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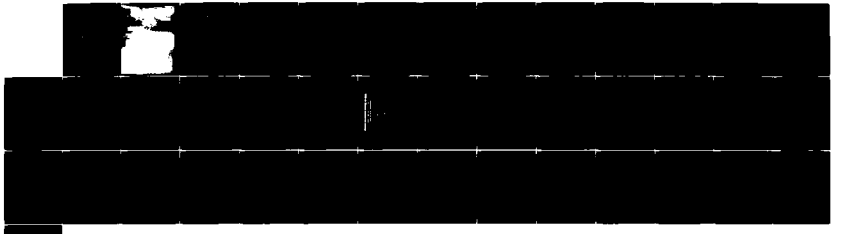

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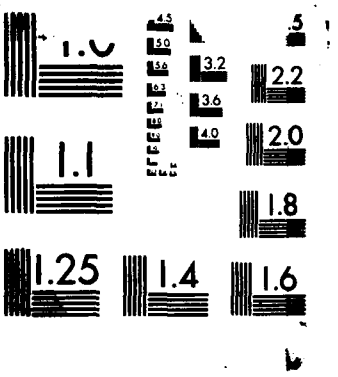
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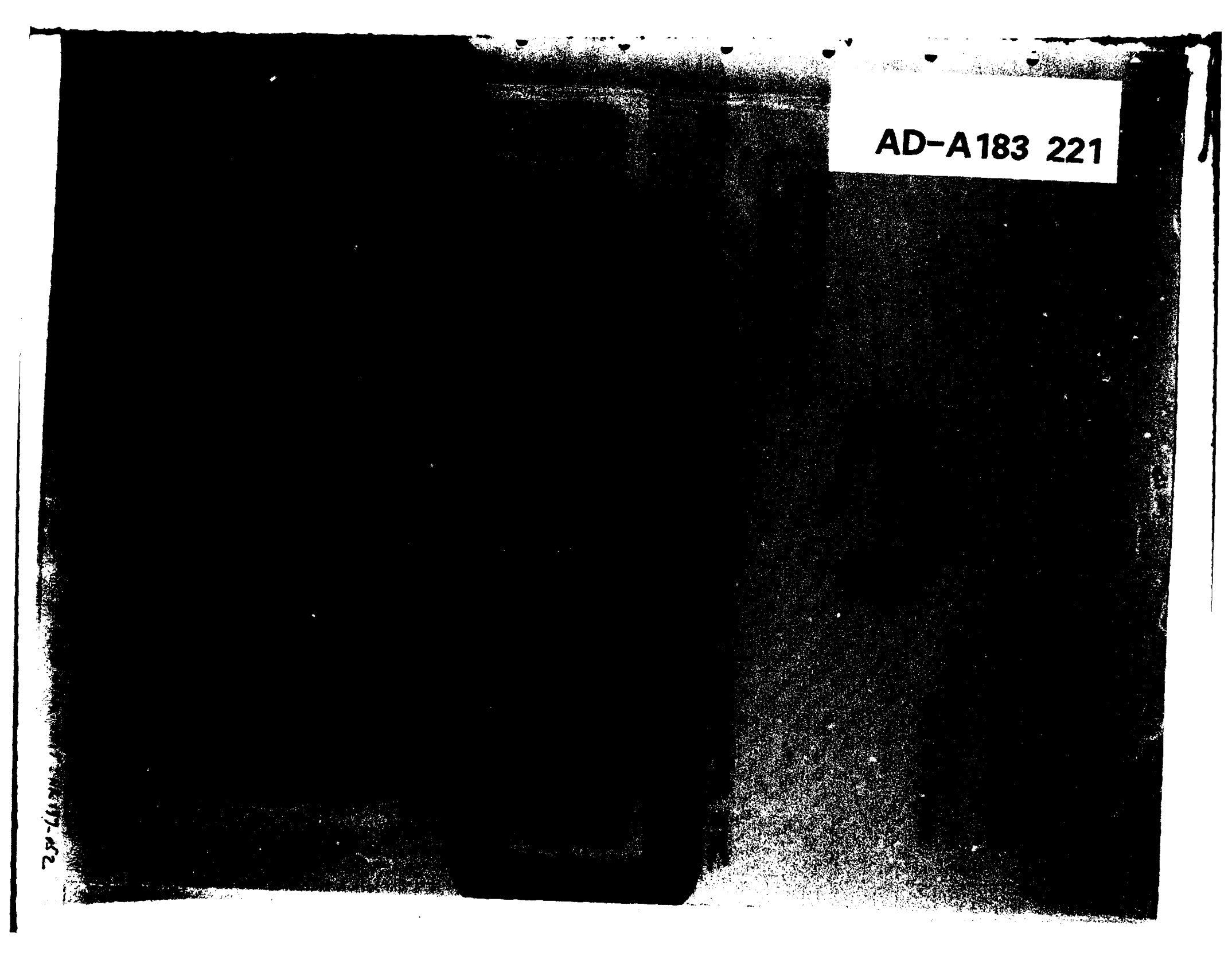

INTERIM PROGRESS REPORT PR 79-10-99

DECISION TEMPLATE CONCEPT:

DEMONSTRATION PLAN AND STATUS REPORT

by

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Prepared for

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Defense Communications Agency

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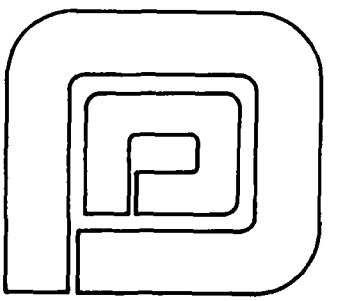
June 1979



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CONTENTS

FIGURES

THE DECISION TEMPLATE CONCEPT: DEMONSTRATION PLAN AND STATUS REPORT

1.0 INTRODUCTION

This report is submitted by Decisions and Designs, Inc. (DDI) in fulfillment of Task 2 of the Statement of Work of Contract N00014-79-C-0152.

The major contractual effort thus far has been the development and continuous refinement of two software decision aids: R-SCREEN and OPSEL. Both of the aids are programmed to run on an IBM 5100 minicomputer, and both have been installed in the Joint Operations Division (JOD) in the Pentagon since early April. R-SCREEN, which supports hierarchical decomposition evaluation models, has been used by the JOD staff. OPSEL, which addresses decision making in the face of uncertainty, has received less attention by the staff to date.

Examples of crisis situations amenable to solution by the two decision aids described above are appended. Appendix A is a real crisis situation that was addressed by a military staff using the types of decision aids discussed herein. Appendix B is a hypothetical crisis situation that has been used in training conducted for high-level students at the U.S. Army War College and senior analysts in the Intelligence Community.

This report summarizes the progress to date and describes the work yet to be accomplished.

2.0 DEMONSTRATION PLAN

2.1 Briefing Aids

Briefings to date have focused on the OPSEL (Option Selection) decision aid designed for the quick analysis of decision options in the face of uncertainty. Two types of briefings have been given: general demonstrations for information purposes only, and specific training sessions to provide potential users with hands-on experience with the aid. The demonstration briefings, developed around the Lebanon evacuation crisis of May 1976, make use of Appendix A, "The Lebanon Evacuation Demonstration," and a live computer demonstration and analysis. The training demonstrations, developed around a hypothetical scenario called the RAMBO crisis, make use of the information materials and worksheets in Appendix B, "The Rambo Crisis." No computer demonstration briefings have been given yet using the R-SCREEN decision aid as it is still under development.

2.2 Briefing Description

Appendix A describes a typical demonstration briefing built around the Lebanon crisis, and Appendix B illustrates the sequence of the RAMBO training briefings. It is to be emphasized that any particular briefing may vary substantially from these descriptions, depending upon the specific interest of those concerned. In addition, changes will occur over time because of the continuous evolution of both decision aids.

2.3 Reactions and Comments

Reactions and comments have been elicited verbally from the participants thus far; a simple questionnaire, based in

part on comments received to date, will be used in future demonstrations. So far, the comments most frequently heard concern the amount of training required, the desirability of displays using fewer numbers and more graphics, and possible installation of the software on other computer systems. Most of those briefed are impressed by the ease of operation and the convenience of the IBM 5110 compared to the World Wide Military Command and Control System (WWMCCS) with which they are familiar.

Detailed comments have been obtained on a weekly basis from the operators of the R-SCREEN and OPSEL aids installed in the Joint Operations Division (JOD), Joint Chiefs of Staff (JCS). These comments are evaluated immediately and have resulted in modification to the aid as appropriate.

3.0 PROGRESS TO DATE

3.1 Decision Aid Development

As mentioned in the introduction, two decision aid concepts have been developed: OPSEL (Option Selection) and R-SCREEN (Rapid Screening). OPSEL is designed for use by well-trained users in those situations where uncertainty is a key determiner of choice and where the user has from three to five hours for the analysis. R-SCREEN is designed for use by less well-trained users in situations where the user must produce an analysis in about one hour.

3.1.1 OPSEL - OPSEL permits the user to take two possible approaches to a solution. The first approach is for the well-trained frequent user who understands how to structure a particular problem and how to provide the necessary inputs. For this user, the aid asks for decision options, outcomes of the key uncertainty, whether or not the likelihood of these outcomes is option-dependent, for probabilities over the outcomes, for criteria, for regrets, and for criterion weights. The aid then calculates the expected regret of each option and permits the user to conduct a variety of sensitivity analyses to test the robustness of the result. These sensitivity analyses include varying probabilities, varying criterion weights, and varying both simultaneously.

The second approach is designed for the less well-trained infrequent user: it provides several levels of tutorial assistance. In its current form, this assumes the user has several decision options clearly in hand. By using a modified repertory grid procedure, OPSEL elicits from the user both the possible outcomes of a key uncertainty and the criteria. Finally, the aid goes through a detailed elicitation

to obtain regrets and criterion weights. An additional module is under design for those problems for which the user has general problem objectives in mind but has not identified specific decision options.

3.1.2 R-SCREEN - The R-SCREEN decision aid is a series of pre-structured, multi-level, multi-attribute utility models. One model has been developed for Force Augmentation/ Show-of-Force Policy decisions; two additional models, including one for non-combatant evacuation, are in the design stage. With these models, the user is required to score each alternative course of action with respect to a number of generic criteria relevant to a particular situation. The aid displays definitions for each criterion as an assist in assigning scores and lets the user modify these definitions as required to match the structure to the specifics of a particular problem. A number of criteria in the structure are initially left un-named to provide further flexibility. The aid uses a "bottom-up" weighting procedure to assign weights to the criteria. After scoring and weighting, it generates an overall score for each decision option. A number of sensitivity analyses are available to facilitate the user's interpretation of the results. One of the most interesting compares the overall best and second-best options, showing the user, in a pro-and-con summary, those inputs that most favor best over second-best and vice versa.

A modification to R-SCREEN currently under design will allow the user operating under a severe time constraint to enter scores initially at a high level of aggregation and then will suggest where further decomposition would be most valuable if there is additional time. Thus, this modification enables the user to obtain results at any time in the analysis. The current approach does not

produce results until scores have been entered at the most detailed level of decomposition.

3.2 Review by EUCOM Personnel

The designs for OPSEL and R-SCREEN were reviewed with personnel of the J-3 Division, Headquarters, U.S. European Command (EUCOM), who have had experience using decision-analytic decision aids in crisis situations over the past two years. One of the key users of these aids, CAPT Michael Hayes, USN, has been reassigned to the Washington area and has agreed to serve on a continuing basis as an informal critic of the aid designs.

3.3 Software Production

Software has been produced that implements OPSEL and R-SCREEN. Preliminary versions of this software were installed on an IBM 5110 computer in April; and the computer, printer, disc drive, and display were moved to spaces in the Joint Operations Division (JOD). As a result of on-the-job experience with the software, a number of modifications have been made already. Based on the observed rate of changes, it is likely that no further software modification will be required after 1 July.

3.4 Briefings and Demonstrations

A number of information and training briefings and demonstrations have been conducted primarily for personnel of the WWMCCS ADP Utility Research Office, other personnel of Defense Communications Agency (DCA), and for members of the JCS. The following personnel have been included in the JCS briefings:

LTG Phillip D. Shutler, USMC-Dir Ops
MG Jerome O'Malley, USAF - Vice Dir Ops
RADM A. L. Kellin, USN - Dep Dir Strategic & Gen Ops
MG Van Doubleday, USAF Dep Dir WWMCCS & Telcoms
RADM M. J. Schultz, USN Asst Dep Dir
BGEN J. H. Johnson, USA Dep Dir Current Ops
BGEN Alonzo Walter, USAF Dep Dir NMCC

In addition, some twenty staff officers in the Current Operations Division of the JOD have received briefings.

3.5 Training

Informal training for JOD personnel has been conducted once every week for approximately two hours during April, May, and June. This training has consisted of applying the decision aids to hypothetical problems and assisting JOD personnel in using the aids for problems of current concern to them. Formal training will take place during July when the decision aid software design is complete.

3.6 Evaluation

Several meetings have been held with the independent evaluation contractor to demonstrate the decision aids and to discuss possible evaluation procedures. It is clear that the concept of carrying out a classical experiment using control and experimental groups is impractical given the limited personnel and severe operating constraints in the JOD. It was proposed instead that a clinical on-the-job case-study evaluation procedure be used. With this clinical procedure a number of criteria are identified with respect to which the aids would be scored both by users and by experienced observers. It was agreed that the clinical

trials would begin about 1 July and cover a period of about four months. During this period, the independent evaluator would spend time each week with personnel of the JOD. The following criteria are suggested as a starting point for the clinical trials evaluation:

Suggested Process-Related Criteria

1. Number of decision options or alternatives considered by the user--does the decision maker consider only one or two alternatives or is a wide range of options thoroughly surveyed?

2. Objectives clearly explicated--does the decision maker explicitly identify objectives and prioritize them?

3. Evaluation of options--does the decision maker carefully weigh the positive and negative consequences of each alternative?

4. Reexamination of assessments and results--does the decision maker reexamine the implications of assessments and understand the reasons for the results?

Suggested Aid-Specific Criteria

5. Ease of use--the extent to which a user can readily prepare data for the aid, apply it, and extract understandable results.

6. Richness of output--the number and types of output variables and forms of presentation.

7. Construct validity--adequacy of the model in providing variables representing the problem situation.

8. Content validity (fidelity)--the extent to which the model's parameters match real-life conditions.

9. Generality--extent to which different problems can be accommodated.

10. Marginal cost of use--value of all effort involving use of the aid over effort required to produce a non-aided solution.

11. Explanation to others--the value of the aid as a briefing tool to explicate the results and the reasons for the results to others.

12. Staff coordination--the extent to which the aid focuses staff debate.

13. Marginal time to solution.

Suggested Results-Related Criteria

14. Coherence--the degree to which the ultimate decision choice is consistent with the informed values and beliefs held by the decision maker.

15. Accountability--the degree to which the aid preserves the specific rationale that led to the selection or rejection of each course of action.

4.0 WORK TO BE ACCOMPLISHED

4.1 Develop Training Materials--Conduct Training

DDI will develop users manuals for the OPSEL and R-SCREEN aids by mid-July. These will lead the user through several examples illustrating the procedures for applying the aid to a variety of problems. Insofar as possible, the manuals will be based on case study materials developed by the JOD personnel using the aids. These manuals will be used to train user personnel who will participate in the evaluation of the aids.

4.2 Refine the Aids

Comments from the demonstrations and on-line problem solving sessions will be incorporated into the decision aids in the form of software modifications as are desirable prior to 1 July when the evaluation begins. Subsequent to 1 July, no major changes will be made which affect model structure, but we will continue to make minor modifications to develop input and output formats that serve to promote human-factors aspects of the aids.

4.3 Conduct Demonstrations and Briefings

Demonstrations and briefings will continue until the end of the project. Many of the people already briefed will be re-contacted and briefed on actual analyses carried out in the JOD. In addition, more briefings will be scheduled for staff officers at the 0-4 through 0-6 levels in the JOD. A video tape will be prepared using the Lebanon evacuation scenario to assist JOD personnel participating in the project who are continually asked for briefings.

4.4 Develop Specifications for Refined Aid

Based upon the results of the demonstrations and the on-line problem-solving experience, we will develop specifications for an improved decision aid to be tested at two geographically dispersed command centers in which the aid would be in operation at both command centers simultaneously to facilitate coordination on a common decision problem.

4.5 Prepare Final Report

We will prepare a final technical report describing each of the decision aids with recommendations for improvement and describing the specifications for the multi-participant decision aid.

APPENDIX A

THE LEBANON EVACUATION DEMONSTRATION

THE LEBANON EVACUATION DEMONSTRATION

The scene: headquarters of the U.S. European Command; the participants: twelve J2 and J3 staff officers; the problem: to select and recommend preparedness actions that should be implemented in the eastern Mediterranean area, given uncertainty about whether or not it will eventually become necessary to evacuate U.S. nationals, and nationals of other countries from Lebanon.

After several hours of discussion, four alternative alert postures for the evacuation force, which in this instance was comprised mainly of U.S. Sixth Fleet resources, had been identified. The J2 and J3 participants, however, were divided as to which of these postures to recommend. About half of them favored maintaining the fleet in its normal operating posture. They argued that this would have minimum impact on fleet readiness, flexibility, and would also minimize the political implications of any U.S. action during this time of heightened tensions in Lebanon. The remaining staff officers favored a stronger alert posture but were divided as to what it should be. The alternatives included moving fleet elements into the eastern Mediterranean where they would conduct routine training exercises, placing selected fleet elements off the coast of Lebanon in a modified location posture of MOD LOC, and the strongest posture which included augmenting the evacuation force with an increased communications and air-lift capability. These more advanced postures had the advantage of reducing reaction time in the event that evacuation became necessary and consequently reducing the risk to U.S. nationals who were exposed to the deteriorating situation in Lebanon. On the other hand, the stronger postures would impact fleet readiness because of curtailed training activities and expenditure of fleet resources that would normally be allocated to

training; they reduced the flexibility of the fleet to respond to other contingencies; and there were potential political implications associated with moving fleet elements into the vicinity of Lebanon during this stage of the crisis.

Typical of many crisis situations was the additional factor that no one was certain whether or not an evacuation would be required. In addition, should an evacuation be required, there was further uncertainty as to whether or not it would be carried out under permissive or nonpermissive conditions. That is, would the safety of the evacuation force be secured by a stable Lebanese or pro-Syrian government or would the evacuation force have to fight its way in and out during the process of evacuation? Finally, there was uncertainty as to how many people might require evacuation. In the case of a permissive evacuation, in which a central government maintained control, it was argued that the numbers of people requiring evacuation could range between 300 and 2,000. On the other hand, in a nonpermissive environment, it was argued that a strong central government would not likely be in power, that mobs would be roaming the streets, and even that the fighting could spread country-wide. In this case, it might be necessary to evacuate from 2,000 to 6,000 people, including not only U.S. nationals but nationals from other countries as well.

Figure A-1 shows the decision structure.

An assessment of the likelihood of each of these possible outcomes was complicated because it turned out that the probabilities depended upon a chain of other uncertain events. For example, assumptions about the level of hostilities in Lebanon had an impact on forecasts of the number of personnel to be evacuated and whether the evacuation would be permissive or nonpermissive. However, an assessment

LEBANON EVACUATION POSTURE DECISION

MAY 1976 ⟶

J-2/J-3 H.Q. EUCOM

- OPTIONS
  - NORMAL
  - ROPS EMED
  - MOD LOC
  - + COMS
- CRITERIA
  - EXPOSURE RISK
  - READINESS COST
  - *FLEXIBILITY LOSS*
  - POLITICAL
- UNCERTAINTY

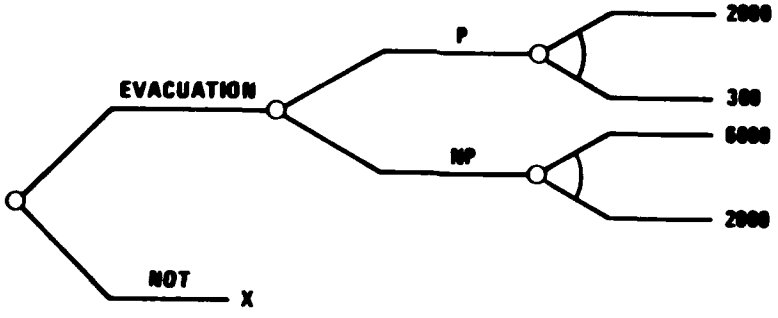


Figure A-1
DECISION STRUCTURE

of the level of hostilities depended in turn on the uncertain outcome of the elections then upcoming in Lebanon. Additional uncertainties affecting the likelihood of an evacuation were, first, what the Syrian armed forces might do, and second, the impact of their action on potential Israeli involvement. It was argued that such involvement would almost guarantee a new round of hostilities in the Mideast and would necessitate immediate evacuation of personnel from Lebanon.

Thus, at this point in the deliberations of the crisis management cell, there was considerable disagreement about which of the four alert postures they should recommend. This disagreement was due both to the conflicting criteria or concerns held by all the staff officers and to the considerable uncertainty as to whether or not an evacuation would actually be required. Because the answer was not obvious, the crisis management cell decided to try the decision analysis procedure as a means of arriving at a recommendation.

The first step for the staff was to describe the possible consequences of each option and each outcome and to assess how happy or unhappy a decision maker would be with a particular decision given each outcome. The staff decided to use four measures to describe the consequences of each option/outcome combination: exposure risk, readiness cost, flexibility loss, and political embarrassment.

After descriptions of the consequences of each option/outcome combination were developed, the next step was to encode these numerically. Figure A-2 shows a computer print-out for each of the four measures described above. Consider, for example, exposure risk. The rows of this matrix are the four possible alert posture recommendations, and the columns are the five possible outcomes ranging from

EXPOSURE RISK WEIGHT 43

	NONE	P-300	P-2K	NP-2K	NP-6K
NORMAL	0	-10	-30	-100	-100
ROP EMED	0	0	-5	-80	-80
MOD LOC	-1	0	0	-5	-10
+COMMS	-1	0	0	0	0

PRESS EXECUTE TO CONTINUE

READINESS COST WEIGHT 17

	NONE	P-300	P-2K	NP-2K	NP-6K
NORMAL	0	0	0	0	0
ROP EMED	-30	-30	-30	-30	-30
MOD LOC	-80	-80	-80	-80	-80
+COMMS	-100	-100	-100	-100	-100

PRESS EXECUTE TO CONTINUE

FLEXIBILITY LOSS WEIGHT 9

	NONE	P-300	P-2K	NP-2K	NP-6K
NORMAL	0	0	0	0	0
ROP EMED	-40	-40	-40	-40	-40
MOD LOC	-90	-90	-90	-90	-90
+COMMS	-100	-100	-100	-100	-100

PRESS EXECUTE TO CONTINUE

POLITICAL WEIGHT 30

	NONE	P-300	P-2K	NP-2K	NP-6K
NORMAL	0	-40	-60	-100	-100
ROP EMED	0	0	-20	-90	-90
MOD LOC	-5	0	0	-20	-20
+COMMS	-10	0	0	0	0

Figure A-2
REGRET MATRICES

no evacuation to a nonpermissive evacuation involving 6,000 people. The numbers in the cells of this matrix describe the regret or opportunity loss as assessed by the crisis cell members considering the single measure or criterion of exposure risk. For example, they said that considering just exposure risk, the worst possible consequence would occur if the fleet were postured normally and the eventuality of a nonpermissive evacuation involving 6,000 people occurred. This consequence was assigned a regret of -100 on an arbitrary scale which ranges from 0 to -100. Zeros were assigned to those consequences which had no regret associated with them. For example, considering the bottom cell in the right-hand column, that is, the column describing a nonpermissive evacuation of 6,000 people, notice that the zero is associated with the strongest posture, +COM's. This implies that had that eventuality occurred and had the strongest posture been selected, the decision maker would have no regret about having made that decision. That is, the best alternative was chosen, given the options available.

It is important to note the distinction between regret, and value measured on some absolute scale. It is clear that on an absolute basis, the consequence associated with normal operations and no evacuation, the upper left-hand cell of the Exposure Risk matrix, is much preferred to the consequence associated with +COM's and nonpermissive evacuation of 6,000 people, the bottom right-hand cell. However, each of these cells has a zero regret associated with it because in both cases, considering the single measure or criterion of exposure risk, the appropriate or optimal course of action, given the criterion and the particular outcome, was chosen. The other numbers in the matrix are an encoding of the other consequences and are scaled between 0 and 100 to reflect the relative regret associated with these consequences.

After all consequences had been evaluated with respect to each of the four measures, the next step was to assess the relative importance of each of these four measures. The crisis cell members agreed that exposure risk was most important, and this was assigned a weight of 100. The political implications of a posturing decision was considered to be next most important, and this was assigned a weight of 80. The two additional measures of readiness cost and flexibility loss were considered substantially less important and were assigned smaller weights. These weights were then normalized, as shown in Figure A-3.

VALUE WEIGHTS

VALUE	WEIGHT
EXPOSURE RISK	43
READINESS COST	17
FLEXIBILITY LOSS	9
POLITICAL	30

Figure A-3
VALUE WEIGHTS

It is important at this juncture to comment that although there was considerable disagreement about the appropriate course of action, there was very little disagreement in assessing the regrets with respect to the four measures and not very much disagreement in assigning weights to each of these measures. The reason is that the template approach decomposes the problem in such a way that the questions asked are very specific and unambiguous, and all of the assumptions underlying any particular issue are highlighted for all to see.

By using the value weights, the individual matrices were collapsed into a single or combined value matrix, (Figure A-4). This combined value matrix indicates that for no evacuation, a normal posture is preferred; for a permissive evacuation, the appropriate posture would be routine operations in the eastern Mediterranean; and for a nonpermissive evacuation, the appropriate posture would be the strongest, +COM's. That is, for each of these outcomes, those postures have associated with them the lowest regret. These results, however, were obtained under conditions of certainty, that is, assuming that it is known for sure which eventuality will occur. Because there is great uncertainty about the outcome, the next step was to carry out a sensitivity analysis to find out how changing the likelihood of these outcomes would affect the choice of a course of action (Figure A-5).

	COMBINED VALUE				
	NONE	P-300	P-2K	NP-2K	NP-6K
NORMAL	0	-17	-31	-74	-74
ROP EMED	-9	-9	-17	-71	-71
MOD LOC	-24	-22	-22	-30	-32
+COMMS	-30	-26	-26	-26	-26

Figure A-4
COMBINED VALUE MATRIX

	EXPECTED VALUE WHEN PROBABILITY OF NONE IS:										
	0	10	20	30	40	50	60	70	80	90	100
NORMAL	-57	-52	-46	-40	-34	-29	-23*	-17*	-11*	-6*	0*
ROP EMED	-51	-47	-42	-38	-34	-30	-26	-21	-17	-13	-9
MOD LOC	-27	-27	-27	-26*	-26*	-26*	-25	-25	-24	-24	-24
+COMMS	-26*	-26*	-27*	-27	-27	-28	-28	-28	-29	-29	-30
				↑			↑				

Figure A-5
SENSITIVITY ANALYSIS

To carry out the sensitivity analysis, the probability of no evacuation was varied from 0 to 100%, that is, from certainty that an evacuation would be required to certainty that an evacuation would not be required. Looking at the right-most column of Figure A-5, a situation in which no evacuation is required, normal operations is the preferred option. As we move to the left, the probability of no evacuation decreases or, correspondingly, the likelihood of an evacuation increases, and a normal posture remains the preferred posture until the probability of no evacuation decreases to 60%. At this point, the preferred course of action shifts to MOD LOC and remains there until the likelihood decreases to 30%; that is, there is now a 70% chance of an evacuation, and at this point the preferred posture switches from MOD LOC to +COM's. For each probability, the computer assigns an asterisk to the lowest regret in each column indicating the preferred course of action and places arrows at the bottom of those columns where transitions from one course of action to another occur.

A graphical representation of the sensitivity analysis appears in Figure A-6.

It is interesting to contrast the results of this sensitivity analysis, in which uncertainty is incorporated into the templated procedure, with the combined value matrix of Figure A-4. Looking at the combined value matrix under conditions of certainty, it was never the case that MOD LOC would be a preferred posture. Under conditions of uncertainty and risk, MOD LOC was one of the preferred postures, and routine operations in the eastern Mediterranean was never preferred. This highlights one of the advantages of templating: it allows risk and uncertainty to be directly incorporated into the analysis.

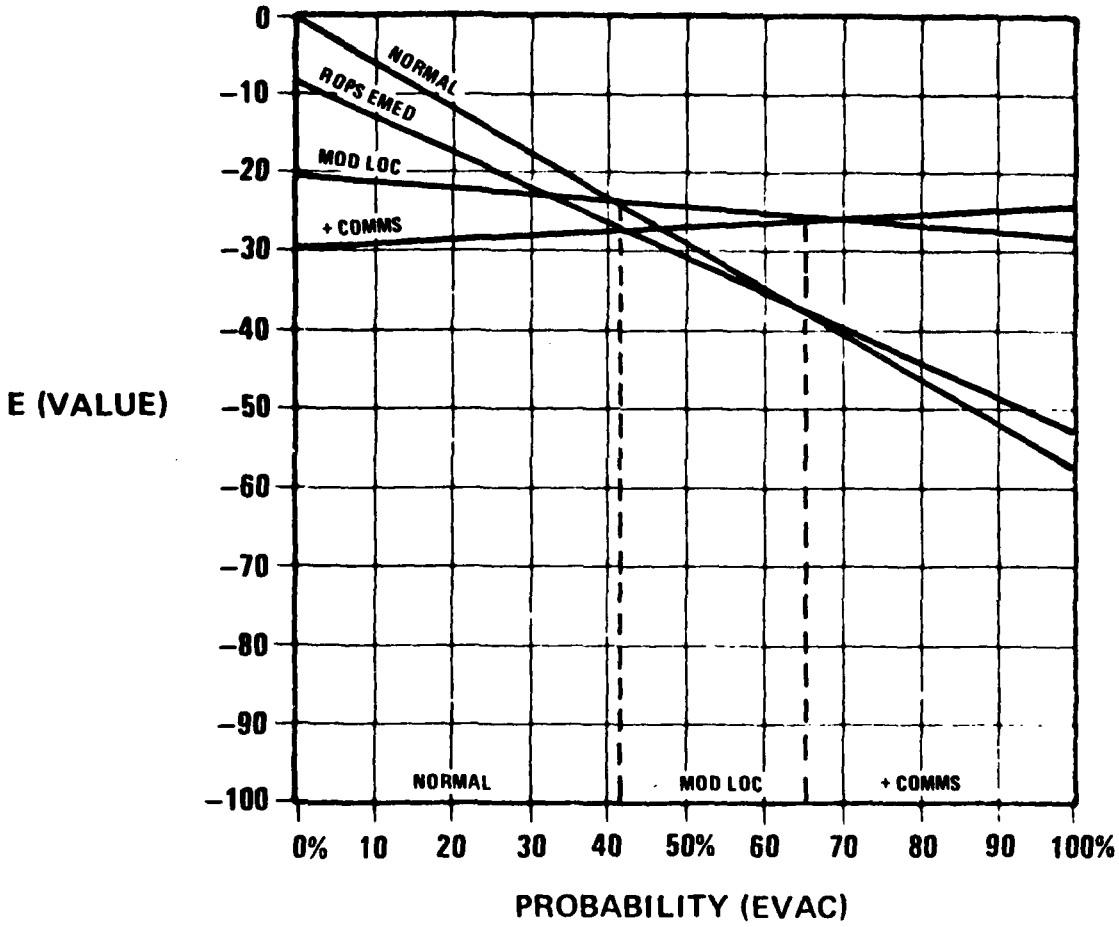


Figure A-6
SENSITIVITY ANALYSIS

The results of the sensitivity analysis provided a form of decision rule for the crisis management cell. If the probability of no evacuation were between 60 and 100%, then they should recommend a normal posture. If the probability of no evacuation were between 30 and 60%, then they should recommend a MOD LOC posture. And if the probability were between 0 and 30%, then the recommendation should be +COM's, the strongest posture. Thus, the next step in the analysis was to obtain an estimate of the probability of no evacuation from the J-2 personnel. This was done by using a conditional assessment technique which took into account the complex relationships among the various events described above. This structure (Figure A-7) was constructed using the model-building software and is an integral part of the templating procedure. The results of the J-2 analysis indicated that the likelihood of an evacuation was around 50% and, therefore, that a MOD LOC alert posture should be recommended.

In the Lebanon case, military personnel were able to use a generalized model and particularize it to a current situation in much the same manner that they would adapt a contingency plan to a new situation; the amount of time required to do this was approximately three hours. But in addition, they were able to perform "what if" analyses and examine the sensitivity of the recommended solution to changes or errors in the intelligence forecast, the importance weights, the regret judgments, or some combination of all of these. Indeed, in the analysis just described, military personnel were able to evaluate the consequences of twenty scenarios in a very short period of time. If, after carrying out these sensitivity analyses, the answer confirms their previously held opinion about the proper evacuation posture, the analysis then gives them added confidence and is helpful in developing the rationale to support their conclusions. If the analysis yields a contrary preference,

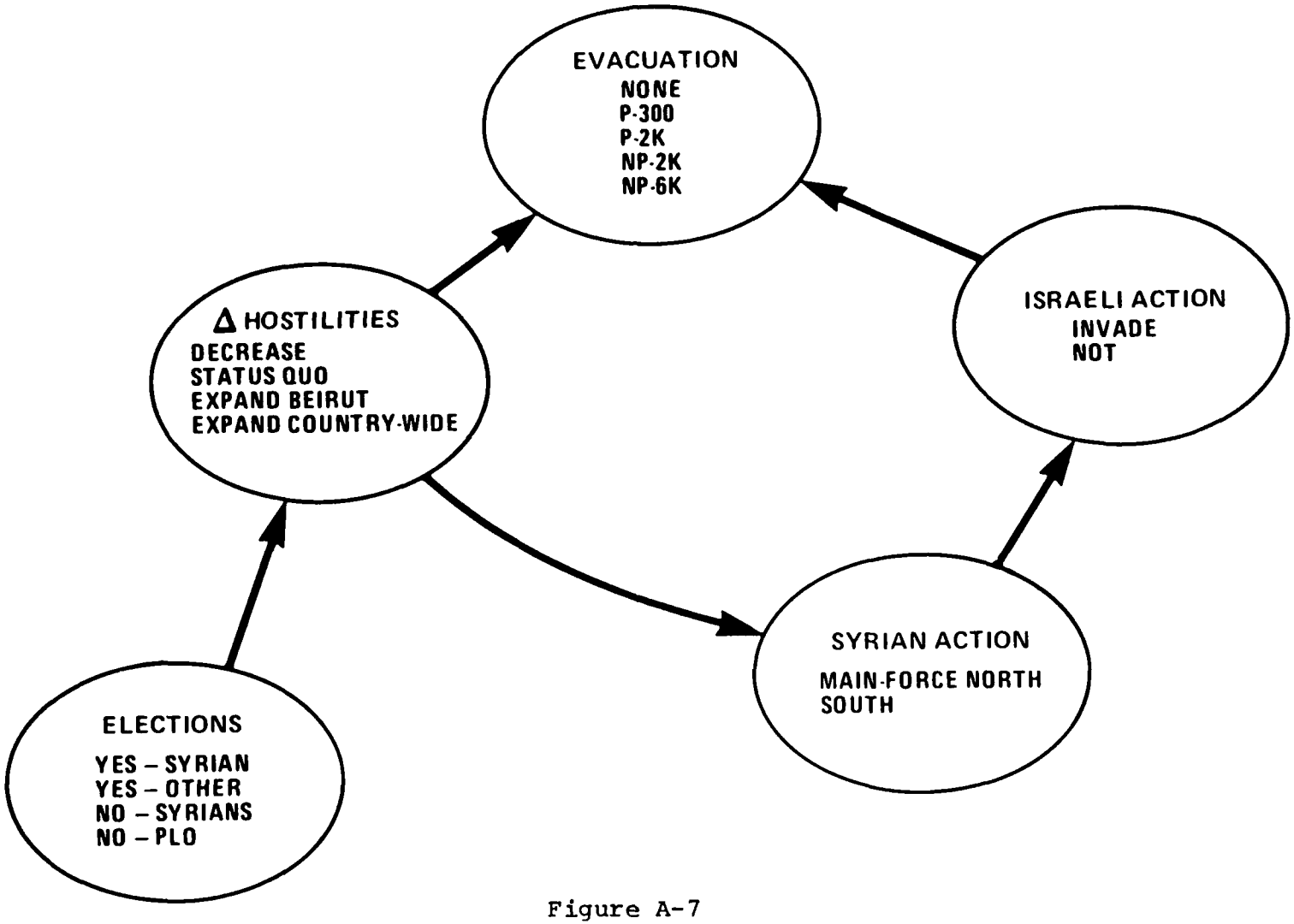


Figure A-7
CONDITIONAL ASSESSMENT STRUCTURE

the staff will no doubt withhold making a final recommendation until more data can be collected and additional assessments made.

One of the greatest advantages of this procedure is that it facilitates communication among different staff elements. They now not only know precisely where they disagree but by how much and what difference it might make. This enhanced communication among staff elements facilitates battle staff integration and reduces the likelihood of critical misunderstandings. In addition, by organizing the dialogue and debate among the crisis management cell members, it substantially accelerates development of a recommendation so that the staff is not overtaken by events.

In summary, what we have described is a formal procedure for structuring the judgments which would normally be made by staff in times of crisis. It requires that the staff identify alternative courses of action, that they consider various uncertainties which could affect the consequences of choosing any particular course of action, that they describe the consequence associated with each course of action and each possible outcome, that they identify criteria against which these consequences can be evaluated, and that they encode these consequences and key uncertainties numerically so that sensitivity analyses can be carried out to develop a recommended course of action.

While some of these steps can be carried out either intuitively or by using pencil and paper methods, we believe that the implementation of the procedure using a computer elicitation procedure provides several advantages. First, using the computer permits repitition of the calculations necessary to evaluate each possible course of action to test, at the direction of the user, the effect of changes in the inputs. In addition, the

computer software performs as a recording device: as the user structures a decision problem, the computer keeps track of and displays the lists of options, outcomes, and value dimensions. Finally, the computer facilitates the development of the problem structure by eliciting relevant information from the user.

APPENDIX B

THE RAMBO CRISIS

THE RAMBO CRISIS

PART ONE

Situation

Intelligence analysts have been concerned with the apparent introduction of defensive surface-to-air and offensive surface-to-surface missiles into the tiny island country of Rambo. The missiles, allegedly located in the small military base of El Freba, pose a serious threat to nearby U.S. installations and transient aircraft.

The Premier of Rambo is a charismatic but fanatical leader who has denounced the U.S. endlessly for years. However, the pace and intensity of his accusations have increased markedly during the past two months. Early this morning he issued a lengthy, emotional, and bizarre world-wide proclamation accusing the U.S. of numerous recent deprivations and provocations, including an attempted assassination attempt on him. He threatened armed retaliation. The proclamation has incited the Rambo citizens to a fever pitch. The government-controlled press is calling for action. Volunteer reserve units have spontaneously begun to report to the base at El Freba.

The U.S. National Command Authority (NCA) believes that if the missiles have in fact been introduced to Rambo, they will be used against the U.S. There seems to be a clear and present danger. The latest intelligence estimate assigns a 60% probability that the missiles have been emplaced; a 40% probability that they have not.

Action

The NCA is considering two courses of action:

CA1 -- RAID. Conduct a helicopter-borne night raid on El Freba; destroy all offensive weapons.

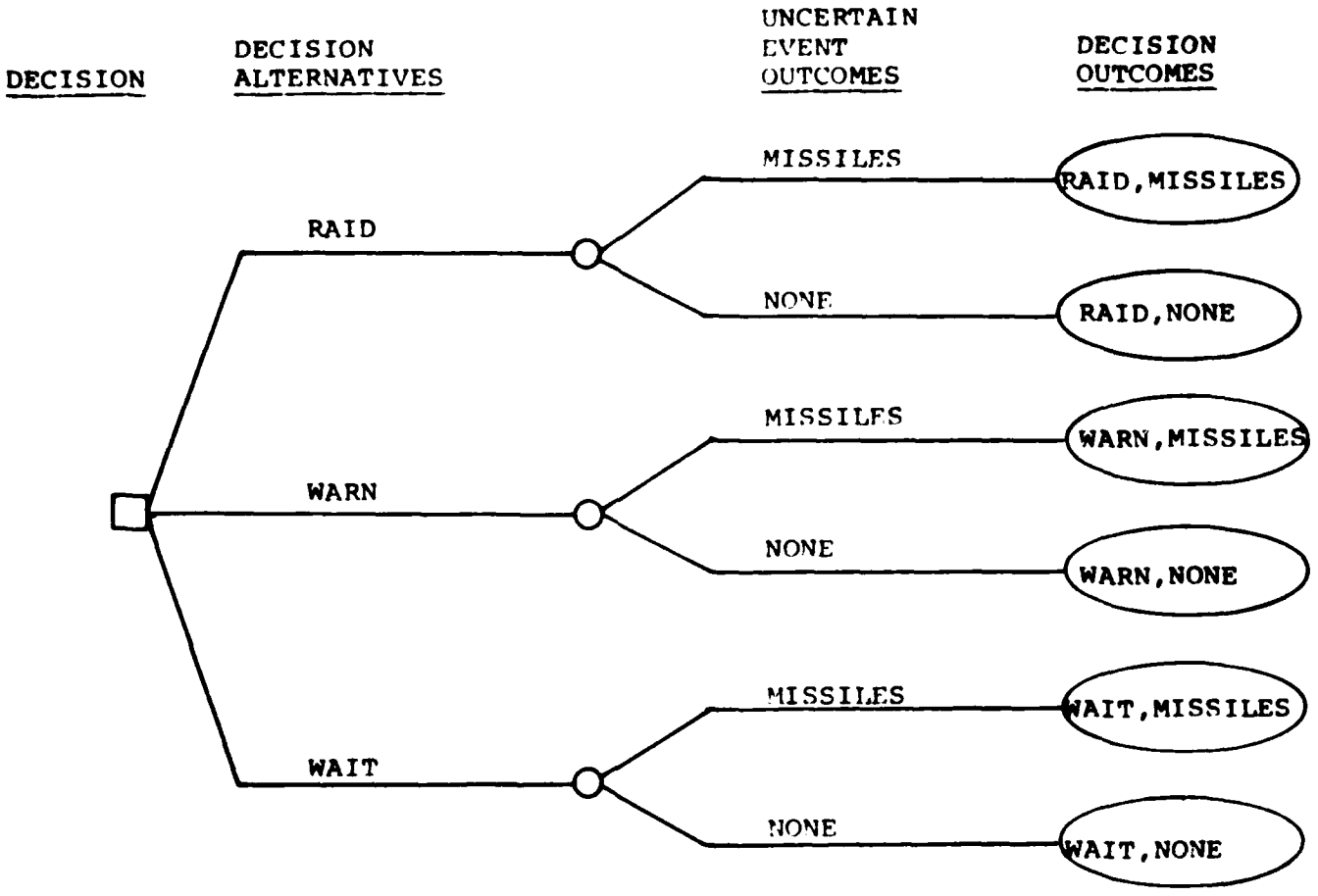
CA2 -- WARN. Issue a stern warning to Rambo that the missiles must be removed within 48 hours.

Note that there is also a third, passive course of action: to postpone the decision. That course should also be included in the decision-making deliberations.

CA3 -- WAIT. Do nothing; await further developments.

Analysis

The following decision tree applies to the Rambo situation.


DECISION
DECISION ALTERNATIVES
UNCERTAIN EVENT OUTCOMES
DECISION OUTCOMES
RAID
WARN
WAIT
MISSILES
NONE
MISSILES
NONE
MISSILES
NONE
RAID,MISSILES
RAID,NONE
WARN,MISSILES
WARN,NONE
WAIT,MISSILES
WAIT,NONE

Assume that the following three criteria are relevant to the decision problem:

- o DOMESTIC AFFAIRS
- o FOREIGN AFFAIRS
- o NATIONAL SECURITY INTERESTS

Assignment 1. Consider the relative attractiveness of the six possible decision outcomes shown on the decision tree. For each criterion, identify the best and the worst outcomes.

Complete the following table.

CRITERION	BEST DECISION OUTCOME	WORST DECISION OUTCOME
DOMESTIC AFFAIRS		
FOREIGN AFFAIRS		
NATIONAL SECURITY		

Assignment 2. Consider the relative importance of the difference between the best and the worst outcomes for the three criteria. Rank the criteria in order of importance, ranking the most important criterion #1, etc.

DOMESTIC AFFAIRS _____
FOREIGN AFFAIRS _____
NATIONAL SECURITY _____

Assignment 3. Maintaining the same rank order, scale the decision criteria based on the importance of the difference between their best and worst decision outcomes. Start by assigning the criterion that you ranked #1 a score of 100. Assign equal or diminished scores to the other two criteria.

DOMESTIC AFFAIRS _____
FOREIGN AFFAIRS _____
NATIONAL SECURITY _____
TOTAL _____

Assignment 4. Normalize the three scores so that they total 100%. (Divide each score by the total score.)

DOMESTIC AFFAIRS _____
FOREIGN AFFAIRS _____
NATIONAL SECURITY _____

Assignment 5. A regret is an expression of the relative degree of dissatisfaction, or loss of opportunity, associated with a decision outcome. Values of regret range from 0 (no dissatisfaction) to -100 (maximum dissatisfaction). You will assess values of regret for each of the six decision outcomes, first with respect to one criterion, then the others.

a. Considering only the impact on domestic affairs, complete the following regret matrix. Use the step-by-step procedure outlined below.

	MISSILES	NONE
RAID		
WARN		
WAIT		

REGRET MATRIX
DOMESTIC AFFAIRS

b. You have already identified the best and worst decision outcomes for this criterion. Assign a regret value of 0 to the best decision outcome and a value of -100 to the worst.

c. Each column in the matrix represents one outcome of the uncertain event. You just put a regret of -100 in one of the columns. Now identify the worst outcome in the other column. Compare it with the overall worst outcome (-100) and assign it an appropriately scaled value of regret.

d. One column has a zero in it. Considering the other column, find the best outcome and assign it a regret of 0 also. (Given that the event represented by the column occurs one course of action must be judged best relative to the others.)

e. Proceeding column by column, complete the matrix. Each intermediate regret value must fall between the two regrets already assigned, inclusive. (Identical values of regret may be assigned to different outcomes.)

f. Using the same general procedure, complete the two remaining regret matrices.

	MISSILES	NONE
RAID		
WARN		
WAIT		

REGRET MATRIX
FOREIGN AFFAIRS

	MISSILES	NONE
RAID		
WARN		
WAIT		

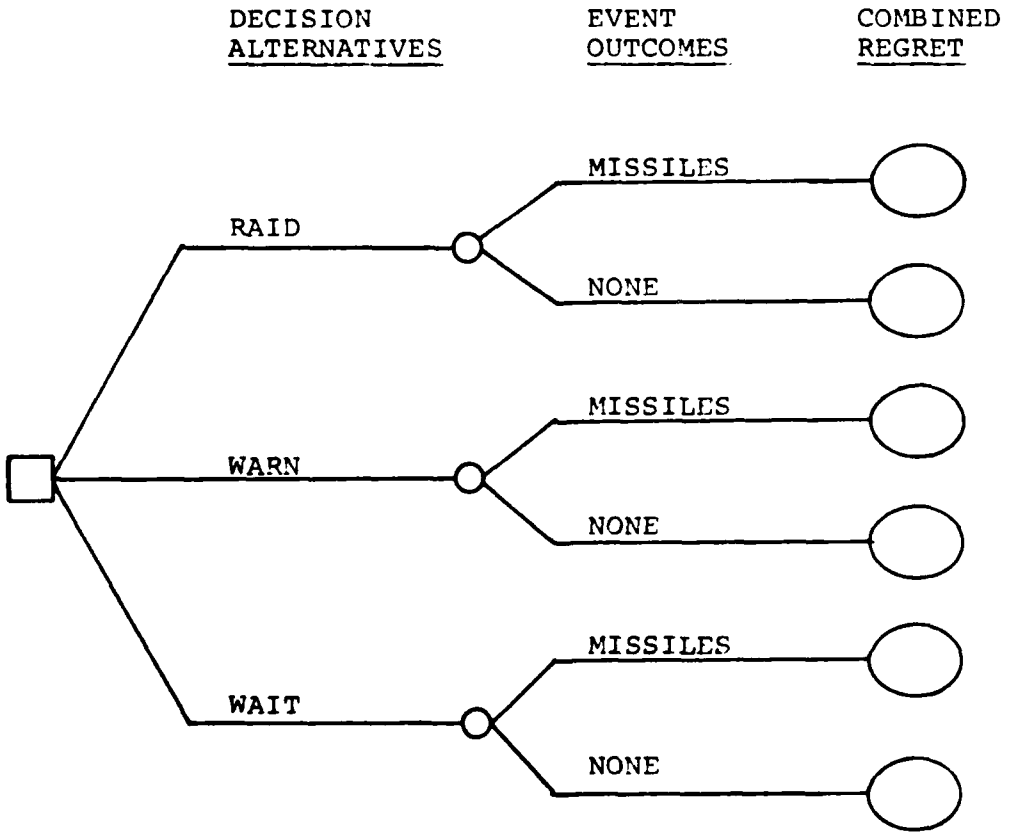
REGRET MATRIX
NATIONAL SECURITY

Assignment 6. Calculate a combined value regret matrix. For each outcome, multiply each individual criterion regret by the weight of the criterion and add the three weighted regrets together.

	MISSILES	NONE
RAID		
WARN		
WAIT		

REGRET MATRIX
COMBINED VALUE

Assignment 7. Solve the decision tree and, based on the expected regrets, recommend a course of action.



PART TWO

Purchasing Information

A fourth course of action is now under consideration: to establish contact with an agent in Rambo. The agent is considered 80% reliable. However, this is a very dangerous course of action; there is an even chance that both of the agents involved will be uncovered and imprisoned.

Assignment 1. Amend the decision tree to reflect the addition of the new course of action. Include any new uncertain events, subsequent decisions, decision outcomes, and decision criteria.

Assignment 2. Assume the contact was made successfully, and the agent reports that missiles have indeed been introduced. Revise the current intelligence estimate to reflect that evidence. That is, complete the following table:

EVENT	CURRENT ESTIMATE	REVISED ESTIMATE
MISSILES	60%	
NONE	40%	

Assignment 3. Repeat the above assuming that the agent reports no missiles.

EVENT	CURRENT ESTIMATE	REVISED ESTIMATE
MISSILES	60%	
NONE	40%	

Assignment 4. Discuss the procedure for solving the new decision tree.