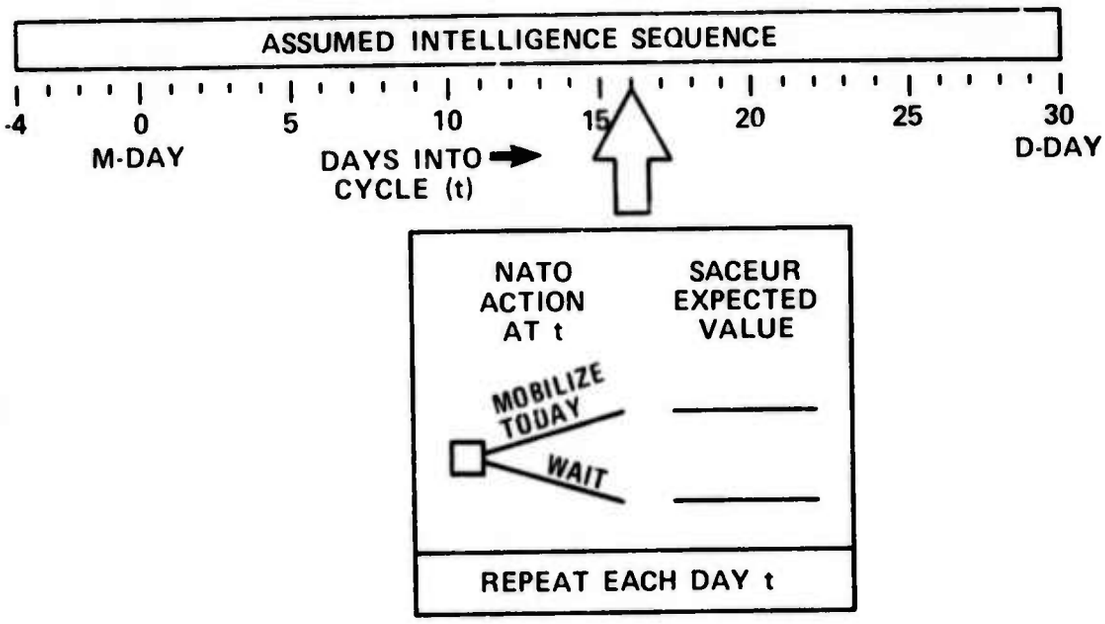

Figure 2-1

ESSENCE OF THE SACEUR RATIONAL–CHOICE MODEL

On any day, t, in the hypothesized Pact mobilization sequence, the model is used to assess the expected value imputed to SACEUR of a decision to recommend that NATO mobilize, that is, to declare a state of reinforced alert on day t rather than to wait and recommend NATO mobilization at a later time. Inputs to the model are time-varying intelligence assessments derived from the given 30-day confrontation scenario. These include answers to the question: "On day t, what is the likelihood that the Pact is mobilizing to attack?" and assumptions about the value judgments of a hypothetical SACEUR which answer the question: "If NATO mobilized today but the Warsaw Pact is not mobilizing to attack, what is the cost of this false alarm?"

The block in the center of Figure 2-1 indicates the decision that must be made each day. The decision-theoretic process used to make this decision involves the comparison of an assessed, expected value for immediate NATO mobilization ("mob today") with an assessed, expected value for deferring a NATO decision to mobilize ("wait"). On each day, t, in the mobilization cycle (wherein the t=0 is Pact M-day), this process is repeated in light of all intelligence information available at that time. If the initial decision (at t=-4) indicates a higher expected value for "wait" than for "mob today" and if the intelligence sequence indicates an increasing likelihood of a Pact attack as t increases, then the expected value of "mob today" will be greater at some point than the expected value of "wait." This is the point in time when immediate mobilization is first preferred to waiting and is hereafter referred to as the cross-over point. The objective of this analysis is to determine when this cross-over will occur after Warsaw Pact M-day.

2.1.2 A possible, complex SACEUR rational choice model - The essence of the decision process presented in Figure 2-1 is the assessment of an expected value for each of the decision options ("mob today" and "wait") as the intelligence sequence unfolds day-by-day. This assessment can be done directly but would be a difficult judgmental task. Instead, consideration was given to the question of how a manageable decision diagram could be used to derive these expected values. An unacceptably complicated but essentially complete decision diagram was simplified in several stages to develop a manageable model.

A detailed rational choice model in schematic form incorporating all possible eventualities is shown in Figure 2-2. This schematic form is further explained in Appendix A.

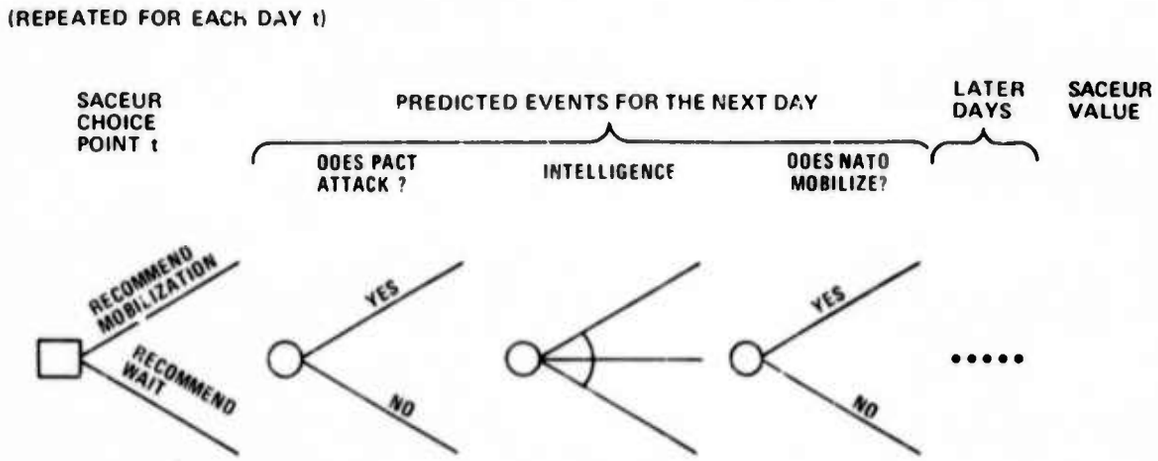

Figure 2-2

POSSIBLE, COMPLEX SACEUR RATIONAL–CHOICE MODEL

The choice facing the SACEUR on any day, t, is to recommend mobilization on that day or to wait. This choice is represented by the decision node, □< , at the left of Figure 2-2. The figure indicates that the expected value of each option is determined by a number of uncertainties which are shown to the right of the decision node. When events are described by a fan, ○<, a continuous variable representing the possible events must be assessed. When events are described by a fork, ○<, a discrete number of possible events must be assessed. In order to use this model, probabilities and values must be assigned to each possible sequence of events to the right of the decision node. An expected value is then calculated for each initial decision option ("mob today" or "wait") by "folding back" the decision diagram, as described in Appendix A.

To calculate the foregoing expected values for any day, t, the model requires, as inputs, predictions of Pact behavior, intelligence received, and NATO response for each day subsequent to day t. That is, given only the intelligence information up to day t, predictions in the form of probabilities are required in response to the following questions:

- Will the Warsaw Pact countries attack on day t+1, t+2, t+3...?
- What intelligence might be received on day t+1, t+2, t+3...? and
- What will NATO do (mobilize or wait) on day t+1, t+2, t+3...?

Implementation of such a model would require assessments of unmanageable complexity involving literally millions of possible sequels to each of the immediate options (mobilize or wait). This is clearly an unacceptable degree of disaggregation in the model. The problem is then to see whether or not a less complex, more aggregated model can be found to capture the essence of the probable outcome of either choice.

2.1.3 The first simplification - Figure 2-3 depicts the first step in reducing the complexity of the original model.

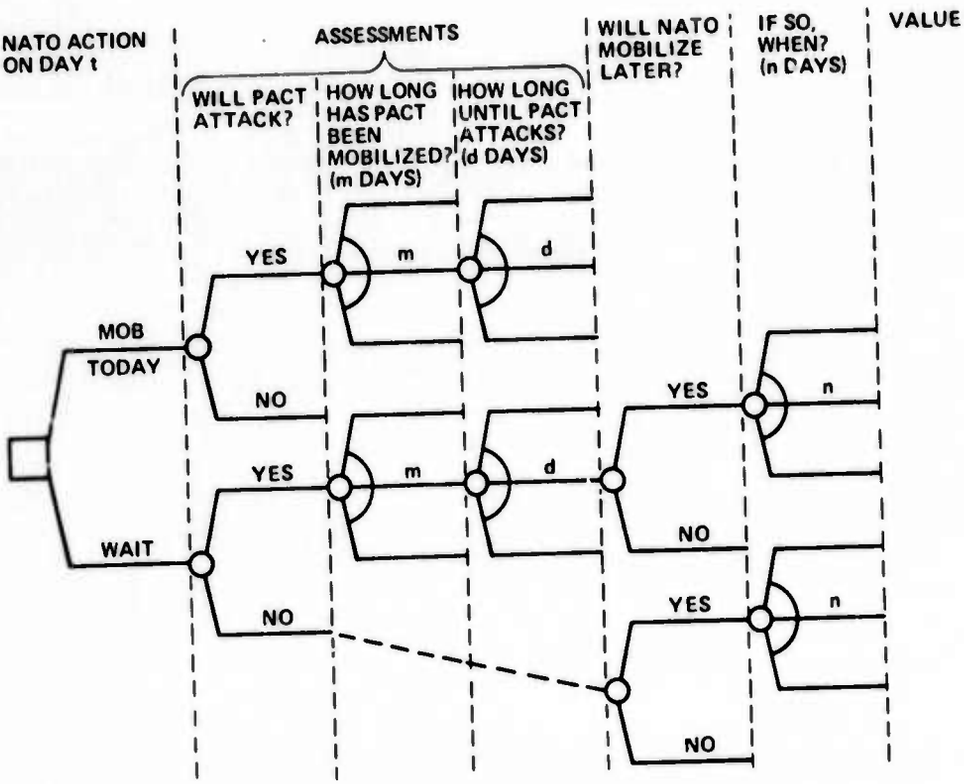

Figure 2-3
FIRST SIMPLIFICATION

The many uncertainties reflected in Figure 2-2 have been summarized in terms of five variables. Although the scenario specifies that the Pact's intention is to attack, SACEUR is not assumed to know its intention. Consider first those events which affect the outcome of a decision to recommend mobilization today. The first of these events is whether or not the Pact will attack. If the Pact is going to attack, the outcome and associated value of a decision to mobilize on day t is determined in part by the relative readiness of the Pact and NATO forces on D-day. This consideration is reflected in the assessments of how long it has been since Pact mobilization started (m) and how long it will be until the Pact attack occurs(d). The sum of these assessments will not necessarily equal the actual duration of the Pact mobilization cycle (30 days) because its duration is unknown. If, on the other hand, NATO mobilizes but the Pact does not attack, then the outcome of the decision is reflected in the cost of a false alarm. (It should be remembered that this model does not address the possibility that the Pact may be influenced by NATO actions nor does it distinguish among different Pact attack plans.)

If SACEUR's choice on day t is to wait rather than recommend immediate mobilization, then, as before, the first unknown affecting the outcome of that decision is whether or not the Pact is going to attack. If the Pact is going to attack, relative capabilities are reflected in assessments of how long the Pact has been mobilizing and how long it will be until the Pact does attack.

Since the decision to wait is essentially a hedging action, which retains the option to recommend mobilization later, relative readiness is also a function of whether or not NATO mobilizes at some future time and, if it does, when. Thus, it is necessary to estimate the likelihood of this possible future action and the point in time at which it might occur in order to assess the outcome of the decision to wait if the Pact is going to attack. In this case, SACEUR's preference for NATO mobilization at a later point in time is being modeled. Whether or not NATO actually does mobilize and when it mobilizes is not a choice that the SACEUR controls directly; accordingly it is treated as an event. If the decision is made to wait and the Pact does not attack, then the outcome of the decision is determined by whether or not NATO mobilizes at some later time, not by when NATO mobilizes, if it does.

It is very important to keep in mind that the assessments required by the model are those of a hypothetical SACEUR; they are based upon his perception of the situation

at time t. Thus, as time progresses and more information becomes available, these assessments, as well as SACEUR's perception of the situation, change. Because of these changes, a separate set of assessments is required for each day of the Pact mobilization cycle. Although the number of assessments is smaller than those described in Section 2.1.4, a further simplification is needed before the rational-choice model becomes a usable tool.

2.1.4 The final simplification - The model finally retained for day-by-day quantification is shown in Figure 2-4.

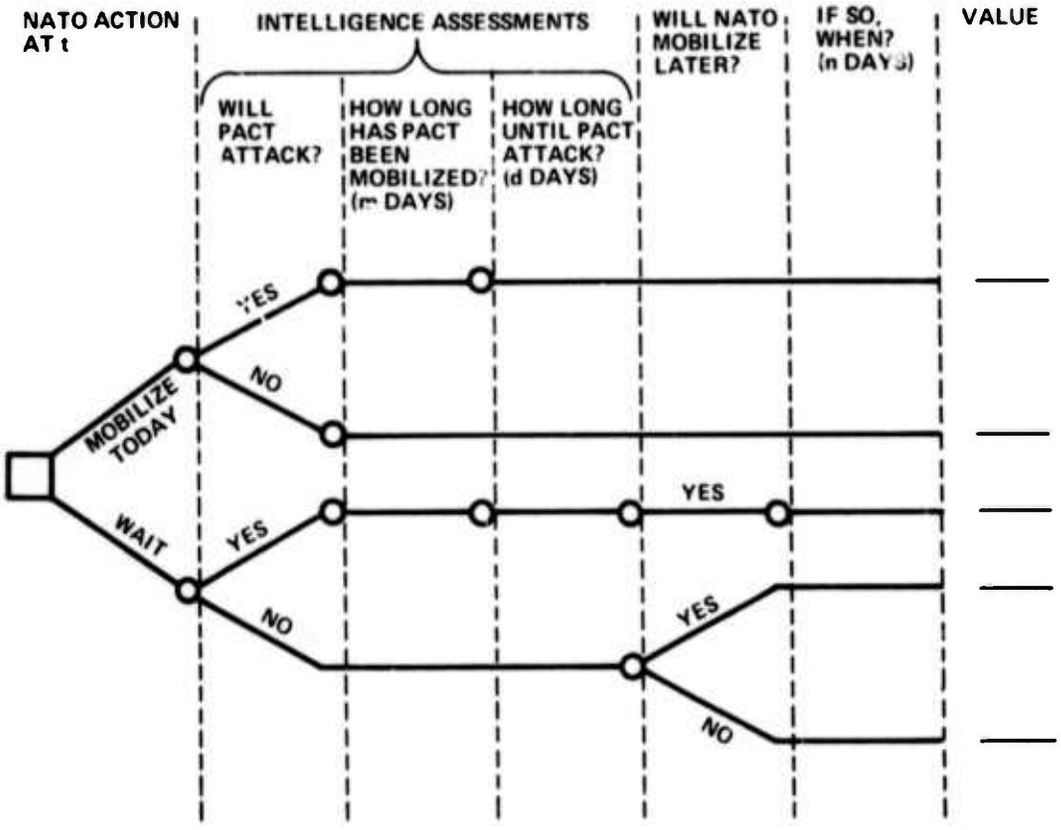

Figure 2-4
SIMPLIFIED MODEL

Essentially, it involves eliminating explicit consideration of particular uncertainties shown in Figure 2-3. A single point estimate for m and d (time since M-day and till D-day) replaces the probability distributions required in the previous model.

In order for this model to be a legitimate simplification, the point estimates need to be interpretable as "certainty equivalents," that is, values which lead to the same results as the more complete probabilistic assessments of the variables. There is no guarantee that simply picking a most probable value (or a mean or a median) will have this property. However, a cautious and unverified judgment is that the approximation is adequate. Likewise, a point estimate, rather than a distribution, is made of n, the delay until NATO mobilization (if the decision at time t is to wait). If the Pact is not planning to attack, the occurrence of a NATO mobilization is important and its probability is assessed, but the timing of such mobilization is of much less consequence and is not assessed.

2.2 Inputs to the Model: Judgments

The task is now one of assigning numerical values required by the simplified model on each successive day, t, so that they will model as closely as possible what SACEUR's judgments and assessments might be. Obviously, there is no way of knowing for sure just what assessments of values would best describe any of SACEUR's judgments at any particular time, t, in the mobilization cycle. It is impossible to be certain about the inferences that any particular SACEUR will draw from a specific intelligence pattern, generated by a particular scenario, or the manner in which the SACEUR will evaluate the relative attractiveness of possible outcomes. Furthermore, one cannot be sure that SACEUR will process his perceptions according to the logic prescribed herein. Thus, it is impossible to know the exact extent to which a particular SACEUR's choice would agree with the model output. However, by assigning some carefully chosen inputs, the output may yield valuable insights into SACEUR's decision process and provide an anchor point on which a probabilistic assessment of SACEUR lag can be based.

It should be noted that the model purports to evaluate SACEUR's preference for NATO's mobilizing or waiting at time t. This is not exactly the same as evaluating a decision to recommend NATO mobilization which SACEUR might recommend earlier, if he expected delay while NAC acted on his recommendation.

2.2.1 Assumed intelligence sequence - Although it would be possible to assign probabilities and other model inputs for each day, t, without reference to any specific flow of information, making so many assessments would be a difficult task. Instead, a specific sequence or script of intelligence information was postulated. Then intelligence experts selected to be surrogates for the SHAPE Intelligence Staff were provided new information from that script for each day, t, and assessed the model inputs for the entire

mobilization cycle. These daily intelligence inputs were selected as being representative of the kind of data one could reasonably expect to have available as Pact mobilization activities progressed toward D-day. Admittedly, in a real situation, there would be more data, much of which would be conflicting and some of which would be irrelevant. Even though the interpretation process would be more complicated, the daily estimates which constitute the intelligence inputs would not be materially different.

During this study, six analysts provided certain model inputs for each day in the mobilization cycle. Specifically, for each day, t, the analysts were given the information available from the postulated intelligence sequence and the assessed probability that the Pact would attack and, if it did attack, the number of days (m) that it would have been mobilizing at time t(m) and the number of days (d) until the attack.

The actual numbers used as inputs to the model reflect the combined assessments of the group of analysts. However, the assessments by individual analysts were reasonably consistent and reflected the kind of moderately cautious evaluation to be expected in a real situation.

2.2.2 Assessment of Pact actions - Figures 2-5 and 2-6 show the actual model inputs obtained from the intelligence sequence after the interpretations of the individual analysts were combined and smoothed. Figure 2-5 indicates how the probability assessed for a Pact attack increases from 11% at day t=-4 (February 1) to 98% at day t=29 (March 6) in response to the assumed intelligence sequence. The probabilities are displayed on a logarithmic scale for practical reasons. Use of the logarithmic scale ensures that equally diagnostic information will result in upward movements which are equal in length.[2]

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[2] Handbook for Decision Analysis, chs. 2 and 12 (McLean, Virginia: Decisions and Designs, Incorporated, 1973).

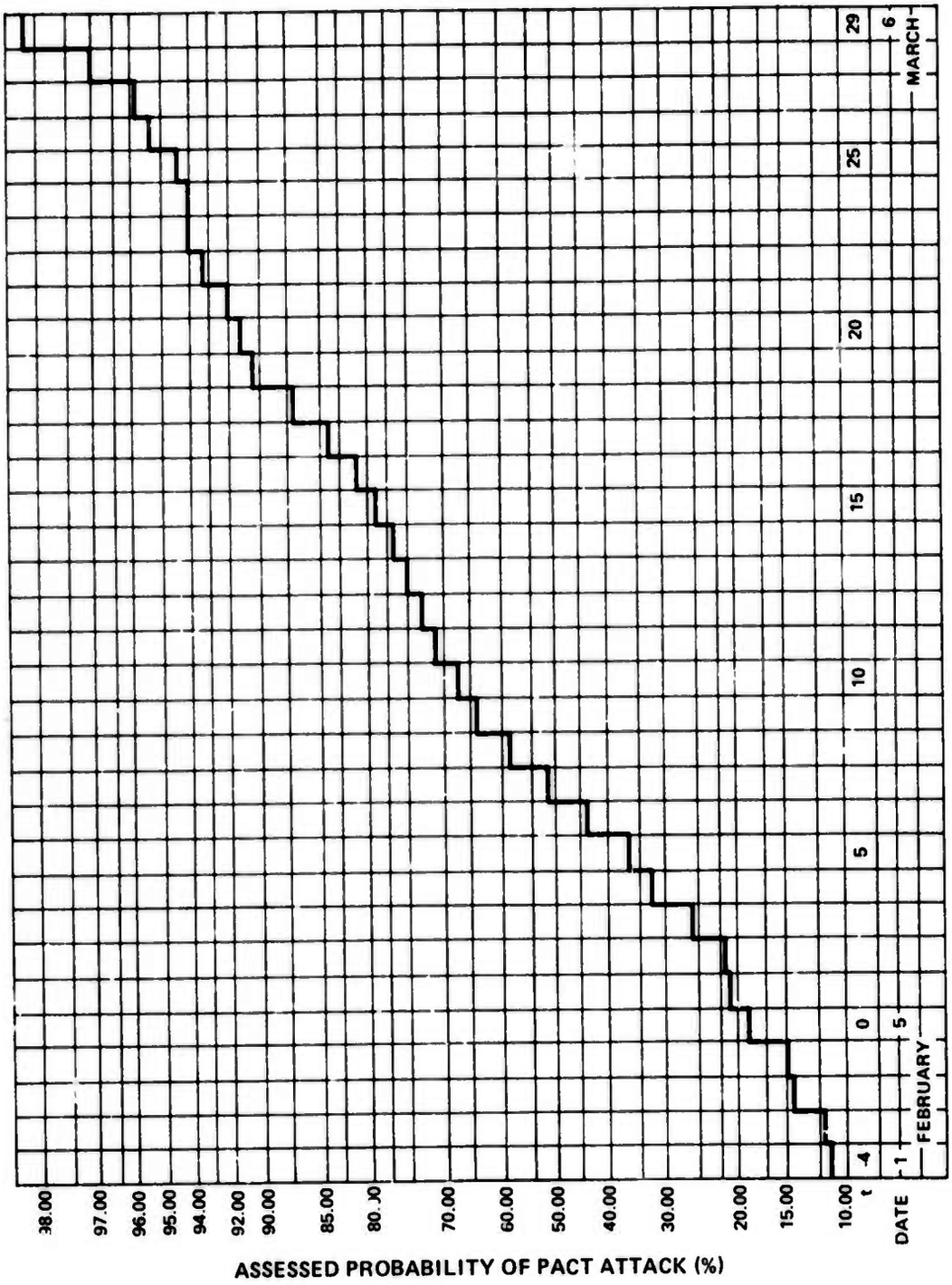

Figure 2-5
ASSESSED PROBABILITY OF PACT ATTACK

Figure 2-6 displays the pooled estimates of both the number of days since Pact mobilization (m) and the number of days until Pact attack (d) as functions of t. The graphs are predictably monotonic since the further one is into the Pact mobilization cycle, the further one estimates that he is into the cycle and the less time that he estimates remains in the cycle.

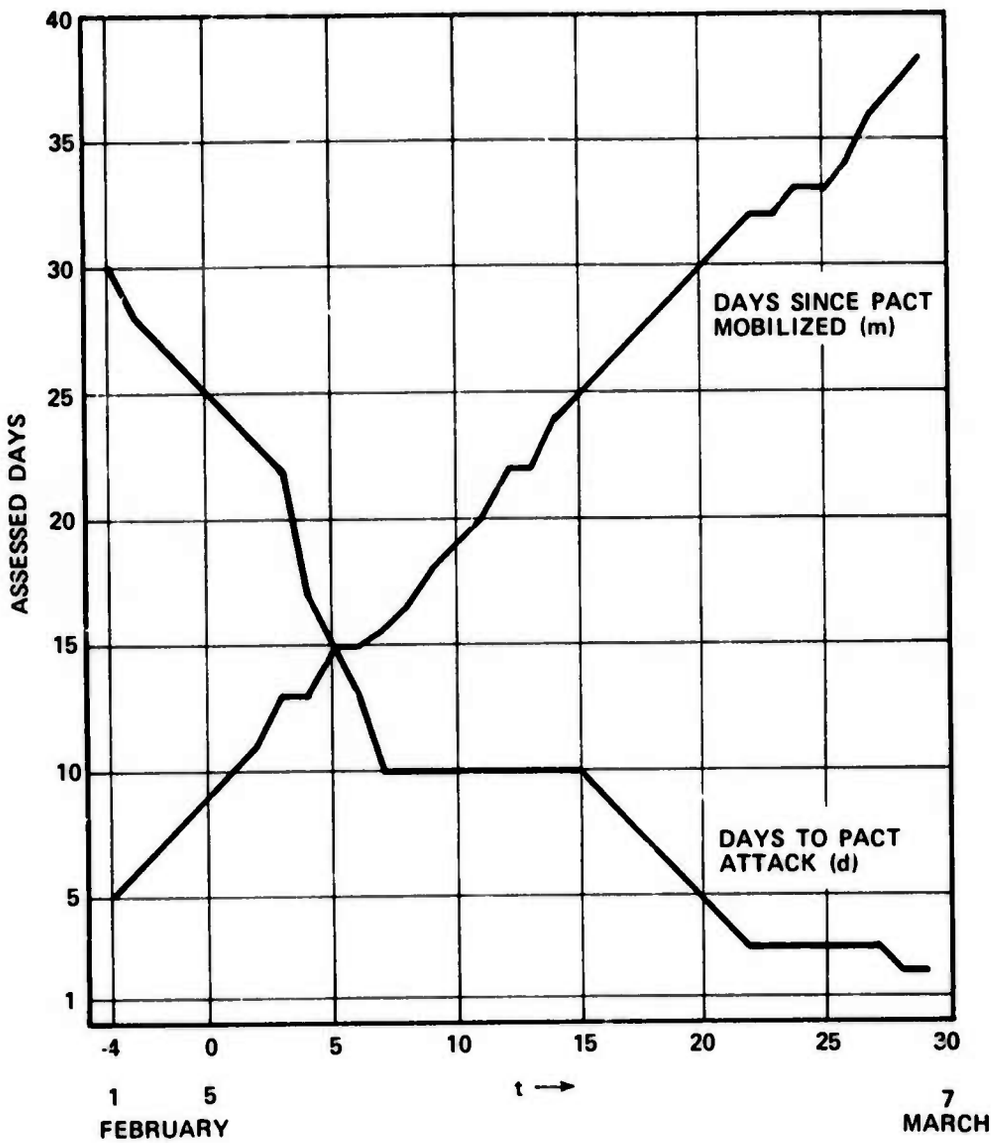

Figure 2-6

ASSESSED DAYS SINCE PACT MOBILIZATION AND UNTIL ATTACK

2.2.3 Prediction of later NATO mobilization - In addition to the input values already assessed, the "predicted later NATO mobilization" (n) must be assessed. This input is the predicted number of days between day t and the day that NATO actually mobilizes, if it does not mobilize on day t.

Figure 2-7 presents the estimate of a defense specialist with respect to n as a function of d. Since d is the number of days assessed until an attack, then as d increases, so does n. Figure 2-7 provides input to the model for any day t when value of d for that day is first obtained from Figure 2-6.

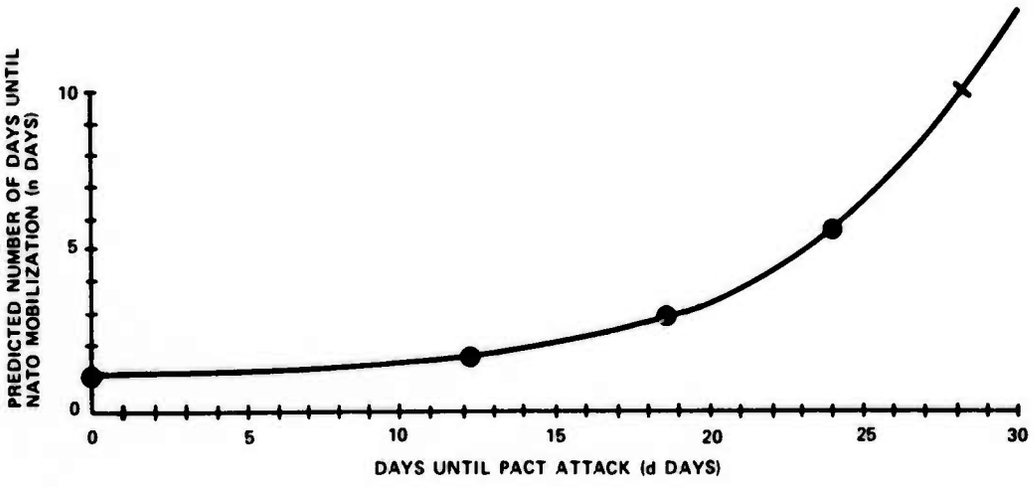

Figure 2-7
PREDICTED LATER NATO MOBILIZATION

2.2.4 Value assessment - Given the selected scenario, individuals with significant military command and intelligence experience provided the numerical values for the inputs to the model. In general, a decision analysis of the type described in this report requires that all possible outcomes which are represented be evaluated on a relative utility scale. However, all that is necessary is that the best and the worst outcomes be assigned arbitrary values, say zero and 1,000, and that all intermediate outcomes be located between these extremes in a way which reflects their relative attractiveness to those involved in such an analysis.

This evaluation was performed at two levels, namely, that of a coarse evaluation of the entire range of possibilities and that of a fine evaluation within a portion of that range. Out of the entire range of possibilities, the following four specific outcomes were examined:

- Neither Pact nor NATO mobilization (a continuation of the status quo). This outcome was determined to be the most preferred outcome and was assigned a value of 1000 utiles;

- Pact mobilization for a full 30 days but no NATO mobilization (a surprise attack situation). This outcome was determined to be the worst possible and was assigned a value of 0 utiles;

- Pact mobilization for a full 30 days and NATO mobilization for a full 30 days (full NATO readiness at the time of attack). This outcome, while better than a surprise attack, is not nearly so attractive as the status quo outcome or the outcome involving no war. However, from the standpoint of attractiveness, this outcome was determined to be closer to the surprise attack outcome than to the status quo outcome in the ratio of 1:9 and thus received a value of 100 utiles. Therefore, the value of full readiness (the difference in value between surprise attack and full readiness) is 100 utiles; and

- No Pact mobilization but NATO mobilization (a false alarm). The value of this outcome was assessed by comparing the value of avoiding a false alarm (the difference between the value of a false alarm and a status quo situation) to the value of full readiness. The value (imputed to SACEUR) of avoiding a false alarm was assigned 1/20 the value of full readiness. Thus, the value of avoiding a false alarm was determined to be 5 (or 1/20 x 100) and this outcome was accordingly valued at 995 utiles (1000 - 5).

These four outcomes and their relative attractiveness is reflected in Figure 2-8.

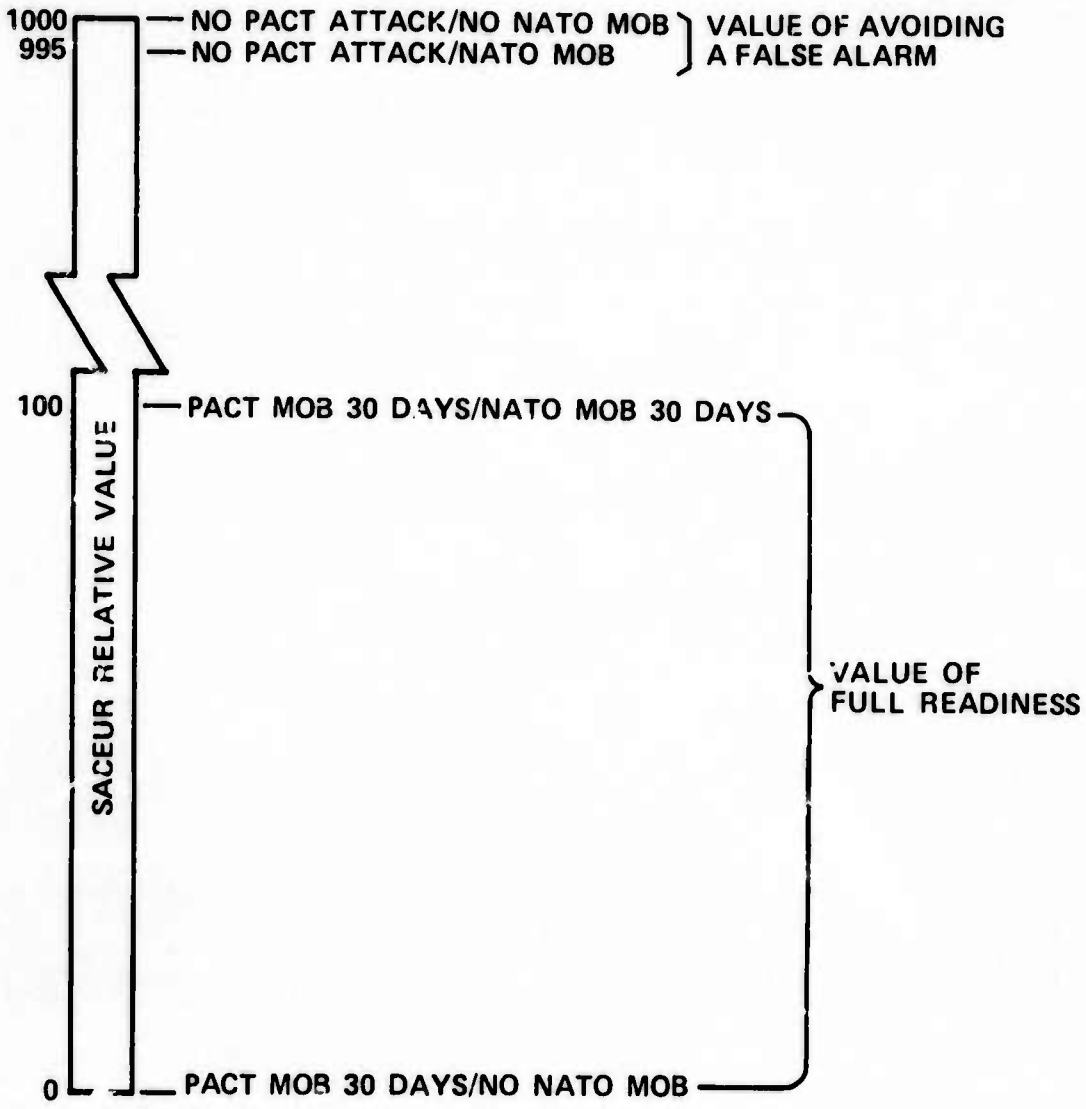

Figure 2-8
SACEUR VALUE SCALE

Although these evaluations are based on informed judgment, they are, nevertheless, controversial; there is certainly no guarantee that SACEUR would actually subscribe to them. The question of how concerned SACEUR might be about the possibility of a wrong decision by NATO to mobilize is of course, difficult to evaluate. SACEUR might believe that, after one or two such false alarms, there would no longer be a politically viable NATO. Or he might believe that a false alarm carries a negligible penalty with it.

He might reason that if, after a period of tension and a series of increased stages of alert, NATO decided to mobilize fully, and if the Warsaw Pact did not attack, NATO would be credited with having discouraged an attack, regardless of whether or not the Pact had planned one.

Although the question of the value of avoiding a false alarm is controversial, it is critical to the output of the model and is material to the decision process; that is, the output of this specific model (as discussed later in Section 2.3) is almost entirely determined by the ratio of the value of avoiding a false alarm to the value of full readiness. The higher the ratio, the more seriously SACEUR judges the risk of a false alarm compared to a surprise attack and the later he opts to have NATO mobilize. Figure 2-8 indicates that ratio to be 1:20. The ratio would be unchanged if the upper two utiles were shifted from 1,000 and 995 to 200 and 195 respectively, and the analysis would not be materially affected.

At the finer level of evaluation, the values of different degrees of readiness in the event of a Pact attack are assessed in Figure 2-9. Each curve represents a different total assessed Pact mobilization cycle (m+d) varying from 20 days to 35 days, and the points on each curve indicate the value of varying the number of days of NATO mobilization at the time of attack (d-n) for the given Pact cycle. The points on each curve correspond to valuations actually made by experienced military personnel, with the remainder of the curve smoothed through them. The point circled on Figure 2-9 indicates that if the Pact attacks after mobilizing for 20 days and NATO has mobilized for 8 days, the value (to SACEUR) is 83 on the scale.

It should be noted that the value of a surprise attack is always evaluated at zero and the value of full readiness is always evaluated at 100, regardless of the total number of days in the attack cycle. Any outcome of less than full NATO readiness, of course, has a value of less than 100. The shapes of the curves reflect judgments that NATO readiness increases sharply in the first few days of mobilization and that the degree of flattening immediately thereafter reflects logistical problems in the intermediate period.

M and d obtained from Figure 2-6 (where m+d determines the proper curve to use) and n obtained from Figure 2-7 (where d-n is the abscissa) make it possible to use Figure 2-9 to provide inputs to the model at day t.

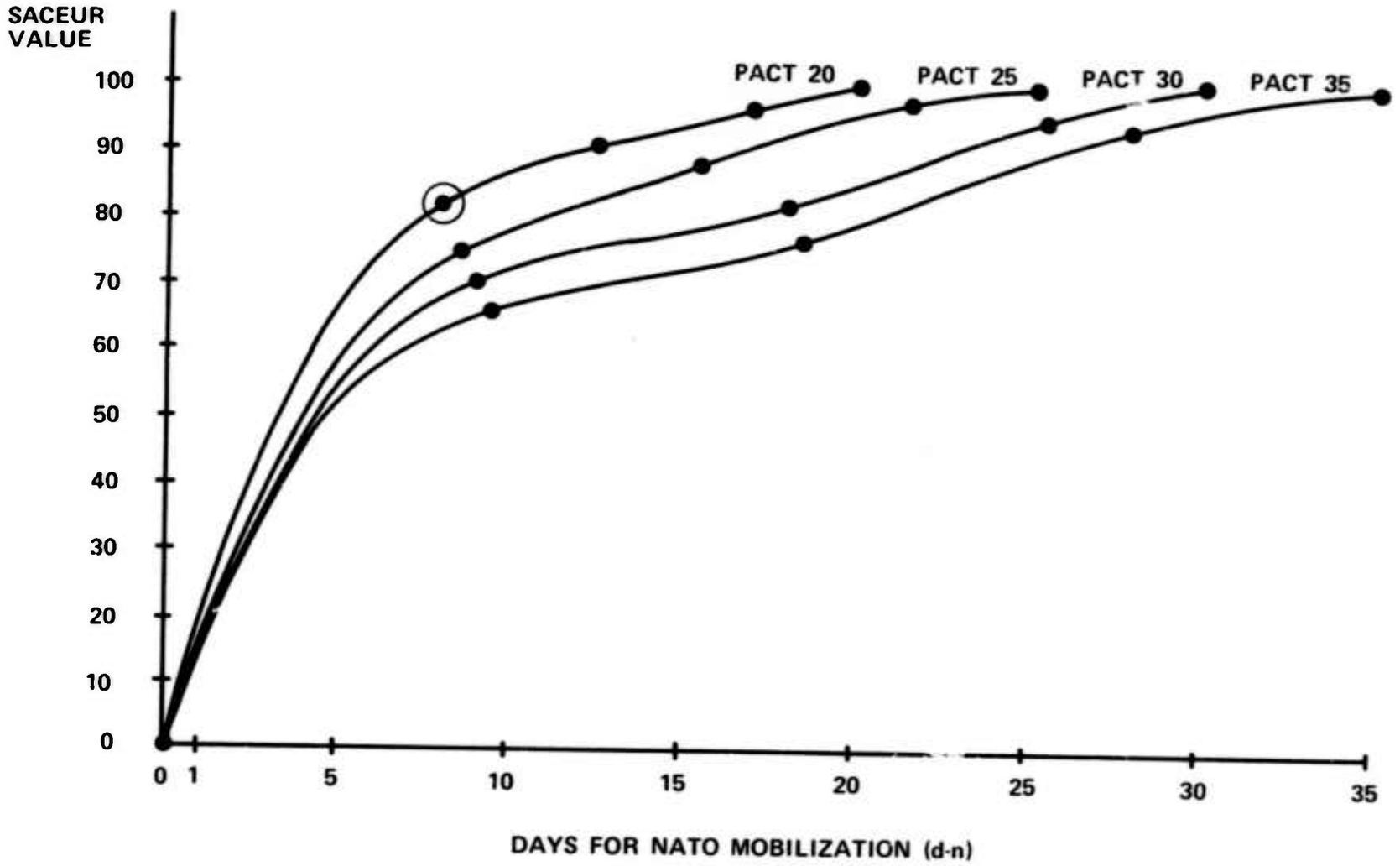

Figure 2-9
VALUE OF DEGREES OF NATO READINESS

2.2.5 Sample sets of inputs - The information developed in Sections 2.2.1 through 2.2.4 makes it possible to solve the decision model shown in Figure 2-4 for each day t. Figure 2-10 shows this process for day t=0 (February 5).

Following the top line of the tree in Figure 2-10, one may observe that the assessed probability that the Pact is planning to attack is .19 (from Figure 2-5). It is assessed that the Pact has been mobilizing for 9 days (m) and will attack in 25 more (d) (from Figure 2-6). In fact, day t=0 is the first day of Pact mobilization, but SACEUR does not know this from the intelligence information available to him at that time. Finally, the value for this outcome is determined to be 89.9 (from Figure 2-9).

The second outcome path in Figure 2-10 represents the false alarm situation and is valued at 995 (from Figure 2-8). Since the estimates of probabilities and of m and d are not judged to be influenced by whether or not NATO mobilizes, these same values are repeated in the bottom part of the tree.

For the third outcome path, it is assessed that, if NATO does not mobilize at day t=0 and if the Pact is going to attack, NATO will nevertheless mobilize 6.9 days later (n) (from Figure 2-7). This outcome yields a value of 77.6 (from Figure 2-9).

The fourth outcome path is the special case of a false alarm. In this case, NATO does not mobilize today and the Pact does not attack, but a 5% chance of NATO's mobilizing later is assessed. This 5% figure is constant throughout the entire cycle (t=-4 to t=30). Since no Pact attack coupled with mobilization of NATO at any time is a false alarm, the outcome is valued at 995.

The final path reflects the maintenance of a status quo and is valued at 1000 (from Figure 2-8).

After folding back the tree (as explained in Appendix A), one may observe that the expected value of a NATO decision to wait at day t=0 is 824.5 compared with 823.0 for a decision to mobilize today. Thus, SACEUR should rationally prefer that NATO not mobilize at day t=0.

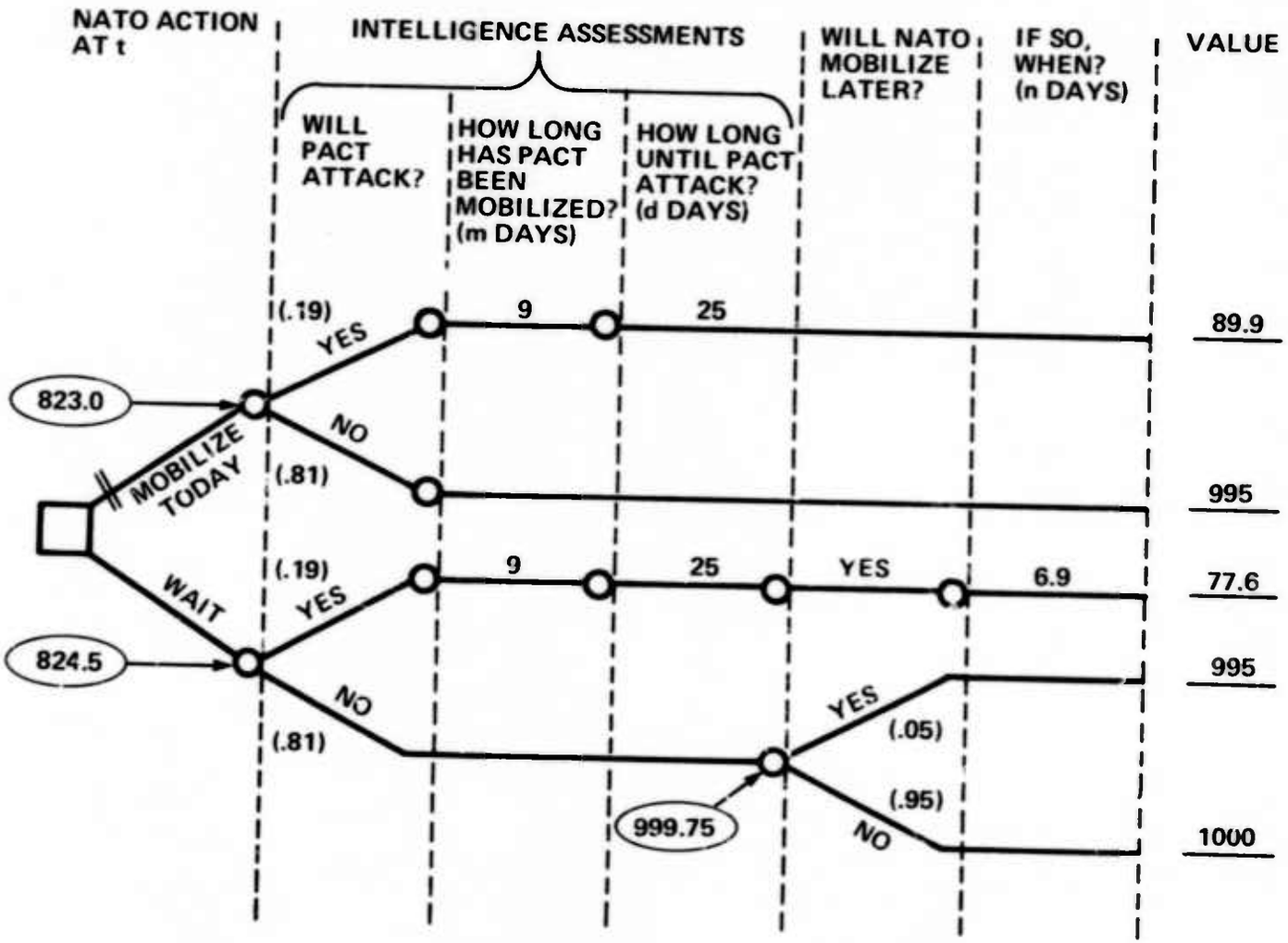

Figure 2-10
SAMPLE INPUT I (t = 0)

Figure 2-11 shows the revised analysis for day t=7 (February 12). By this time, the intelligence received is such that a 53% chance of attack is assessed (compared to 19% at day t=0) and other inputs have changed as well. Largely because of the increased probability of a Pact attack, the expected value of mobilizing at t=7 has now increased slightly above that of waiting. In fact, this is the first day on which mobilization is preferred to waiting.

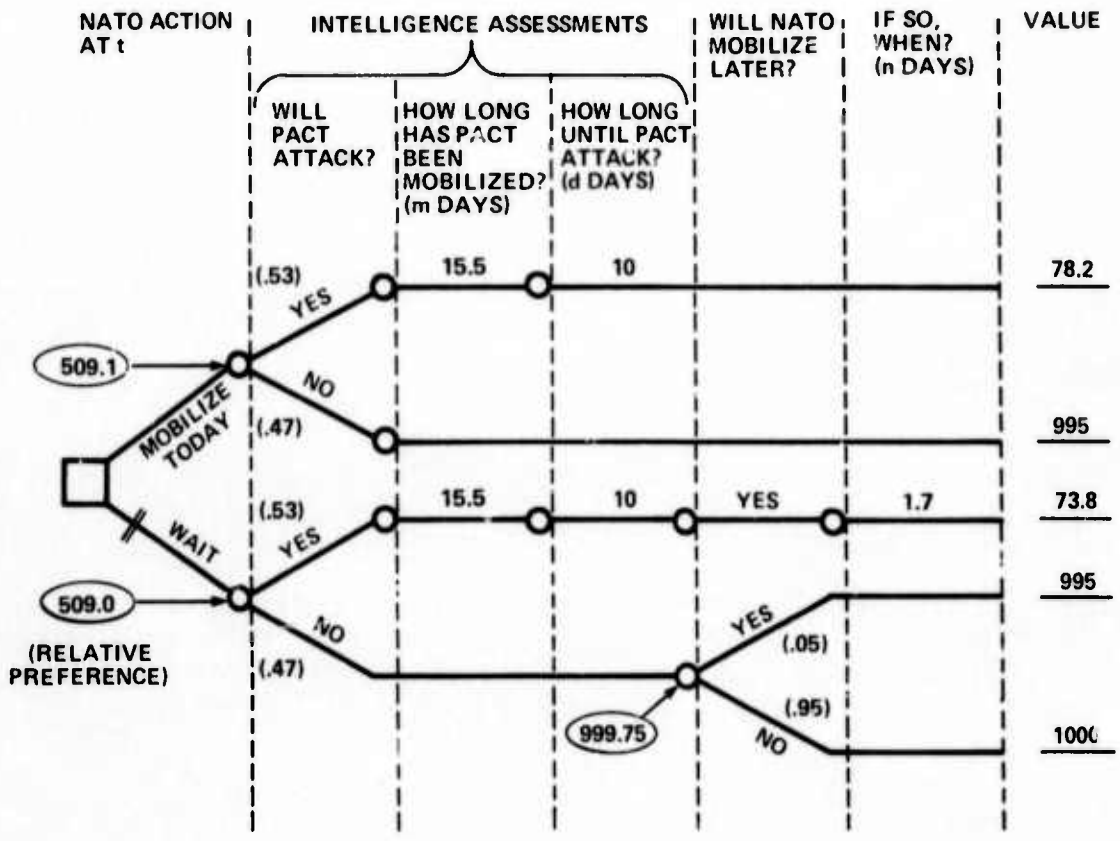

Figure 2-11
SAMPLE INPUT II (t = 7)

The reason that expected values for both mobilization and waiting are substantially lower than they were at t=0 is because the value of a Pact attack is so much lower than that of no attack, and its probability is much larger (regardless of whether or not NATO mobilizes today).

2.3 Outputs from Given Inputs

Applying the analysis exactly as described in Section 2.2.5 for each day t from t=-4 (the beginning of the intelligence sequence) through t=29 (the day before an attack), one obtains the results shown in Figure 2-12. The graph is expressed as the value of mobilization minus the value of waiting so that any value above zero indicates that mobilization is preferred to waiting.

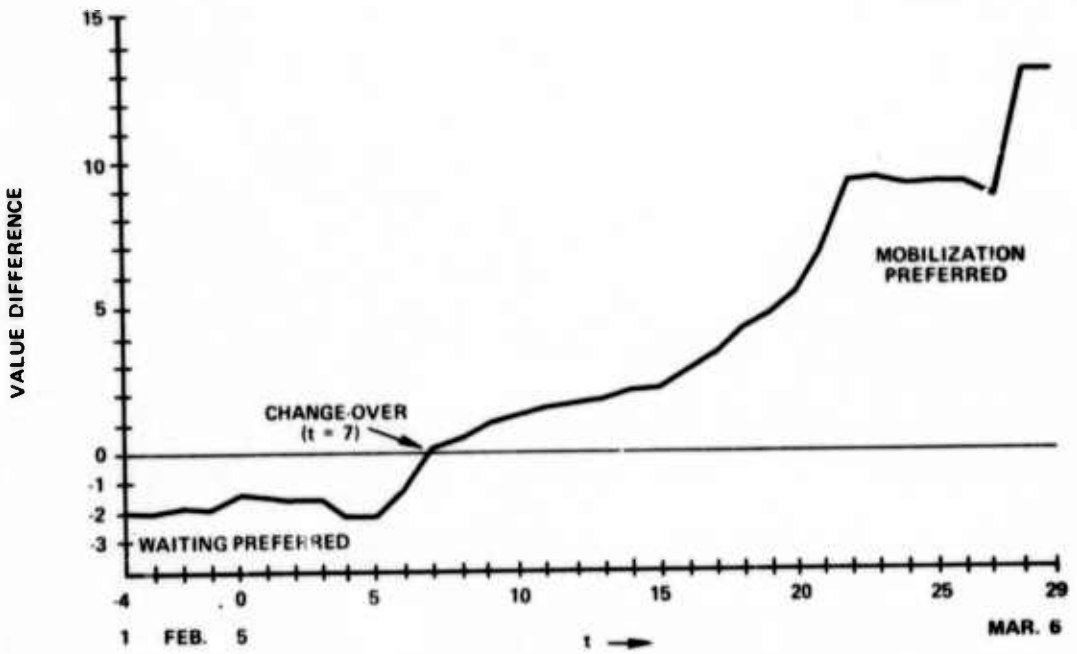

Figure 2-12
MODEL OUTPUT

On the basis of the inputs described in Sections 2.2.1 through 2.2.4, the first day on which mobilization is preferred to waiting is day t=7 (February 12), 7 days into the Pact mobilization cycle. If it is assumed that SACEUR will recommend mobilization to NAC on the first day that he prefers immediate NATO mobilization to waiting, then SACEUR lag is determined to be 7 days.

3.0 ASSESSMENT OF TOTAL MOBILIZATION LAG

The previous section presented a specialized approach using a decision-analytic model to assess the point in time when SACEUR would rationally recommend NATO mobilization. It is now possible to combine the output of this analysis with reasoning of a more informal nature to make an estimate of total mobilization lag bounded by a margin of uncertainty.

3.1 An Assessment of the Timing of NATO Actions Leading to Mobilization

Analysis of the rational-choice model suggests that SACEUR would recommend NATO mobilization about seven days, plus or minus about 2 days, after Pact mobilization had commenced. The same representative intelligence sequence used for the model was presented to a number of intelligence and military experts for a direct assessment of the point in time when SACEUR would recommend mobilization. A majority of them expected a SACEUR recommendation within the same range as that suggested by the rational-choice model and thereby confirmed to some extent the analytical results.

It is worth noting that in a realistic situation, there is a high probability that an accommodation with the Pact would be reached before a decision for full NATO mobilization had been approved and implemented. As the intelligence evidence about the developing confrontation unfolds, SACEUR can be expected to implement timely, authorized, military alert actions in an orderly manner. Such actions, extending over a period of a week or so would condition NATO political elements and provide much of the initial momentum for the decision processes. In such a situation, in effect a test of the NATO deterrent concept wherein failure to act might mean the end of NATO, it is very likely that a settlement would be reached short of both war and full mobilization. This conclusion, of course, assumes that Pact plans and intentions are revocable and that the Pact, having tested NATO resolve, would be willing to divert its preparedness activities to the conduct of a large-scale training exercise in the forward area just prior to returning to a normal peacetime posture.

Assuming, however, that the Pact resolve to attack is not revocable (and this assumption may not be completely realistic), intelligence analysts and other military personnel were asked to give their judgments about how NATO might be expected to react over time. A consensus of their views serves as a basis for a more detailed assessment of total mobilization lag. It develops as follows:

- o 1-5 February (Pact M-5 to Pact M-day): An increased intelligence watch and improved security measures would be instituted;

- o 5-10 February (M-day to M+5): Various stages of increased alert, that is, Military Vigilance and Simple Alert, would be implemented;

- o 10-15 February (M+5 to M+10): Reinforced Alert would be recommended to the North Atlantic Council;

- o 15-20 February (M+10 to M+15): Available intelligence would be reevaluated, new intelligence requested, some mobilization actions taken by certain countries, and Reinforced Alert taken under consideration; and

- o 20-25 February (M+15 to M+20): Reinforced Alert approved by the NATO nations.

3.2 Assessment of the SACEUR Lag

The formal model developed in Section 2.0 assumed that SACEUR would react in the manner specified by the model. In this section, it is worth considering to what extent SACEUR might actually think about the mobilization problem in the same manner that it was structured for the model and to note the impact of any differences on the mobilization date.

Although the model was formulated to represent a consensus of how a typical SACEUR might view a given military situation and how he might respond to it, in reality, different military commanders can be expected to perceive situations differently and to respond to them in a different manner. For example, if SACEUR viewed the Warsaw Pact resolve to attack as revocable, as it might well be in an actual situation, and the NATO decision process as a means of deterring the Soviets, he might be inclined to make an earlier recommendation for mobilization. He would then see an added value in earlier mobilization beyond that of achieving a certain state of preparedness. It would mean that while the model called for a recommendation to mobilize on 12 February (t=7), this particular SACEUR might make an earlier recommendation to the NAC. From intelligence evidence that major Pact troop deployments were taking place for announced exercise activity, SACEUR might attempt to resolve the dilemma between Pact attack and Pact exercise by recommending mobilization three or four days earlier than the model. Recalling the values used for the model, we see that SACEUR would not be too concerned about the possibility of a false alarm as an eventual outcome. In fact, he might

welcome such an outcome in the belief that his early recommendation had persuaded the Soviets to find other means of pursuing their European objectives.

It does not appear that SACEUR would be tempted to act precipitously in a situation in which East-West tensions had been rising slowly over a long time period. Instead, the early, evidential intelligence base suggests that Pact plans and activities are more methodical than feverish, neither requiring nor prompting a rash response.

While it is possible to conceive of a SACEUR reacting sooner than the model date of 12 February (t=7), it is more difficult to visualize SACEUR's delaying more than a day or two beyond 12 February (t=7) for this scenario. One reason is that considerable Pact military preparedness activity is posited as taking place in an area in which intelligence sources are reasonably good.

The first combination of firm and disturbing intelligence concerns unusual supply activity, and it is collected at about the time the Pact starts to mobilize, 5 February. SACEUR can be expected to request special authorizations during this early time period to confirm or deny the reported logistics build-up in the forward areas. But even so, it is difficult to see how the results of these operations would be available much earlier than M+2 or M+3.

In general, SACEUR will be more responsive to intelligence inputs than NAC would be. For example, incoming intelligence evidence that indicated an accelerated Pact mobilization would more likely be recognized as such by SACEUR than it would be by the national authorities of the NATO nations. In particular, SACEUR would draw more effective inferences from poor quality or ambigious intelligence than would NAC.

If some of the more important intelligence inputs were not collected until later, SACEUR's recommendation would doubtlessly be delayed. However, a large number of observable preparedness actions will be part of any 30-day mobilization scenario. Information about some of these will always be collected, albeit in a different order and perhaps later than in this analysis.

In summary, it is believed that SACEUR could react as early as M+3 or M+4 (see Figure 3-1) but not later than M+9. It appears also that there would be less SACEUR lag than

NAC lag and that estimates about SACEUR lag are less uncertain than those about NAC lag.

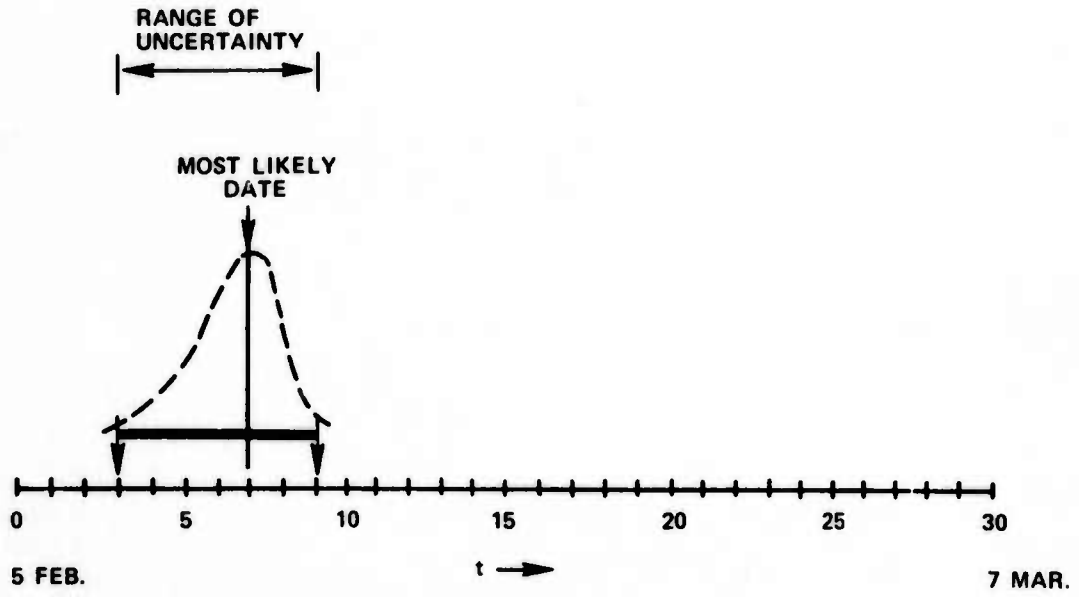

Figure 3-1
PROBABILISTIC PREDICTION OF SACEUR RECOMMENDATION

3.3 Assessment of the NAC Lag

3.3.1 Background on NATO processes - Some military experts believe that complete, full mobilization of NATO would mean World War III and that the ultimate decision would, in any case, be made by the United States. They conceptualize NATO as a political-military organization oriented primarily to prevent a full-scale war in Europe. Accordingly, while the alerting system is complex, it is also a deliberate, step-by-step process designed to demonstrate a strong NATO resolve in the face of a developing Warsaw Pact threat. However, if NATO were to go through each stage of increasing alert toward complete mobilization, a condition would be reached from which NATO could not very well retreat without a significant accommodating response on the part of the Pact. It can be inferred that there would be some delay in any final NAC decision to mobilize.

In contrast to SACEUR, who can be assumed to act in a logical manner as approximated by a rational-choice model, the NATO process will be heavily influenced by a

variety of complex political and bureaucratic considerations which do not permit it to be treated as a rational unitary decision maker.[1] NATO is a loose federation of nations vitally concerned about their sovereignty and all painfully aware that increases in alert postures and mobilization measures involve costly civil as well as military consequences. Some stages of alert, for example, impact on such segments of the economy as rail and barge traffic and the allocation of POL reserves. The proximity of a NATO country to the developing threat and the influence of that country on other NATO nations affect the decision process. The nature of the current political structures within key NATO nations is, of course, a factor. A less stable government may have greater reservations about the possibility and consequences of military action as an outcome than a more stable government.

3.3.2 Assessment of NAC lag with a given intelligence sequence - In the first instance, we should consider the situation in which intelligence input occurs according to the sequence specified in Appendix A and used for the judgments outlined in 3.1. As the intelligence evidence about the developing confrontation unfolds, SACEUR can be expected to implement timely, authorized, military alert actions in an orderly manner. Such actions, extending over a period of a week, would serve to condition NATO political elements and provide much initial momentum for the NAC decision process.

If, as given in the confrontation scenario, the Pact resolve to attack is irreversible and and war inevitable, it is possible that certain NATO countries would not be fully committed to formal mobilization when the attack started. But neither would NATO have backed down; as a result of partial mobilization and certain authorized military actions taken by SACEUR, most of the national forces of the major countries would be in an advanced stage of readiness. Although the scenario specifies considerable pre-attack Soviet naval activity in the Mediterranean and Baltic, the main Pact thrust appears to be planned for the central region of NATO. The nations most sensitive to this and the order in which they would most likely respond are Germany, France, the Benelux countries, and the U.K. Based upon the postulated intelligence situation, a state of Military Vigilance could be expected about 8 to 10 February and a recommendation for Simple Alert approximately 48 hours later.

These NATO countries would begin to receive from their national intelligence sources information about

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[1] Allison, op.cit.

military activities taking place in East Germany and the call-up of reserves in the Soviet Union. A few days later, evidence of more explicit Warsaw Pact pre-attack preparations would become available during the period 13 to 16 February (M day +8 to 11) after U.S. and U.K. Embassy personnel in Moscow were arrested by Soviet authorities. (Recall that we have argued in Section 2 that SACEUR would recommend mobilization around M+7 on the basis of this intelligence sequence.)

After 15 February (M+10), civil and military preparedness alerting actions would be initiated in some of the central NATO countries. Information concerning activities in the Pact area would become available on 15 February. By 18 February (M+13), these central European NATO nations would have reacted by initiating many important national civil and military actions called for in a declaration of Reinforced Alert.

Additional intelligence received two days later (M+15) concerning the movement of Soviet divisions into the forward area would almost certainly lead to the equivalent of Reinforced Alert within a day or two. On the basis of this intelligence, NAC's lag can be assessed as approximately 10 days after the SACEUR recommendation. (See Figure 3-2).

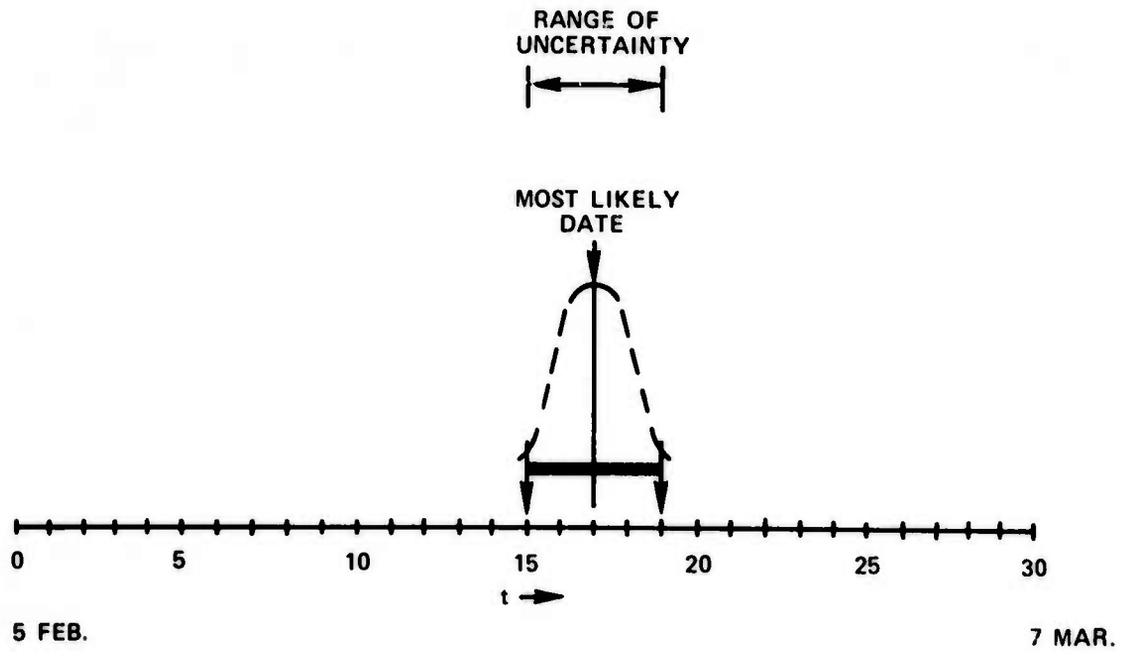

Figure 3-2

NATO MOBILIZATION DATE FOR A SPECIFIED INTELLIGENCE SEQUENCE

Direct assessment suggests, therefore, that NAC would decide to mobilize about 17 days after the Pact had started. That is, when the Pact attacked after mobilizing for 30 days, the state of NATO's readiness would be the equivalent of 13 days of mobilization plus certain military actions that SACEUR had taken during the 10-day period between his recommendation and NAC's decision to mobilize.

3.3.3 Assessment of NAC lag with varying intelligence sequences - The above analysis assumes a specific sequence of intelligence inputs. NAC's decision process will, in fact, be dependent upon not only the quality of the intelligence, but also its time of arrival.

In the sequence analyzed above, all of the intelligence data is reasonably relevant and arrives in a timely and sensible manner. Fairly clear evidence of Pact preparations to attack becomes available about M+10 (three or four days after we estimate that SACEUR's recommendation to mobilize is made to the NAC); at this time, the NAC decision process would begin in earnest. By 20 February, or about eight days after the SACEUR recommendation (M+15), most of the essential intelligence needed to support a decision would be available. The same 30-day irrevocable confrontation scenario could, however, generate intelligence on a schedule which either accelerated or decelerated the NATO mobilization process.

Some of the major uncertainties surrounding the intelligence data can be examined by reviewing when and how the data were collected. For example, there are approximately 15 relevant intelligence inputs that would not necessarily arrive in the same timely and orderly manner as postulated.

As noted in Figure 3-2, a mid-point for NAC's decision was originally estimated at about 22 February (M+17), or approximately 10 days after the predicted SACEUR recommendation. If the intelligence sequence is modified, for example, by assuming that selected items of intelligence information are all available at the earliest collection opportunity, NAC's decision could conceivably be reached as soon as 14 February (M+9). However, if those data are not collected in a timely manner and if reports on forward deployment and dispersal are delayed several days, NAC's decision could be delayed until 25 or 26 February (M+20 or +21). The variation in NATO mobilization is shown in Figure 3-3.

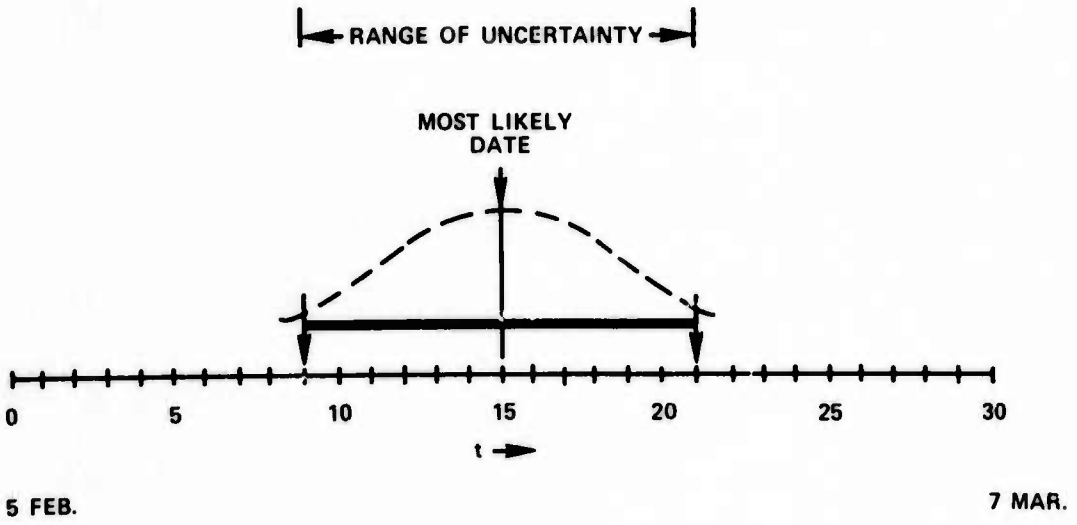

Figure 3-3

NATO MOBILIZATION DATE
WITH VARYING INTELLIGENCE SEQUENCES

3.4 Overall Results and Limitations

The combined results of assessing SACEUR's decision lag and NAC's decision lag with a varying intelligence sequence is shown in Figure 3-4.

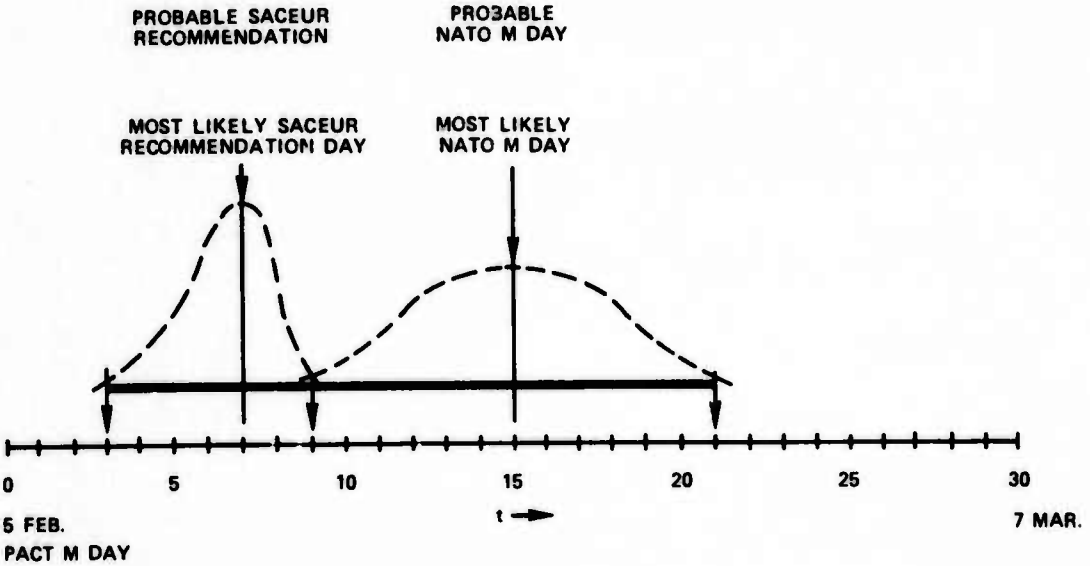

Figure 3-4

ASSESSMENT SUMMARY

This study is limited to providing an improved prediction of mobilization lag in the event of a specific confrontation scenario. A succession of comparable studies would be required to permit generalization beyond this particular scenario. Such studies should include scenarios with different Pact mobilization cycles and, more important, scenarios indicating that Pact behavior may be influenced by NATO behavior.

A number of limitations in the applicability of the decision model should be noted. In the first place, the prediction, even for the given scenario, is anchored to a rather restrictive set of assumptions, later relaxed by informal judgment. For example, the SACEUR rational-choice model assumes that SACEUR will think the way our model prescribes and that his judgments will be those we attribute to him. Nevertheless, our model can accommodate different judgments about SACEUR's assessments and value system though a computerized model would be needed to make the model completely effective.

Another recognized limitation is the fact that there is more to NATO readiness in the event of a Pact attack than the simple mobilization lag which has been modeled. Clearly there is a difference between a situation in which NATO goes into a state of reinforced alert directly from complete unpreparedness to one in which a gradual build-up leading to reinforced alert takes place. In the latter case, as a result of many actions that would be taken by military authorities, NATO readiness would be substantially greater, but our model as now formulated would not necessarily show it.

The intelligence inputs used for the SACEUR rational model were obtained from analysts who based their estimates directly on the written scenario. In a live situation, these inputs would reflect a combination of SACEUR's personal judgments and the SHAPE Intelligence Staff's interpretation of the collected intelligence data. For this reason, the value of this study might be enhanced if, at some future date, the scenario were given to selected foreign nationals in order to obtain their estimates of Pact intentions. Such data, applied to the model, would give additional insights into the NATO, if not the SHAPE, decision-making process.

It has been assumed that the SHAPE commander, SACEUR, would follow the dictates of good military judgment and recommend whatever action he considers necessary. Therefore, the final SHAPE headquarters estimate about the

probability of Pact attack and the number of days until the attack will also be highly reflective of his personal interpretation of events. Accordingly, the nature of the evidence collected may well be more important than his staff's interpretation of it.

In addition to being sensitive to probability assignments, the model is sensitive to the assignment of values for the various potential outcomes of a NATO mobilization decision. Varying these values permits the effect of a nation's aversion to war or of an individual's concern for the impact of a premature NATO decision to mobilize to be examined. Specifically, the decision to mobilize is likely delayed as the perceived cost of a mobilization for a false alarm increases.

Again, it should be possible at some future time for the user to demonstrate the model to selected foreign nationals in order to learn more about their (and NATO's) concern about the possibility of war and their concern about the consequence of an early NATO decision to mobilize. This information, used experimentally with the model, should shed further light on the NATO decision-making process.

Model results obtained from the analysis do, however, show a good correlation with direct assessments predicated on the same confrontation scenario and intelligence script. From the SACEUR model, a theoretical recommendation for NATO to mobilize begins to pay off around M+7. Direct assessment by informed military sources suggests that it is extremely doubtful that mobilization would be recommended before M+3 or M+4 but is almost certain before M+9.

An analysis of NATO readiness should emphasize that in reality SACEUR would implement to the extent of his authority certain military actions to improve the readiness and security of NATO forces even though a NAC mobilization decision has not been forthcoming. The degree of this independent action would markedly affect NATO's state of readiness. This factor can be reflected implicitly in the model, for example, by the assignment of values for potential outcomes (though it could be modeled explicitly at some added effort). Moreover, the present model produces only one measure of NATO readiness as output (NAC lag); other measures, such as independent action by NATO members, though not explicitly modeled, are also relevant.

Studies of this sort can be of value in determining the extent to which certain authorized SACEUR military actions could compensate for anticipated NATO lag and, additionally, how certain new authorities might further improve the situation.

4.0 FURTHER RESEARCH POSSIBILITIES

This study has been concerned with assessing mobilization lag in the event of a very specific confrontation scenario in which the Warsaw Pact embarks upon an irrevocable 30-day mobilization cycle. Substantially the same exercise could have been undertaken for a 10-day cycle and for other cycle lengths. Somewhat less straightforwardly, the assumption of irrevocability can be relaxed. The focus for the study could have been broadened still further by analyzing some immediate options of interest to general purpose force planning, for example, U.S. positions on MBFR, in which mobilization lag is of interest. Appendix B indicates the broad lines that such an analysis using the tools of decision analysis might take.

Alternatively, the analysis presented in this report, based on a specific 30-day scenario, could have been refined in a number of directions. For example, instead of basing the analysis on a single intelligence sequence and handling possible variations from that sequence informally, alternative intelligence sequences could have been specified to yield mobilization lags of varying duration. A Bayesian hierarchical model could have been used to refine these assessments and to identify the contribution of each intelligence source as a prelude to assessing the value of improved early warning information.[1]

Further, for any one intelligence sequence, multiple sets rather than a single set of judgmental and value inputs to the SACEUR choice model could be conjectured. This multiplicity of inputs would lead to the formal development of a distribution over SACEUR lag rather than to an informal assessment of this distribution for a single model estimate.

The assessment of the NAC organization lag has been handled informally in this study. At the current state of the art of organization modeling, some improvement in prediction of the NAC lag could be achieved by the use of formal models. In addition, useful insights into the NAC organization processes might be achieved by a limited degree

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[1] Clinton W. Kelly III, Application of Bayesian Procedures to Hierarchical Inferences, (Ann Arbor: University of Michigan doctoral dissertaion, 1972); Clinton W. Kelly III, "Further Investigation of Hierarchical Bayesian Procedures," Technical Report B/XG-3382, (Federal Systems Division, IBM Corporation, 1972); and Clinton W. Kelly III and Scott Barclay, "A General Model for Hierarchical Inference," Organizational Behavior and Human Performance, 10.3 (December, 1973), 388-402.

of formalization. For example, the rational-choice model could be adapted for members of NATO other than SACEUR to help predict when they would be receptive to a mobilization r commendation. An attempt could be made to formalize Allison's bureaucratic process model, though, so far as we know, this attempt has not been made. A Paretian analysis might be used for this application and for determining when a reasonable consensus among NATO partners might be achieved. Total NATO lag might be subdivided into component lags of varying kinds by using the concepts of stochastic critical-path analysis.

A computerized version of the rational-choice model used here has been programmed. Further implementation of this model using interactive computer graphics can enhance its use for training purposes in which players would incorporate their judgments and values into the model and instantly determine the impact on mobilization lag. Such a model can also be used by planners to perform sensitivity analyses on the output of this study by means of alternative inputs.

Some of the specific possibilities for future research are discussed in the following sections. Which of these possibilities should be pursued depends critically on the ultimate purpose of the exercise. (Is it to make a specific decision related to MBFR? Is it to provide input to training games?) A common and sensible rule of thumb would be to apply the further research effort where it will yield the greatest impact on the objectives of the total exercise.

4.1 Broadened Focus of Study

4.1.1 Scenario generalization - We have considered only one specific scenario: a 30-day Pact attack cycle which specifies that Pact intentions are unshakable by anything NATO members can do. It would be relatively straightforward to apply essentially the same approach described herein to other specific scenarios, for example, 10-day, 5-day, or 20-day cycles. This extension could be carried out by SAGA or other qualified staff with relatively minor technical assistance. Relaxing the assumption of Pact's unshakable resolve would involve some less straightforward adaptation of the approach. In particular, some additional assessments and corresponding modifications to the rational-choice model would be required.

Generalization from a limited set of scenarios to the whole range of possible scenarios which takes into account their relative probabilities would involve a different level of analysis and would be strongly conditioned by the specific purposes for which mobilization lag were being assessed. For example, if assessments were needed in order to compare alternative MBFR postures, a complete set of assessments

would be needed under each alternative option. The present analysis was predicated on no substantial change in the NATO/Pact balance of forces. It is conceivable that under alternative MBFR assumptions the probabilities of different confrontation scenarios would be changed and that the value or probabilities called for in the models would be changed. The cost of a false alarm might be lower if MBFR had substantially progressed than if it had not.

4.1.2 Measures of readiness other than mobilization lag - In the current study, the only measure of NATO readiness at attack explicitly assessed is mobilization lag, that is, the delay until NATO goes into a state of Reinforced Alert. The state of NATO readiness compared to that of the Pact may be determined by a much richer set of contingencies, for example, the time at which the U.S. or other individual NATO partners go into unilateral Simple Alert and generally implement security measures short of concerted NATO mobilization. The existence of other, richer measures of readiness affects this analysis in two ways. One, the rational-choice model used to predict mobilization lag could accommodate richer dimensions of value. Two, additional points on the way to full NATO mobilization might be predicted through adaptations of the approach used here.

4.2 Refined Assessment of NAC Lag

The interval between the date that SACEUR recommends mobilization and the date that the NAC actually initiates mobilization, which we have called "NAC lag," is assessed informally in this study. There are a number of conceptual approaches to modeling this organizational lag which, while they may not add appreciably to the accuracy of the ultimate prediction, should provide valuable insights into the nature of those processes and at least indirectly develop intuitive assessment skills.

The following specific approaches might merit consideration:

- Formalization of Allison's bureaucratic process model (not hitherto attempted).[2] No doubt a good deal of methodological research on that model is called for before operationally useful results can be expected;

- Reiteration of the rational-choice model for NATO parties other than SACEUR. Reiteration may indicate some outer bounds on the time by which major NATO members would call for mobilization;

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[2] Allison, op.cit.

- Paretian analysis based on the rational-choice model, from which a Pareto-optimal range of mobilization dates might be identified; and

- Decomposition of total mobilization lag into two or more components corresponding to necessary steps in the organizational process leading to NAC initiation of mobilization.[3] Statistical techniques for decomposed assessment would be used to combine probability distributions on each component into a total lag.[4] (The same technique could have been used to combine distributions on SACEUR lag and NAC lag in the current study. Instead, that combination was carried out informally.) A more complex variant would involve modeling the process as a network by using some of the concepts of critical-path analysis.

In all probability, however, the most substantial improvements in the validity of estimates would follow from more extensive discussions with informed sources, for example, SHAPE headquarters personnel or NATO representatives of major countries.

4.3 Refined SACEUR Rational-Choice Model

In this study, a probabilistic prediction of when SACEUR would recommend NATO mobilization was based on a structurally simple model and a single set of inputs imputed to a SACEUR. There are many ways in which the approach to assessing a probability distribution for SACEUR lag can be refined, notably in the direction of increasingly complex formalization. In general, however, we would assign these refinements a lower priority than those directions for further research noted in Sections 4.1 and 4.2 above.

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[3] Rex V. Brown, Andrew S. Kahr, and Cameron R. Peterson, Decision Analysis for the Manager, (New York: Holt, Rinehart and Winston, 1974); and Rex V. Brown, Research and the Credibility of Estimates (Boston: Division of Research, Graduate School of Business Administration, Harvard University, 1969).

[4] Lawrence D. Phillips, Bayesian Statistics for Social Scientists, (New York: Thomas Y. Crowell, 1974); Clinton W. Kelly III and Cameron R. Peterson, "Probability Estimates and Probabalistic Procedures in Current Intelligence Analysis," Technical Report II/DAHC 15-72-C-0136 (Federal Systems Division, IBM Corporation, 1973); and Decisions and Designs, Incorporated, Handbook for Decision Analysis, Ch. 12 (Advanced Research Projects Agency and Office of Naval Research, NONR-N00014-73C-0149, NR-197-023, 1973).

4.3.1 Refining inputs to the existing model - The elicitation of the necessary assessments can be modified in a number of ways without changing their nature. For example, the daily probability assessments of Pact attack can be indirectly assessed by using likelihood ratios in prior-posterior analysis or a hierarchical Bayesian inference model. The model also makes it relatively easy for point estimates like those for the number of days since Pact mobilization and days until Pact attack to be replaced by probability distributions. However, there are problems of conditioned assessment that need to be carefully considered here and which may indicate a more extensive modification in the structure of the model.

Uncertainty about what inputs SACEUR would subscribe to as well as uncertainty about the intelligence sequence on which assessments would be based could be accommodated by introducing probabilities at both levels and using standard Monte Carlo simulation techniques to simulate alternative SACEUR inputs and intelligence sequences. Sensitivity to alternative views about intelligence, inferences, or values can be readily tested by sensitivity analysis with the same model.

All of these refinements will be greatly facilitated through the construction of a computerized version of the model, possibly with graphic input and output devices. (Most of the effort on this computerized program has already been completed, but not on graphic extensions.)

4.3.2 Model extensions - The current model looks at two options for SACEUR and two strategies for the Warsaw Pact. This simplification was made to expedite the decision-modeling effort and permits investigation of the reaction time for SACEUR by means of a rational-choice model. Two extensions of the model and combinations of these two extensions should be considered to broaden the applicability of the model and allow more pragmatic reflection of the actual environment.

The first extension is to expand the number of strategies for the Pact. The current rational choice model allows for only two hypotheses: the Pact is mobilizing for irrevocable attack against NATO, or it is not. Other hypotheses could be entertained: the Pact could be mobilizing either to conduct an exercise if NATO responds or to attack if NATO does not respond; or the Pact could be mobilizing for the main purpose of unsettling the NATO members. Of the many possible strategies which could be motivating the Pact, only these will be considered.

For this extended model to be of use, it is necessary to obtain estimates of the probability that the

Pact is following any one of the particular strategies. That is, in addition to an estimate of the probability that the Pact is mobilizing to attack, it is also necessary to estimate the probability that the Pact is mobilizing under another strategy, such as mobilization for an invasion of a non-NATO country, like the Czechoslovakian incursion. This estimate could diminish the usefulness of the extended model since the increased requirement for direct probability estimates as a function of time would weigh heavily on the analyst and might decrease confidence in the results. However, the use of a Bayesian hierarchical model to obtain the necessary estimate, in lieu of direct assessment, could eliminate this problem.

The second extension of interest is expanding the number of strategies available to NATO or to model SACEUR's direct options, or recommendations. In essence, the options available to NATO and SACEUR are more complex than a simple choice between mobilization or no mobilization. For example, SACEUR could initiate an exercise which could lead to mobilization if the information available to SACEUR continued to indicate that the Pact was mobilizing to attack. Another option available to SACEUR could be an increased alert of NATO forces within his authority. In fact, at some point in time, SACEUR would no doubt ensure that all NATO forces were alerted to his perception of the deteriorating situation so that, if his worst fears were realized, the NATO forces would not be completely unprepared. Then, if no attack took place, there would not have been unreasonable cost to NATO of having gone to an increased alert status. A third option available to SACEUR is the increased intelligence alert. This alert, while not actually placing NATO forces on alert, has the end result of validating the current intelligence estimates. This option may not change the relative values of a conflict outcome but may change SACEUR's estimate of the point in time when NATO would mobilize if the Pact was mobilizing to attack. The immediate effect of the increased intelligence alert would be that of compressing into a shorter time span the intelligence scenario information.

Figures 4-1 and 4-2 show examples of extensions of the rational-choice model which accommodate richer NATO and Pact options respectively. These particular extensions of the decision model more fully reflect the SACEUR decision process but at the same time contain simplifications carried over from the original. These simplifications are manifested in the requirement to assess the days C1, C2, C3, and C4. These assessments are the surrogate decision maker's best estimate of the time required for NATO to make the mobilization decision under varying conditions. Also, the surrogate

decision maker is required to estimate the probability of NATO's making a wrong decision; that is, after it decides initially not to mobilize, NATO mobilizes when the Pact does not. The relative values reflect the possibility of a NATO decision precipitating a conflict.

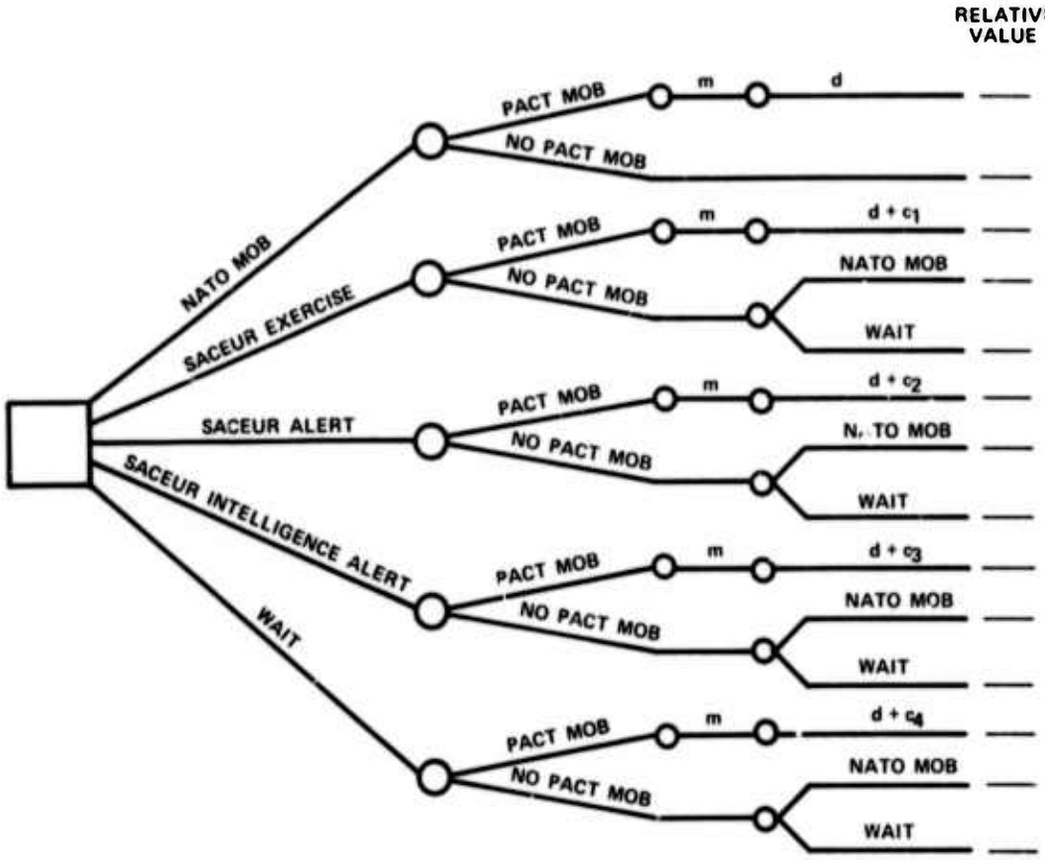

Figure 4-1

MODEL EXTENDED FOR RICHER NATO OPTIONS

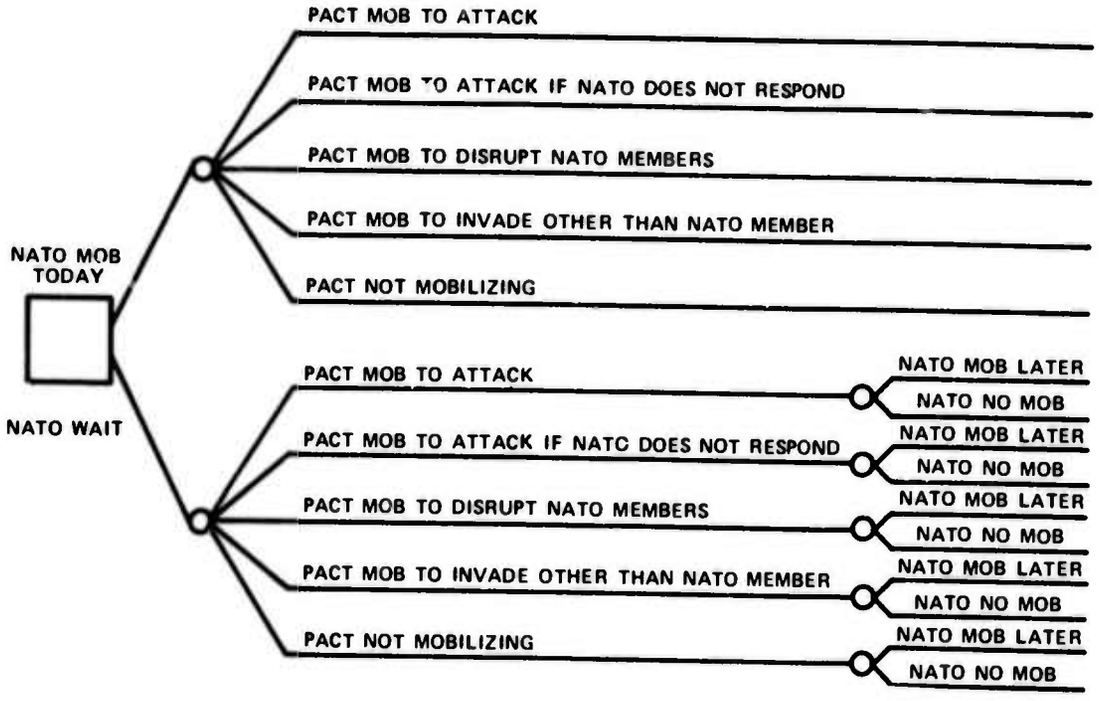

Figure 4-2

MODEL EXTENDED FOR RICHER PACT OPTIONS

These two extensions of the SACEUR decision model permit the visualization of a third extension predicated on a combination of the preceding two. This third would be the most realistic of the four discussed because it portrays the many options available to each participant. There is a price to pay in using such a model, however; it is the demands of the many more required assessments and estimates. The model extensions do not take the form of decomposing the initial assessments, that is, making them more tractable, but compound the number of like assessments of varying shades.

Further research is called for to determine what trade-offs can be made for these and other possible model extensions to arrive at a SACEUR decision model which would best capture the flavor of the actual environment and would be readily usable by diverse analysts for a spectrum of NATO decision problems.

APPENDIX A

DECISION ANALYTIC APPROACH[1]

A.1 Philosophy

The kernel of the approach developed in this paper is a quantitative model which can be used to predict the choice of a rational, unitary decision maker. This choice model is derived from decision theory, the formal prescriptive theory of decision making in the face of uncertainty. Although decision theory is a normative, rather than a descriptive, theory--that is, it prescribes what choice a decision maker should make rather than what choice he may actually make--it nonetheless possesses considerable descriptive power and, given the assumptions of rationality postulated above, is appropriate as an initial model of SACEUR behavior.

As used here, the essential role of decision modeling is to describe precisely an artificial decision maker who bears a recognizable relationship to the real decision maker. The model may be a good approximation of the real decision maker, if the choices predicted by the model closely parallel those of the real decision maker faced with the same situation. However, even if the model is not a good approximation in the above sense, it may be easier to adjust the predictions of the model than to attempt to predict without the aid of the model what the real decision maker might do.

A.2 Constructing the Decision Model

Decision theory provides for the description of a decision process in terms of four kinds of components. Each of these components is clearly specified as an input to the decision model:

The first component is a set of initial courses of action. A decision problem exists only if a decision maker faces a choice among alternative acts. Each of the choices which the decision maker wishes to consider should be listed.

The second is the possible consequences of each initial act. What are the important things that can happen to make one act more valuable or worth more than another act? Relevant sequences of subsequent events and follow-up acts must be identified for each initial act.

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[1] Howard Raiffa, Decision Analysis (Reading, Massachusetts: Addison-Wesley, 1968); and Howard Raiffa and Robert Schlaifer, Applied Statistical Decision Theory (Boston: Division of Research, Graduate School of Business Administration, Harvard University, 1961).

The third is the attractiveness or unattractiveness of each possible consequence of each act to the decision maker. What is its value to the decision maker?

The fourth is the likelihood that a particular act will result in each of the consequences?

It is an essential tenet of decision theory that all relevant considerations affecting a decision can be assigned to one or another of the above four components:

- Initial options
- Possible consequences
- Values
- Uncertainties.

In addition, they can in principle be represented fully in a decision diagram, or decision tree. In other words, for every conceivable decision, a decision tree can be constructed which captures everything a decision maker feels is relevant to the choice in question.

A decision tree consists essentially of a network of branches corresponding to possible sequences of acts and events fanning out from an origin at the left to a time-horizon at the right. Acts are choices open to the decision maker. Events are possible occurrences determined by chance and are outside the direct control of the decision maker although the chance of one of them happening may be influenced by acts that the decision maker has carried out earlier. The decision tree is made up of a concatenation of forks which are either act forks or event forks. A path through the tree corresponds to a possible sequence of acts and events and is characterized by a value assigned to the consequence of that sequence.

An act fork includes as branches all of the acts that might be chosen at a particular point in the tree. An event fork displays exclusive and exhaustive possible outcomes to an uncertainty at any point in the tree. By "exclusive" and "exhaustive," we mean that all of the outcomes can occur, but one and only one of the outcomes described by the act fork will occur. By convention, an act fork, describing decision options, is represented by a box, an event fork, describing uncertainties which can affect the outcome of the decision, is represented by a circle. (Forks may also be called nodes.) Figure A-1 illustrates the structure of a decision tree according to these conventions.

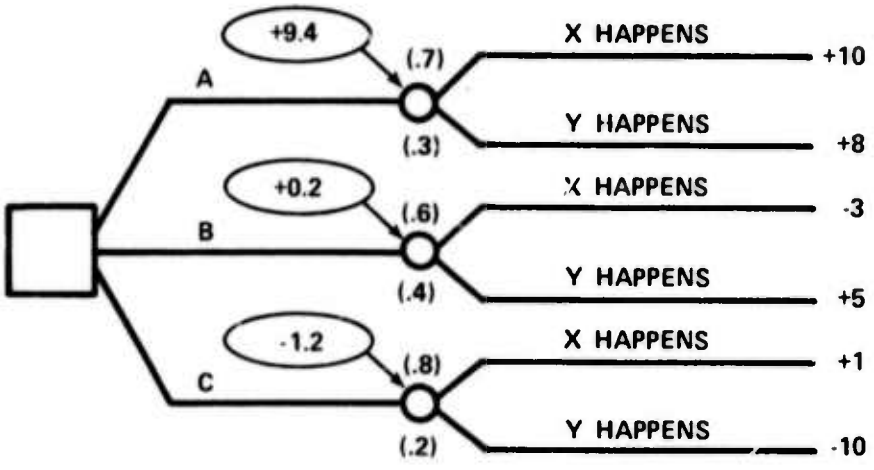

Figure A-1
ILLUSTRATIVE DECISION TREE

Figure A-1 may be interpreted in the following way. The decision maker has three options available to him, A, B, and C. In the event that he selects one of the options, the outcome of the decision will be affected by whether X happens or Y happens. Thus, a possible consequence of the decision described in Figure A-1 would be the result of selecting B and having Y occur.

In order to select a course of action, it is necessary to assign values to each consequence of the decision, and probabilities to the uncertainties, and then to calculate average or expected values by multiplying probabilities by values, by summing at each node, and by repeating, or "folding-back," the process until an expected value is assigned to each of the primary options, A, B, or C. The folding-back process is illustrated in Figure A-1. Values have been assigned arbitrarily to each possible consequence of the decision on a scale from -10 to +10. Similarly, probabilities have been assigned to each of the uncertain events. To illustrate the calculation of expected values, look at the first option, A. If the decision maker selects option A and X happens, the consequence has a resultant value to him of +10. On the other hand, if he selects option A and Y happens, the consequence has a value of +8. It is estimated that there is a 70% chance that X will happen and a 30% chance that Y will happen if he selects A. Therefore, the average or expected value of selecting A is calculated by multiplying .7 x +10 and adding to that .3 x +8, for an average value of 9.4. Calculating expected values for the

remaining options, we arrive at a value of 0.2 for option B and -1.2 for option C. Therefore, decision theory would say that if the decision maker accepts the values assigned to the consequences of the decision and the probabilities assigned to the uncertainties, he should select option A.

A.3 Schematic Representation

It is often useful to describe a decision situation in terms of a schematic tree rather than a tree given in extensive form, as in Figure A-1. The schematic tree for Figure A-1 is shown in Figure A-2.

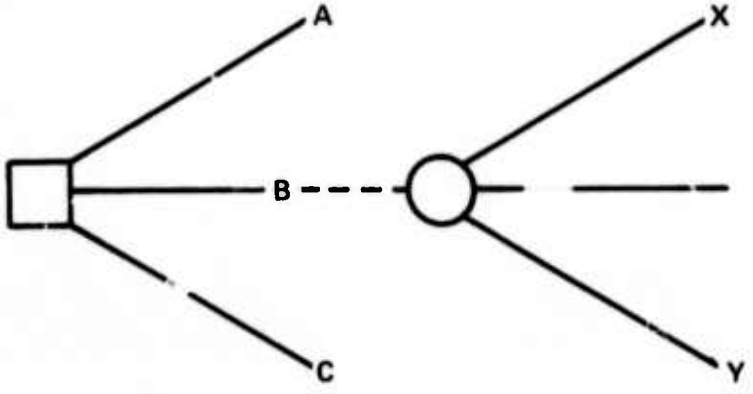

Figure A-2
SCHEMATIC DECISION TREE

The use of a schematic notation allows very complicated decision processes to be described in very compact form. Although the schematic notation is very useful in describing a complicated decision process, the evaluation of the process in the sense of calculating expected values for the initial decision options can be accomplished only by expanding the schematic tree into an extensive form tree. A rough idea of the size of this extensive form tree can be arrived at by multiplying the number of branches at each node in the schematic tree together. This provides only an approximation, however, because the implication of symmetry does not necessarily hold in practice.

APPENDIX B

DECISION ANALYSIS FOR A POSSIBLE GENERAL PURPOSE FORCE PROBLEM

Appendix A describes the decision-analytic approach, an approach which can handle a decision problem at any level of aggregation. This study has focused on just a small portion of the General Purpose Force (GPF) decision problem. A look at the total GPF problem in decision-analytic terms may suggest the broader contribution this kind of study can make to the larger problem.

Figure B-1 shows, at a coarse level of aggregation, the framework for a possible GPF decision problem. All possible options for alternative U.S. positions on MBFR are recorded on the act fork at the left of the figure, with each option on a separate branch. The event fork in the middle of the figure contains all possible outcomes (with their respective probabilities of occurrence) associated with each possible option. Next, as shown on the right of the figure, a value (either relative or absolute) is assigned to every path (combination of option and outcome) through the tree. When the tree is completed in this manner, it is a routine matter to fold the tree back (as explained in Appendix A) to determine the option with the highest expected value (or expected utility). This option is the preferred one. It is easy to see that any realistic evaluation done in this manner would result in an unmanageable number of paths.

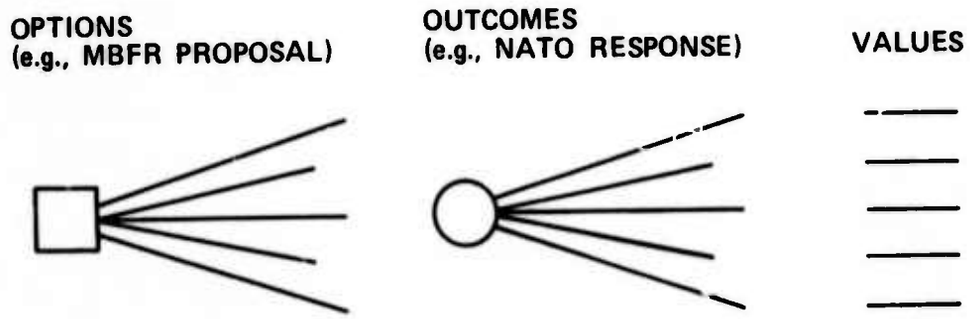

Figure B-1

FRAMEWORK FOR POSSIBLE GPF DECISION PROBLEM

Figure B-2 shows a model which is more specific and less aggregated than the previous one. As before, each option is represented on the act fork on the left of the figure, and each path is characterized by a value on the right of the figure (in this case, a relative value from zero to one hundred). In this tree, though, the sequels to each option are identified more specifically as scenarios and outcomes. That is, for each option, different scenarios are possible (for example, a 30-day attack cycle with a certain sequence of intelligence information); and for each scenario, different outcomes are possible (for example, different states of NATO readiness at the Pact attack date).

Some paths through the tree are indicated in Figure B-2, here, those for the option to maintain the status quo with respect to MBFR. Of the different scenarios which may develop, only the possibility of a 30-day Pact attack cycle (with a particular sequence of intelligence information) is shown. For this particular attack cycle, different states of NATO readiness are possible, ranging from equal readiness (30.30) to complete NATO unpreparedness (0.30). Since there are no other outcomes of interest in this example, each of these endpoints is evaluated. In this case, evaluation is based on a relative scale of zero to one hundred.

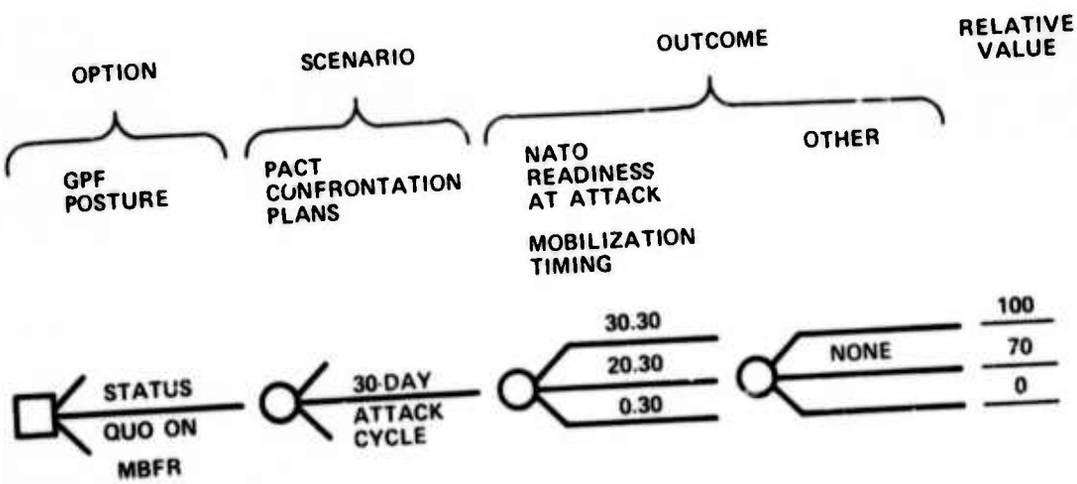

Figure B-2

SPECIFIC TREE FOR BROAD GPF PROBLEM

Addressing a major decision problem in this manner is a substantial undertaking beyond the scope of this particular study. However, the study does address an element of this broad problem, the probabilistic prediction of NATO readiness under a specific scenario. The study was used to quantify some of the probabilities called for in the broader problem.

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