Technical Report PQTR-1046-77-9
Contract MDA903-77-C-0184
ARPA Order No. 3344
September 1, 1977

AN INTERACTIVE COMPUTER AIDING SYSTEM FOR GROUP DECISION MAKING

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NOTES

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This report describes progress on work centered on the demonstration of an interactive computer aid for group decision making.

The report includes: (1) a new sensitivity algorithm for decision tree analysis that incorporates information about individual differences in judgmental knowledge, (2) procedures for identifying and resolving utility conflicts, (3) a refined version of the group/machine and (over)

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20. ABSTRACT (Continued)

intermediator/machine interface and displays, (4) a preliminary problem scenario booklet to be used in the system's empirical evaluations, and (5) a report on the project's software development efforts. The next phase of the program will concentrate on the system's implementation, operational testing, and initial evaluation.

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1.1 Report Period

The second quarter of contract activity involved: (1) defining an improved sensitivity algorithm, (2) analysis and design of group multi-attribute conflict resolution procedures, (3) further refinement of the group/machine interactions, (4) construction of a problem scenario, and (5) software development. The following specific tasks were accomplished during the report period.

(1) A new sensitivity algorithm which attempts to incorporate information on individual judgemental knowledge was designed. In addition, the new algorithm permits the evaluation of decision worthwhileness as a guide to the value of utility conflict resolution.

(2) Specific conflict resolution procedures were defined for using multi-attribute utility model procedures in interactive group decision making.

(3) The group/machine and the intermediator/machine interfaces were refined further and tested through mock simulations of system operation.

(4) As part of the experimental design materials for evaluating the group decision aiding system, a draft of a briefing booklet describing a terrorist situation was written.

(5) A detailed system design was completed which includes a program design language description (PDL) of principal system modules and their operation. Interface software for various terminals and graphics functions was designed and implemented.

1.2 Next Period

The contract activity during the next quarter will primarily concentrate on the system implementation and its operational testing. In addition, the experiments and materials for evaluating the initial system will be completed and preliminary experiments will be conducted. The specific items of work for the next period include:

(1) Code, test, and integrate components of the detailed software design on the PDP 11/45 computer system.

(2) Conduct operational tests of the entire group aiding system through practice sessions using in-house personnel as participants.

(3) Plan, define, and prepare the tests for evaluating the group aiding system and finalize the scenario briefing booklet and procedures.

(4) Perform initial system evaluation using participants selected from military reserve groups, police units, and other representative user populations.

1.3 Program Milestones

The milestone chart for the contract program is shown in Figure 1-1, with the report period illustrated as the shaded portion.

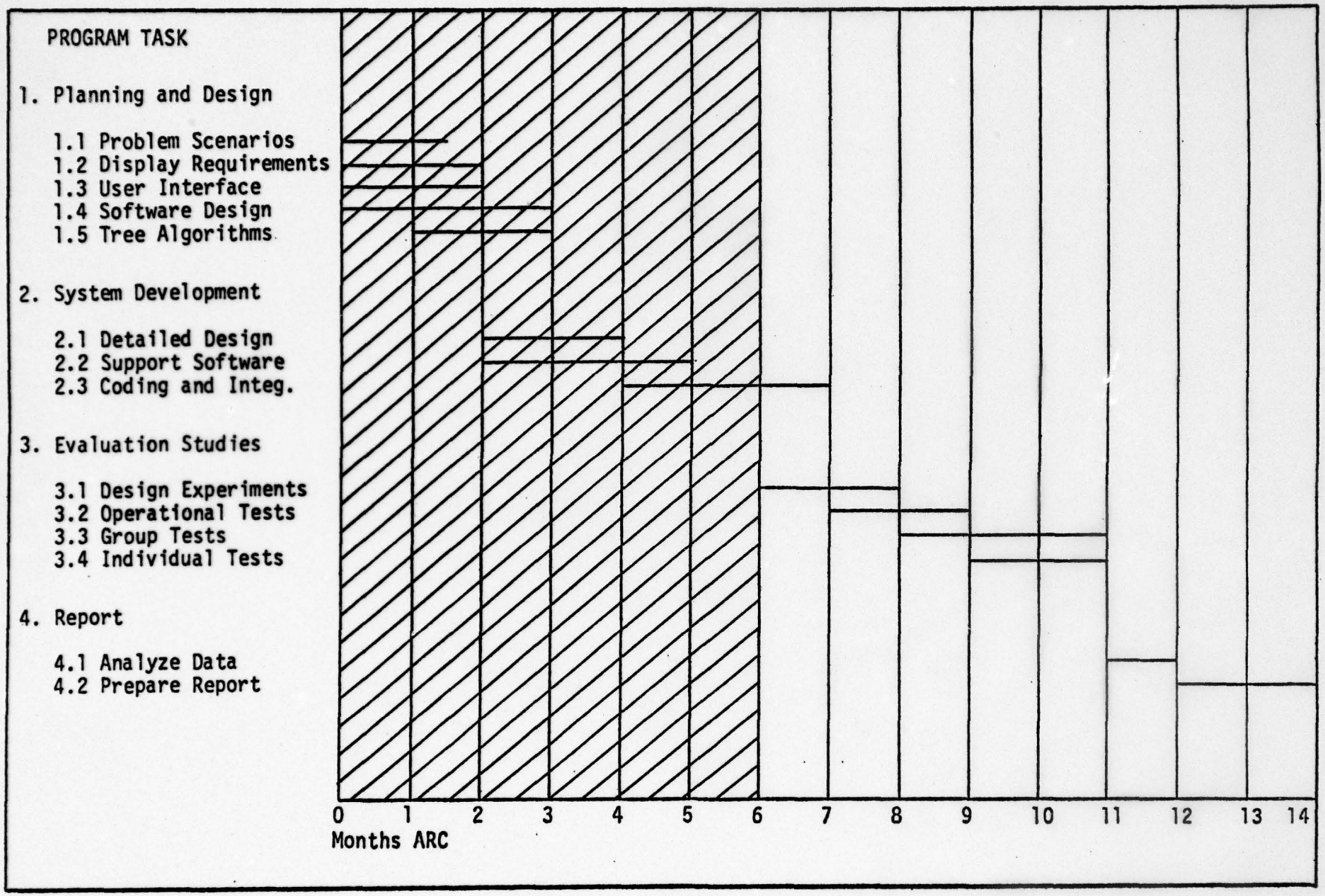


FIGURE 1-1. PROGRAM MILESTONES

2. PROGRAM OVERVIEW

2.1 Statement of Problem

Constant escalation in weapons cost and effectiveness, as well as the increasing complexity of international relations, makes military decision making more critical today than ever before. In today's military environment, most upper-level decisions are made by committees and staff groups. Typically, such groups contain experts from several speciality areas, who bring to the decision environment disparate sets of values. Decision time is usually limited, the decision making procedure is relatively unstructured, and intragroup conflicts arise on a broad variety of issues. Consequently the group is unable to consider the maximum set of alternatives, conflicts are not resolved in an optimum manner, and the resultant decision is rarely up to the aggregate potential of the group membership.

2.2 Rationale

Decision analysis offers a promising approach to solving these problems. The analytical procedure of building a decision tree formalizes the decision process, and permits incorporation of individual values (utilities) into the selection of alternative courses of action (Hays, O'Connor, Peterson, 1975). However, decision analysis as it is usually practiced is a highly personal and time-consuming process. Decision analysts are often called upon to assist in the solution of problems ranging over a large variety of domains. In most cases the decision analysts know far less about the problem domain than do their clients. Thus their contributions are confined primarily to the phases of formalization and optimization. While optimization is usually computer assisted, the formalization phase invariably has been accomplished

manually, using lengthy interviews of persons more familiar with the problem area. This approach is generally incompatible with the conditions of command group decision making.

Accordingly, it would be highly worthwhile to automate the formalization phase, using an interactive computer system to interrogate the group members and to construct a decision tree based on their responses. The purpose of the research undertaken here is to develop and evaluate the means by which such an interactive aid could be used to improve group decision making.

2.3 Objectives

The goal of the research program addressed in this progress report is to develop an automated decision tree elicitation system using on-line sensitivity analysis with direct real-time group feedback and evaluate its effectiveness in aiding group decision making.

The specific objectives of the current program include the following:

(1) Develop computer programs for efficient, comprehensive, elicitation of decision trees from a decision making group.

(2) Develop computer programs for identifying structural and numerical differences among the contributions of individual group members, for merging these contributions and for resolving the points of conflict.

(3) Develop effective means for displaying to the group the results of the elicitation procedures and conflict analyses.

(4) Integrate the various programs and techniques into a complete aiding system which can be readily transferred to other test environments.

(5) Experimentally test the group decision aid, using a variety of representative military decision problems, to demonstrate its advantages under realistic conditions of use.

(6) On the basis of the developmental effort and the experimental results, establish guidelines and recommendations for future military applications of the group decision aiding methodology.

3. SENSITIVITY ANALYSIS UNDER JUDGMENTAL DISAGREEMENT

3.1 Introduction

Disagreements among "experts" can be classified into two categories: (1) conflict of interest, and (2) knowledge disagreement. Conflict of interest occurs when the group members compete on the consumption of limited resources. Knowledge disagreements arise when the group members agree on the ultimate desirable goal, but differ in their opinion as to how this end goal could best be achieved.

3.2 Knowledge Disagreement

Knowledge disagreement may show up in both dispersive probability and utility estimates, and is caused by two main factors: diverse experiences, and diverse analysis. It is clear that two persons exposed to two different experiences could have different opinions as to what goes on in the world (probability conflict) and what is good for mankind (utility conflict). However, even when exposed to the same experience, and even having interpreted this experience equally, two people can still express opposing opinions simply because they use different mental procedures to access knowledge and relate it to decision situations. Techniques for achieving consensus in group situations should treat both sources of knowledge disagreement.

3.2.1 Disagreement from Diverse Experience. Consider the following example: If I have seen only 2-tail coins, and you observed only 2-head coins throughout our experience, no technique in the world can be employed to inspire consensus among us concerning what we saw in the past. However, after hearing your opinion that all coins are double headed, I may be willing to modify my knowledge about coins and introduce the possibility that there might be two bags of coins in the world and that we are both

victims of selective sampling. I would be more inclined to do so if instead of insisting on general statements such as "all coins are double headed," you would moderate your tone and describe the circumstances leading you to such a conviction. At that time, trusting your reliability as an experience transducer, I may wish to amalgamate your experience with that of mine to form a more faithful picture of the world. For this to happen it is important that:

(1) I am given a chance to hear your opinion;

(2) You are willing to expose not only your opinion, but also its origin;

(3) I am somewhat familiar with you in order to form a model of your relation with the experimental world.

Consequently, disagreements from diverse experience can be resolved with further discussion that illuminates individual positions.

3.2.2 Disagreement from Diverse Analysis. The second source of knowledge disagreement, that related to limited analytical power, can be exemplified as follows. For example: When I am going to buy a car, I may suddenly be reminded that my children must go to college, at this time the price assumes ample importance. A moment later I imagine dashing through the streets with a new convertible, and so on. My inability to digest all the future ramifications of my action at one time may cause my estimate to become erratic and vulnerable to external influence. Such fluctuations with any one individual would naturally cause a disagreement when group judgments are compared, since different group members may focus their intention on different aspects of this problem at any given time. These differences can be resolved by continued tree expansion or multi-attribute

utility analysis, but do not necessarily benefit from group instruction. (It might, however, be assisted by the latter.)

3.3 Identifying Forms of Disagreement

In view of these considerations, it appears that the proper method of treating disagreement should depend on its origin; disagreements stemming from diverse experiences should be treated by group interaction while those generated by a limited mental analysis could best be resolved by continued analysis of individual trees. How then can one discriminate between these two sources of disagreements? We submit that the latter could be identified by the degree of confidence the group members assign to their own estimates. When a utility or probability estimate is a coherent representation of one's experience, the individual would not find it hard to express the estimate with a definite numerical value. On the other hand, when the estimate depends on which part of his knowledge network the individual chooses to explore at any given time, a definite number would be hard to come by and a range for the possible values of the estimate would be more representative of that individual's state of knowledge. This argument leads to the following test: Ask the group members to provide, not a single estimate, but a range for the utility or probability estimates. If the individual ranges are large, compared with the differences among the group members, continue with expansion of individual trees, otherwise stop and conduct an interactive session.

3.4 Tree Expansion and MAU Analysis

In the preceding argument, we have treated tree expansion on the same level as MAU analysis. Indeed the two have a lot in common. Both techniques aim at achieving a more accurate estimate and both accomplish this goal by first separately obtaining a person's estimate on the various components which make up the situation, and then by combining the estimates

mechanically. The question "How important is price to you?" is essentially identical to "Assume you paid a high price for this car, try to place a value on this situation." The structure of reasoning underlying MAU analysis is a condensed version of a decision tree whereby the attribute weights correspond to the provisional values of decision alternatives and the attribute levels correspond to event's alternatives.

MAU structure is a non-condensed form of its equivalent tree structure because the latter is highly redundant when the assumptions leading to the MAU model are valid. It is clear that every MAU model has an equivalent (redundant) decision tree model. What is not obvious is whether a given decision tree has sufficient redundancy to be collapsed into a equivalent MAU model. The practical import of this question lies in deciding which conflict resolution technique to use at any given node: MAU procedure or continued tree expansion. At this time it appears to us that such a decision cannot be mechanized, but should be delegated to the human mediator. The basic difficulty in obtaining some sort of computerized aid for such a decision is that the latter depends primarily on the property of the tree emanating from the node in question and so, very little information, if any, on that structure is available from the data collected so far.

3.5 Node Selection

At this point, we turn our attention to the problem of which node should next be selected for expansion, regardless if the expansion is in the form of tree expansion of MAU analysis. In answering the question above, one should keep in mind the ultimate purpose served by expansion, i.e., obtaining more accurate estimate of the values at the tip nodes so that the final decision adopted will yield a higher (expected) overall utility. In this respect, node expansion can be considered as an experiment whose outcome assists in adopting a better decision, and the problem of

selecting a node for expansion becomes that of selecting an experiment, which if performed, would result in the highest increase in the expected utility of the root node.

There are, however, several major differences between the problem of node selection and that of evaluating experiments. First, experiments have traditionally been characterized by conditional probability matrices expressing the probability that a given experimental outcome will be realized assuming that a given state of the world prevails. Such information is hardly available from the nodes of a partially expanded tree. If the provisional values estimates are the only information we have on the tip nodes, then all models have the same priority as contenders for expansion, or, no expansion at all seems necessary. The need for expansion surfaces only when the belief of sharpening the accuracy of value estimates via expansion is given formal characterization.

Fortunately, in a group decision environment, we possess additional information on nodes aside from their provisional values, that is, the disposition or variance of the provisional values among the group members. That dispersion is an indicator of the range where the final back value might be found after expansion. However, since the group dispersion is a by-product of two factors, experience differences and analytical shortcomings, only the latter contribution stands to be resolved by expansion. A better measure of the latter contribution would be the mean individual assessment of the range of the provisional value. To this end, it is advantageous to characterize each node by three parameters. V, Δ_G, and σ where if $V_j^{(1)}$, $V_j^{(2)}$ are the low and high range values given by individual j, respectively,

then:

$$V = \frac{1}{n} \sum_j \frac{1}{2} (V_j^{(1)} + V_j^{(2)}) \qquad \text{(mean provisional value)}$$

$$\Delta_G = \sqrt{\sum_j [\tfrac{1}{2}(V_j^{(1)} + V_j^{(2)}) - V]^2} \qquad \text{(group dispersion)}$$

$$\sigma = \frac{1}{n} \sum_j \frac{1}{2} (V_j^{(2)} - V_j^{(1)}) \qquad \text{(mean individual dispersion)}$$

We take Δ_G to indicate that range around V where the node value is likely to be after resolving differences resulting from diverse experiences, i.e., after conducting an interactive discussion. We take σ to indicate the range around V where the node value is likely to be found after gaining further visibility into one's knowledge base, i.e., after conducting node expansion on individual trees.

For the sake of evaluating the value of expansion versus discussion, we assume the following conditional probabilities:

$$\text{Prob.}[v<x|V] = \begin{cases} \frac{1}{2\sigma} & V-\sigma<x<V+\sigma \\ 0 & \text{otherwise} \end{cases}$$

where V stands for the backup value after expansion (discussion).

The analysis to follow will refer to evaluating the worthwhileness of expansion, that of discussion, as idential with replacing σ by Δ_G.

A second difference between evaluating experiments and evaluating node expansion lies in the fact that experiments are evaluated in isolation while node expansion should take into account the fact that several expansion stages are likely to take place before a final action has to be decided upon. However, an analysis of the value of sequences of nodes expanded would require both excessive computation and additional knowledge to be elicited. As a first order approximation, we assume:

(1) That the range values acquired measure the range of V after <u>one expansion level</u> (not total expansion);

(2) That the worthwhileness of node's expansion has the same ranking as the expected value of the root node assuming an action is to be decided <u>immediately after the result of expanding one node becomes known</u>.

With these two assumptions, a calculation of the value of node expansion has been carried out with the following result:

$$\Delta U_i = \begin{cases} \frac{\Pi_i}{4\sigma_i} (\sigma_i - S_i)^2 & \text{For } \sigma_i > S_i \\ 0 & \text{otherwise} \end{cases}$$

where

ΔU_i is the expected increase in the utility of the root node as a result of expanding the ith node.

σ_i is the dispersion in the provisional value assigned to node i.

S_i is the sensitivity differential of the ith node (Leal, 1977, pages 4-11) computed top-down (with V's as inputs). It is the

change required in the provisional value of node i to cause a chance in the choice of the provisionally most promising action.

Π_i is the product of all probability labels on the arcs leading from the root to node i.

The interpretation of the ΔU_i formula is as follows: all nodes whose anticipated swing in value (σ) is less than the amount necessary to cause a change in the currently most promising action(s) have zero expansion value. Otherwise, the expansion value is proportional to the mean overswing $\frac{\sigma - S}{2}$ times the probability of overswing occurrence $\frac{1}{2\sigma}$. The proportionality factor Π_i scales down the amplitude of the overswing at the node level to match its influence on the value of the root node.

With the help of the ΔU_i formula, we envision the following procedure for deciding on continuing expansion:

(1) For each tip node calculate ΔU_i

(2) Choose for expansion the node with highest ΔU_i

Note that ΔU_i can be calculated recursively from root to tip, since S_i is calculated that way.

Note also that the value of interaction discussion concerning node i, $\Delta U^G{}_i$, can be evaluated using the same formula with Δ_{G_i} replacing σ_i. Thus, the mediator inspecting the two values: $\max_i \Delta U^G{}_i$ and $\max_i \Delta U_i$ can decide whether to proceed with individual tree expansion or with group discussion.

From a practical viewpoint, one should also attempt to keep the group within the same context of affairs and to avoid jumping to a different scenario even when it promises a high ΔU_i. This consideration could be satisfied by setting a threshold value for ΔU_i below which no change of context could take place.

4. MULTI-ATTRIBUTE UTILITY MODEL PROCEDURES FOR INTERACTIVE GROUP DECISION MAKING

4.1 Introduction

One can expect several types of intragroup conflicts during the tree-building process. Conflicts regarding decision alternatives and their possible outcomes are easily resolved by merger or trimming. Conflicts regarding probabilities can also be handled in standard fashion. Conflicts regarding utilities, however, are anticipated to produce the most severe disagreements during group interaction, because they directly reflect differences in the value structures that group members bring to the decision problem. In such cases, multi-attribute utility analysis provides a means for arriving at the required single utility by decomposing the specific alternative or outcome into its constituent attributes or dimensions.

Gardiner and Ford (1976), as well as Sheridan and Sicherman (1976), have shown that through group elucidation of values on each attribute separately, a more accurate picture of the utility conflict is achieved, and therefore agreement can be more readily reached. The process allows each decision maker to present his own viewpoint on the critical aspects of the problem, while leading the group as a whole to an eventual consensus. (Such a local decomposition is, of course, not necessary if everyone agrees immediately on global utility assignments for the set of alternatives.)

4.2 Nomenclature

(1) Attributes. Attributes are characteristics of the decision problem. For example, in purchasing a car some typical attributes are size, cost, maintenance, etc.

(2) Attribute Weights. The attribute weights are values assigned to each attribute to describe the relative importance of that attribute. Weights must sum to unity.

(3) Attribute Levels. The attribute levels are values assigned to each attribute to describe the amount of that attribute possessed for a particular decision problem. For example, the weight given to low cost for a car may be high, say .9, but for some specific car being judged, the level of attribute could be quite low, say 10, on a scale of 0 to 100. That is, cost is important, but on a Rolls Royce the cost is very high. Thus, we assign a low level for this attribute.

(4) Utility. The utility for an attribute is defined as the product of its corresponding weight and level for an alternative or an individual decision maker.

(5) Weighted Utility. The weighted utility is the sum of the utilities across all attributes on each alternative (or decision maker in the case of the group decision aiding system).

4.3 Determining When and How To Resolve Utility Conflicts

A critical observation regarding utility elicitation and subsequent conflict resolution is that not all conflicts need to be resolved. A computer program that is assisting or directing a group in the elaboration of a decision structure should only direct the group to resolve those conflicts which are likely to impact the decision structure. Conflicts worth resolving can be identified using sensitivity analysis on the current decision structure. Figure 4-1 shows a simple decision tree that illustrates this point.

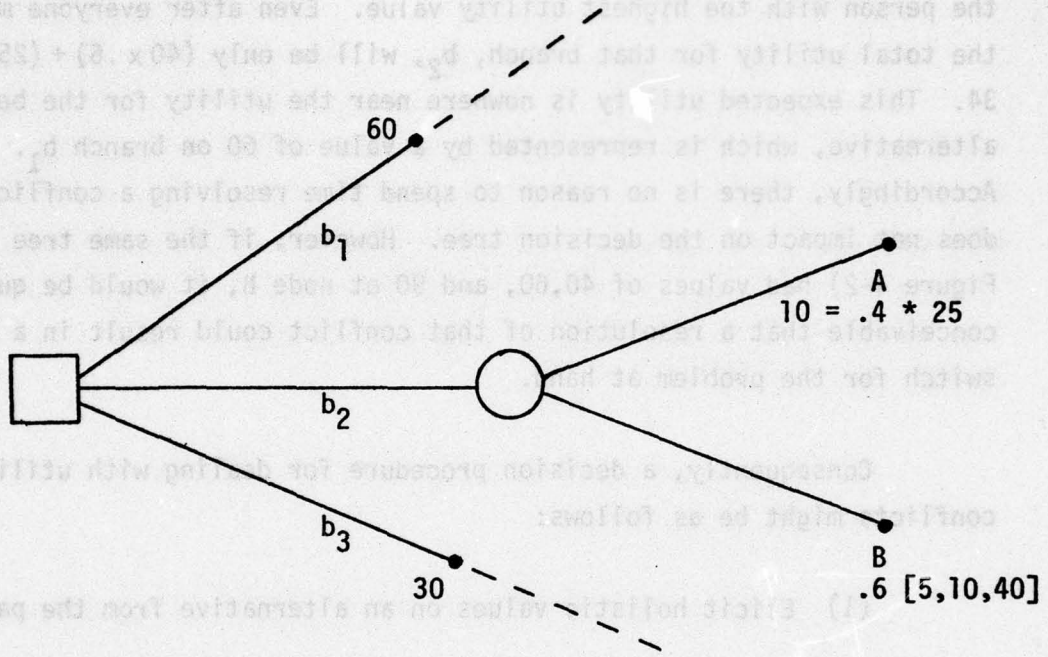


FIGURE 4-1. CONFLICT RESOLUTION UNNECESSARY

What is the value of resolving the utility conflict at node B of three people represented by the values 5, 10, and 40 in Figure 4-1? The answer may be very little. Consider if everyone adopts a value of 40; this means that everyone changes their utility estimate to match that of the person with the highest utility value. Even after everyone moves up, the total utility for that branch, b_2, will be only $(40 \times .6) + (25 \times .4) = 34$. This expected utility is nowhere near the utility for the best current alternative, which is represented by a value of 60 on branch b_1. Accordingly, there is no reason to spend time resolving a conflict that does not impact on the decision tree. However, if the same tree (see Figure 4-2) had values of 40,60, and 90 at node B, it would be quite conceivable that a resolution of that conflict could result in a decision switch for the problem at hand.

Consequently, a decision procedure for dealing with utility conflicts might be as follows:

(1) Elicit holistic values on an alternative from the participants.

(2) If the maximum holistic value from the group will not significantly affect the decision structure, average the holistic values and proceed even if those values are in conflict.

(3) If this decision could conceivably have some impact on the structure, then elicit attribute weights and levels from the group.

(4) Calculate new weighted utilities.

(5) If there is now agreement then quit and return the new aggregate group utility.

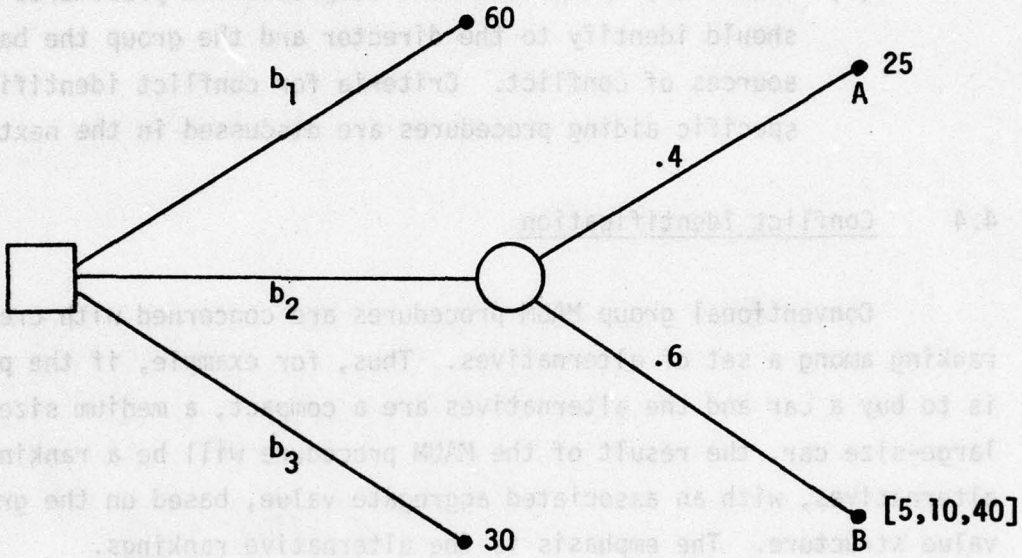


FIGURE 4-2. CONFLICT RESOLUTION NECESSARY

(6) If there is a minimal amount of conflict and/or this looks like a small-to-medium importance node then ask the group to directly estimate a new utility or suggest a new value to each person and get their confirmation.

(7) Otherwise, invoke the more comprehensive procedures which should identify to the director and the group the basic sources of conflict. Criteria for conflict identification and specific aiding procedures are discussed in the next section.

4.4 Conflict Identification

Conventional group MAUM procedures are concerned with creating a ranking among a set of alternatives. Thus, for example, if the problem is to buy a car and the alternatives are a compact, a medium size, or a large-size car, the result of the MAUM procedure will be a ranking of these alternatives, with an associated aggregate value, based on the group's value structure. The emphasis is the alternative rankings.

In the context of resolving utility conflicts for a group decision structure, the emphasis is not on relative alternative rankings but on obtaining a group utility on just one alternative. Thus, our interest is directed below the level of alternatives to the atomic values (i.e. weights and levels) from which the group members' utilities have been calculated.

For the following examples, assume weighted utilities have been calculated from a preliminary MAUM procedure and there is disagreement. There are three major cases of utility conflict.

4.4.1 Case 1: Attribute Conflicts. There is identifiable disagreement on one or more attributes. A simple case is shown in Figure 4-3. The numbers in

	D_1	D_2	D_3
A_1	5	5	60
A_2	20	20	20
A_3	20	20	20
	45	45	100

FIGURE 4-3. ATTRIBUTE CONFLICT

the table are utility values calculated by multiplying a vector of attribute levels times a vector of attribute weights for each group member. A_1, A_2, and A_3 represent three attributes, and D_1, D_2, and D_3 identify three group members.

There is clearly disagreement on attribute 1. However, as we shall see, that disagreement may be due to biases in weighting, levels, attribute definition, or attribute resolution.

4.4.2 Case 2: Individual Conflicts. There is identifiable disagreement stemming from one or more specific group members. Figure 4-4 illustrates this case. This disagreement is really not across attributes but solely because group member 1 is at odds with everyone else.

4.4.3 Case 3: Combinational Conflicts. There is disagreement, but it is "hidden" in the utility table. That is, it is not clearly assignable to specific persons or attributes. Figure 4-5 is an example of this type of disagreement. Each person appears to be in disagreement across all attributes and with all other group members.

4.4.4 Further Conflict Identification. For each type of conflict described above, it is sometimes possible to identify the conflict source in greater detail. The next section discusses how to identify specific types of conflicts and appropriate resolution procedure.

4.5 Conflict Resolution

In general, the group decision aiding system will always attempt to suggest to the director or the group what it believes to be the major source or sources of conflict. Sometimes the system will be able to pinpoint the exact conflict area and its cause. At other times, the system will only be able to suggest the most probable conflict area. This

	D_1	D_2	D_3
A_1	5	30	30
A_2	5	30	30
A_3	5	35	35
	15	95	95

FIGURE 4-4. INDIVIDUAL CONFLICT

	D_1	D_2	D_3
A_1	0	25	70
A_2	0	5	20
A_3	6	0	10
	6	30	100

FIGURE 4-5. COMBINATIONAL CONFLICT

section describes means of identifying different forms of conflict and appropriate conflict resolution strategies.

4.5.1 Attribute Conflicts.

Case 1a: Attribute Level Conflicts. In this case the utility disagreement arises from differences in level estimation. For example, the utilities for attribute 1 in Figure 4-3 were 5, 5, and 60. Figure 4-6 shows an extreme case where the weights are all exactly the same but the levels assigned by each group member differ significantly. There are three major explanations for the differences in level.

(1) There may be an information problem on quantifiable attributes. For example, three people estimate the level of highway deaths due to driver fatigue. Each person has some quasi-quantitative measure for this event. The disagreement can sometimes be resolved simply by gathering more information, often by group discussion.

(2) For subjective attributes (e.g. the beauty of redwood forests), the differences may be a matter of scale definition. Group members may value redwood forest beauty on different scales. This conflict may require defining "templates" for mapping individual scales into a common group scale.

(3) The attribute resolution may not be fine enough. Consequently, this attribute must be broken down into more detail so that it has specific meaning to all of the participants.

Regardless of the exact explanation for the difference, the group should eventually resolve the conflict by assigning new attribute levels. The resulting utilities may be in conflict, but it will be a true conflict as opposed to one of information, scaling, or attribute resolution.

	Weight		Level		Utility
D_1	1.0	x	5	=	5
D_2	1.0	x	5	=	5
D_3	1.0	x	60	=	60

FIGURE 4-6. ATTRIBUTE LEVEL CONFLICT

Case 1b: Attribute Weight Conflicts. This type of conflict is the opposite of that described by Case 1a and is not resolved as easily. The conflict is a function of weighting, not level, and is illustrated by Figure 4-7.

Attribute weight conflicts arise from the different importance values assigned to attributes by individuals in accordance with the individual goal structures. The problem requires discussion where the focus is on evaluating individual weights with respect to overall problem goals.

Unlike differences in level, a reweighting of an attribute requires adjustment of all other weights because of the requirement that weights over attributes sum to unity. The solution is a procedure that reweights the conflicting attribute weights while preserving the agreement in the remainder of the utility matrix. The reweighting requires a careful sensitivity analysis of all manipulated values to insure that the entire procedure converges to agreement. The procedure must avoid an oscillation condition where forcing agreement on one set of attribute weights leads to conflict in other areas and a final weighted utility that is in disagreement.

Case 1c: Attribute Combination Conflicts. Combinational conflicts are ones in which the utility disagreements are hidden by the interaction of the attribute weights and levels from which the utilities are computed. Figure 4-8 shows how the utility values 5, 5, and 60 from Case 1 can be composed from weights and levels that differ across attributes and individual.

In general, combinational conflicts are the most difficult to resolve. The recommended procedure is a function of the amount of time

	Weight		Level		Utility
D_1	.05	x	100	=	5
D_2	.05	x	100	=	5
D_3	.6	x	100	=	60

FIGURE 4-7. ATTRIBUTE WEIGHT CONFLICT

	Weight	*	Level	Utility
D_1	.1		50	5
D_2	.5		10	5
D_3	.8		75	60

FIGURE 4-8. ATTRIBUTE COMBINATIONAL CONFLICT

that can be spent on the alternative in question. If time permits the system should iteratively resolve the conflict through a three step sequence of sensitivity analysis, discussion, and re-evaluation. The sensitivity analysis can be used to identify the individual, weight, or level contributing the most to the conflict. The director can use this information in focusing group discussion to understand and then resolve the conflict. If time does not permit, the system may employ some form of averaging or direct reassessment of the elicited utilities.

Case 1d: Attribute Definition Conflicts. Sometimes disagreements may occur because the attributes by which the alternative is being evaluated are not well understood by the group. Definitional conflicts should be avoided by preliminary group discussion of the attributes and their meaning.

4.5.2 Individual Conflicts. Individual conflicts may be classified as either constant or ranking differences. The type of difference can usually be identified by plotting each group members' utility (level X weight) on an x/y scale, where y is the range of utility values (i.e., 0 to 100 in our case) and x are interval points representing the set of attributes. If the lines plotted for each group member do not intersect, then the conflict is classified as a constant difference. If the lines intersect, then there is a ranking difference. Both cases are discussed next.

Case 2a: Constant Differences. Figure 4-9 depicts an instance of an individual conflict where the utility intervals are a constant function for each group member. Notice that the utilities for group member D_3 are at odds with those for members D_1 and D_2, but that there is a constant difference across each attribute. The source of constant differences may be attribute level estimates or combination of attribute level and weight estimates as described in cases 1a and 1c, respectively. A conflict of

	D_1	D_2	D_3
A_1	30	25	5
A_2	30	25	5
A_3	30	25	5

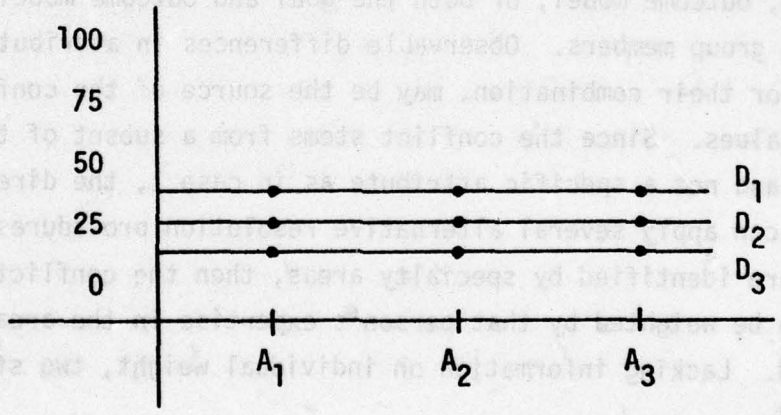


FIGURE 4-9. CONSTANT DIFFERENCE INDIVIDUAL UTILITY CONFLICT

differing level estimates is illustrated by the table of utilities shown in Figure 4-10. This type of conflict is symptomatic of situations where the groups' goal structure (as represented by individual attribute weights) are in agreement, but individuals differ on the consequences (i.e., outcomes) of the alternative being considered. A two step resolution procedure for this type of conflict would be to first discuss, and then estimate again, the attribute levels. If the utilities calculated from the new level estimates are still in conflict, then the levels should be adjusted proportionally, according to the aggregate positions of the group assuming unit weighting among group members. Resolution of combinational conflicts where one or more individuals differ by a constant unit should be done iteratively, by identifying to the group the attribute that is contributing the greatest amount of disagreement. Discussion, followed by reassessments of weights on new level assignments, should be allowable.

Case 2b: Ranking Differences. Ranking differences usually represent true disagreement by one or more group members with the goal structure, outcome model, or both the goal and outcome models of the remaining group members. Observable differences in attribute level, weights, or their combination, may be the source of the conflicting utility values. Since the conflict stems from a subset of the group members, and not a specific attribute as in case 1, the director or computer can apply several alternative resolution procedures. If group members are identified by specialty areas, then the conflicting individuals' input can be weighted by that person's expertise in the area being discussed. Lacking information on individual weight, two strategies are suggested.

The first strategy uses the group to provide an expertise rating on other participants or, if identifiable, points of view as characterized by gross classification of position on the alternative (e.g., low, medium, or high utility). The ratings are then used to weight and automatically

	Attribute Weights			Attribute Levels			Utility		
	D_1	D_2	D_3	D_1	D_2	D_3	D_1	D_2	D_3
A_1	.3	.3	.3	100	84	17	30	25	5
A_2	.3	.3	.3	100	84	17	30	25	5
A_3	.35	.35	.35	86	84	17	30	25	5

FIGURE 4-10. CONSTANT DIFFERENCE CONFLICT FROM CONFLICT IN LEVEL ESTIMATION

aggregate individual inputs. The second strategy eliminates conflict by simply eliminating disonant values. The aggregation procedure can operate by throwing out the utility values of the person or persons who are in most direct disagreement with the general group position. The danger with this approach is: there is no guarantee that you are not eliminating the best evaluator in favor of majority rule.

4.5.3 Combinational Conflicts. To encourage individual participation, resolution of combinational conflicts should focus on isolating differences of utility as opposed to individual differences. Accordingly, the computer should identify the most sensitive attribute and display to the group the relative positions of group members on that attribute. Discussion and further computer assistance should then be used to identify the exact source of conflict.

Finally, the group members should reassess the level, or the weight, or both, for that attribute. The computer should direct the group to other contenious attributes and repeat the procedures until the conflict is resolved.

4.5.4 Summary of Resolution Procedures. Table 4-1 summarizes the different cases for utility conflicts and the recommended resolution procedures.

TABLE 4-1. CONFLICT RESOLUTION PROCEDURES

Conflict Type	Explanation	Action
1. Attribute		
a) Level	Information problem Scale definition Attribute resolution	1) Identify and display attribute(s) in conflict to the group 2) Group reassesses attribute level
b) Weight	Differing goal structures	1) Identify and display weighting differences 2) Focus discussion on overall problem goals 3) Group reweights attribute in conflict 4) Computer normalizes other weights
c) Level/Weight Combinations	Differing goal and/or outcome models	1) Inform director with list of conflict points 2) Director selects averaging or direct reassessment as the resolution procedure
d) Definition	Lack of discussion	Avoid conflict with use of prior group discussion of attributes and their meaning
2. Individual		
a) Constant Difference (Level)	Differing goal structures	1) Identify, display, and discuss the outcome levels for the attributes in contention 2) Reassess attribute levels 3) If necessary, proportionally adjust the critical attribute levles
b) Constant Difference (Level/Weight)	Differing goal/outcome models	1) Display relative disagreement across attribute and individuals 2) Isolate key contention feature 3) Discuss 4) Reassess that feature
c) Ranking Differences	True disagreement on goals or outcomes	Either: 1) Weight contributions of specialists according to expertise on current problem, or 2) Eliminate dissident individual values
3. Combination	None	1) Computer should isolate and display the most sensitive attribute and individual positions 2) Attempt to identify conflict source 3) Reassess weights or levels as required

5. GROUP/MACHINE INTERACTION

5.1 Introduction

This chapter presents a revised description of the system's group/machine interface initially described in the first quarterly technical report (Levin et al, 1977). The description is presented as a set of successive frames, each of which describes the group's actions and the contents of the current group display. Due to space limitations, and since the group's actions in building a decision structure are basically iterative, only a partial problem session is presented.

Section 5.2 discusses the composition of the decision making group and the roles of different group members. Section 5.3 describes the decision problem and the physical setting in which the group meets. Section 5.4 is a frame-by-frame description focusing on how the group interacts with the group decision aiding system. Section 5.5 is a frame-oriented description describing the intermediator's man/machine interface.

5.2 Group Composition

The decision making group is composed of the participants, an intermediator, and a director. The participants are the decision makers. The intermediator and the director are procedural interfaces between the participants and the computer system.

The intermediator takes the participant's requests and formats them for input to the decision aiding system. The inputs are lists of alternative actions and events, modifications to previously stored information, and commands for the display of selected information. The director is an interface in the other direction. He takes the computer's output, often instructions as to what to do next, and presents them to

the participants. The group director focuses the group's activities and insures that the group's inputs are appropriate for the decision aiding system. The major information flow among the group members and the computer system is shown in Figure 5-1.

In the initial system design each role (i.e., participant, intermediator, and director) is conceptualized as being performed by separate individuals. This design approach, which makes each role relatively independent, will permit easy redefinition of system characteristics and create greater flexibility in experimenting with different decision aiding configurations. The first version of the system will, in fact, combine the intermediator's and the director's roles. Thus, in the description that follows, inputs and outputs to these conceptually separate individuals are directed to one person.

5.3 Group Decision Making Setting

In the example problem, a group of high-level decision makers has been assembled to deal with a terrorist situation involving the seizure of property and hostages. We assume the decision aiding system has been demonstrated to the group at an earlier time.

Each participant (i.e., decision maker) is seated at the conference table and is provided with a simple data entry terminal. Participant terminals consist of a numeric keypad, a set of function keys, a group of indicator lights, and a LED display. The intermediator/director is seated at the table and provided with a small-scale black and white CRT and a full keyboard. When acting as director, this person receives prompting and other guidance information from the computer. As the intermediator, he enters group requests, calls for specific information, and enters group information (e.g., alternative decisions and events).

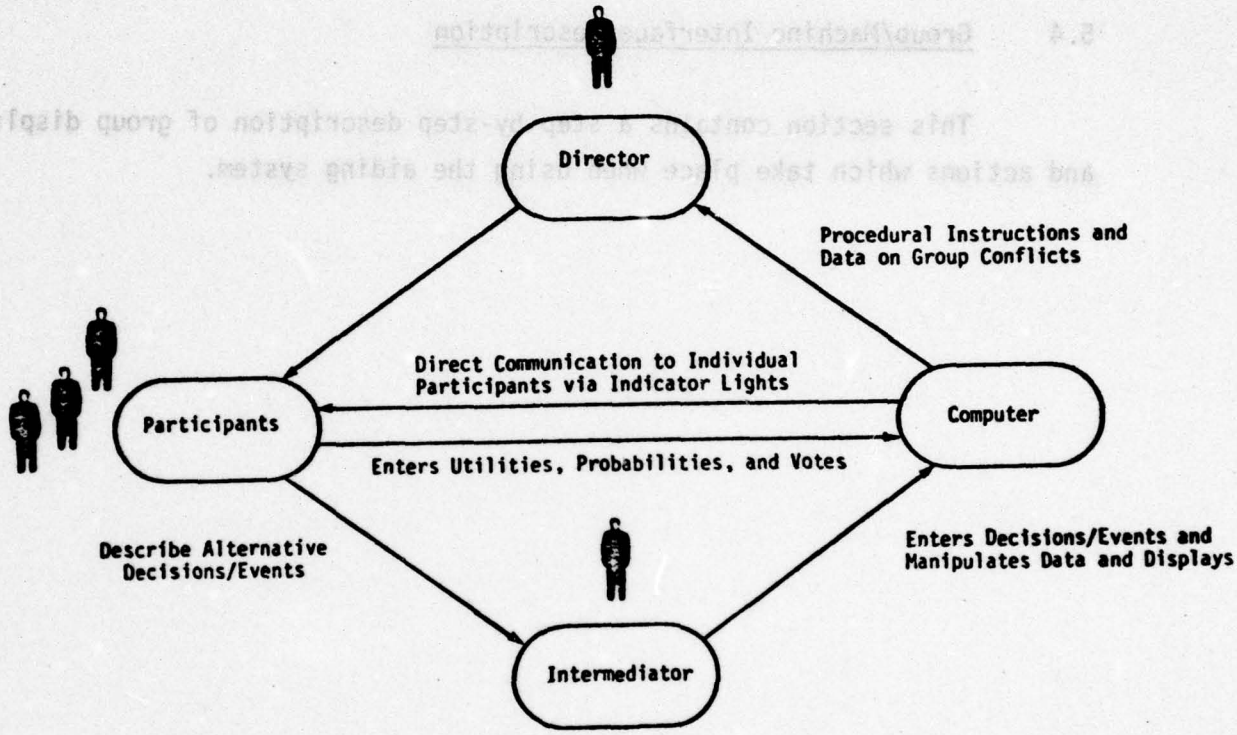
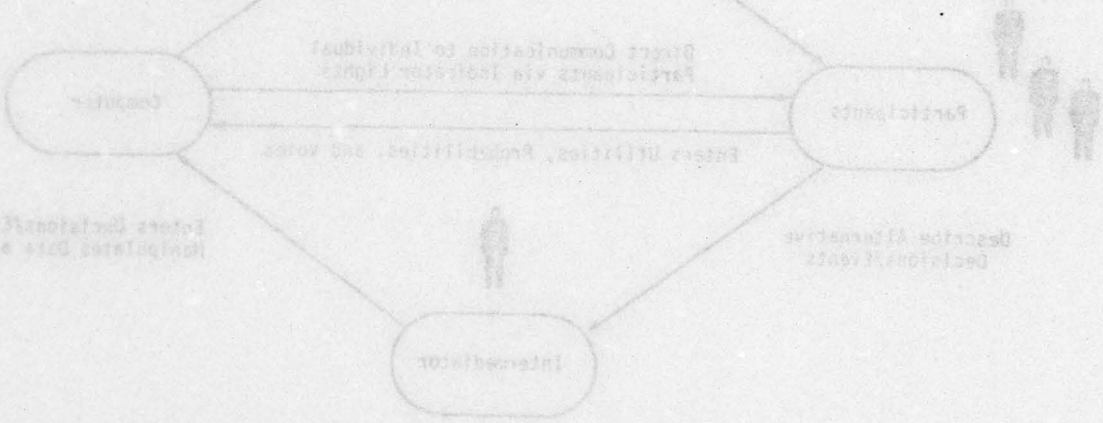


FIGURE 5-1. INFORMATION FLOW IN THE DECISION MAKING SYSTEM

Facing the entire group is a large screen onto which can be projected alphanumeric or graphical information in color or black and white. The contents of the display screen are computer generated and either automatically controlled by the system's elicitation program or explicitly controlled by the intermediator.

5.4 Group/Machine Interface Description

This section contains a step-by-step description of group displays and actions which take place when using the aiding system.

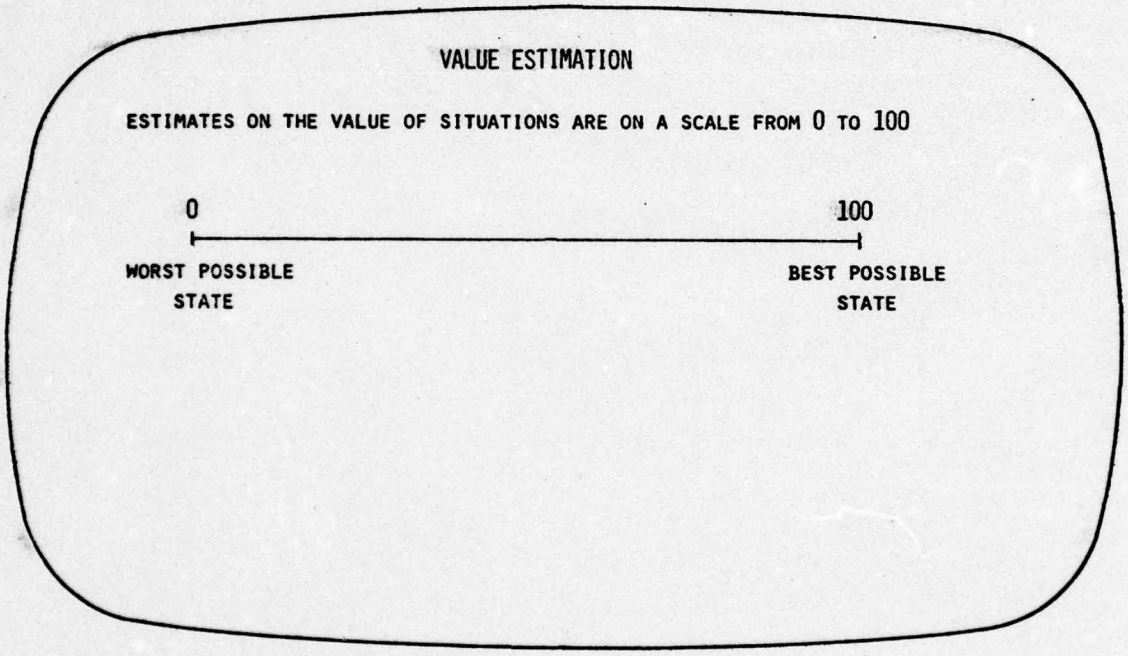


THE INTERMEDIATOR STARTS UP THE COMPUTER PROGRAM.

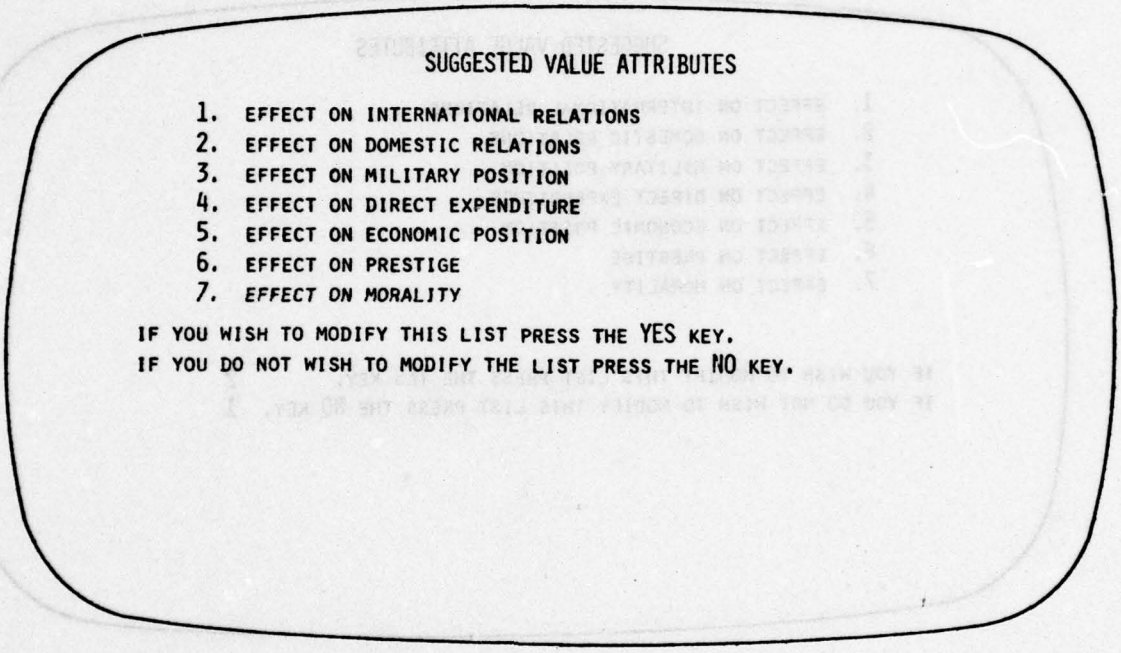
THE PROGRAM ASKS THE INTERMEDIATOR TO ENTER EACH PARTICIPANT'S NAME (INTERMEDIATOR: INITIALIZATION)

THE PARTICIPANTS ARE BRIEFED ON THE PROBLEM. THE BRIEFING MAY BE IN BOOKLET FORM OR USE A STORED COMPUTER/VIDEOTAPE MEDIA. A DISCUSSION MAY ARISE TO CLARIFY TO ALL PARTICIPANTS EXACTLY WHAT IS THE PROBLEM.

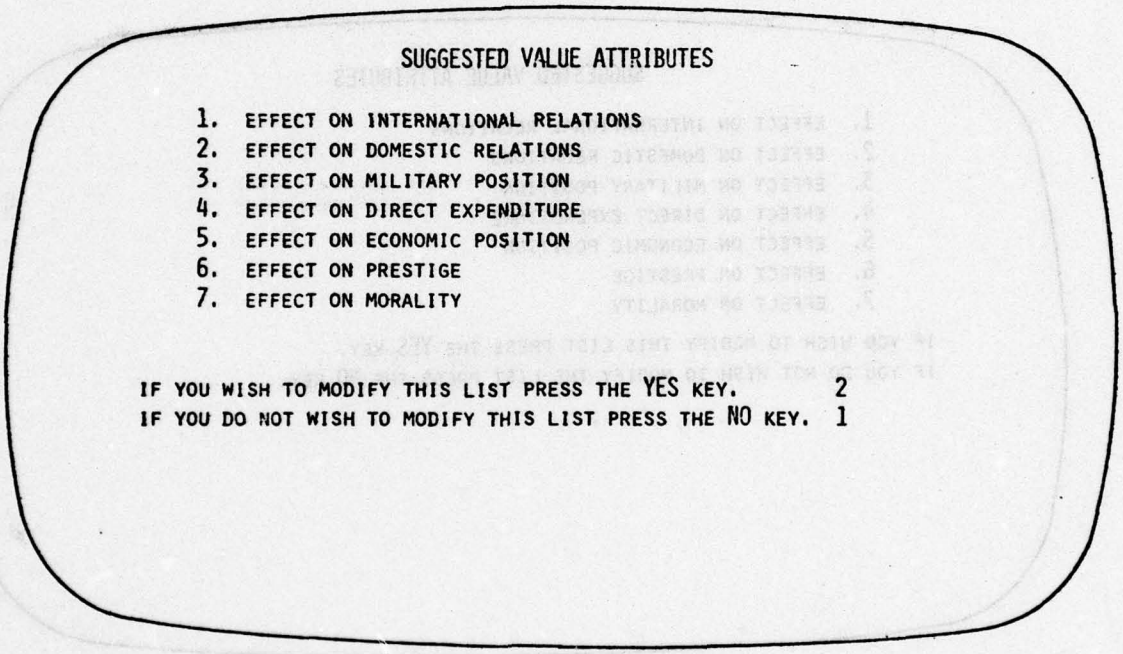
THE DIRECTOR EXPLAINS THAT THE VALUE ASSIGNED TO ALTERNATIVE SITUATIONS, BE THEY EVENTS THE OPPOSITION TAKES OR THOSE CONTROLLED BY THEIR OWN FORCES, IS ESTIMATED ON A SCALE FROM 0 TO 100. ZERO IS UNDERSTOOD TO BE THE WORST POSSIBLE STATE TO THE GROUP, WHEREAS 100 IS THE BEST.



THE DIRECTOR EXPLAINS THAT THE HOLISTIC VALUES THAT WILL BE ELICITED SHOULD BE BASED ON A SET OF VALUE ATTRIBUTES OF THE GROUP'S CHOOSING. A SUGGESTED SET OF VALUE ATTRIBUTES IS DISPLAYED. THE DIRECTOR TELLS THE COMPUTER WHEN TO PROCEED, I.E., DISPLAY THE SUGGESTED VALUE ATTRIBUTES. THE GROUP VOTES TO INDICATE THEIR PREFERENCE REGARDING THE LIST.

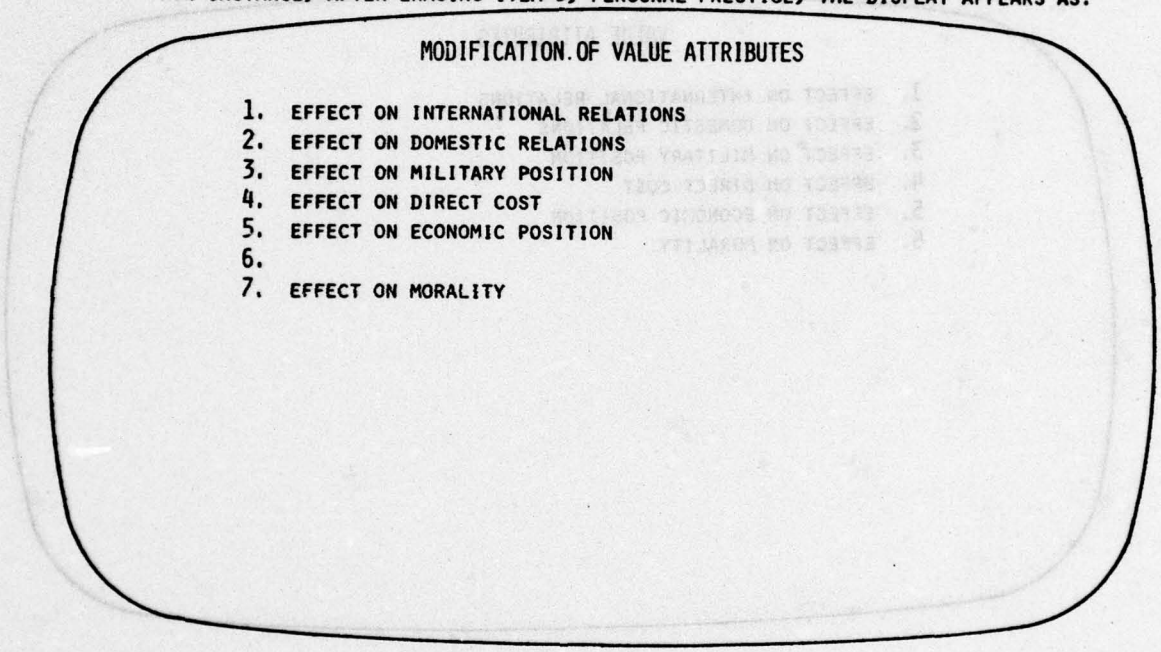


AFTER ALL GROUP MEMBERS VOTE -- THE VOTE IS DISPLAYED. THE DIRECTOR TELLS THE PROGRAM TO EITHER ALLOW MODIFICATION OF THE LIST OR TO KEEP THE LIST AS IS.

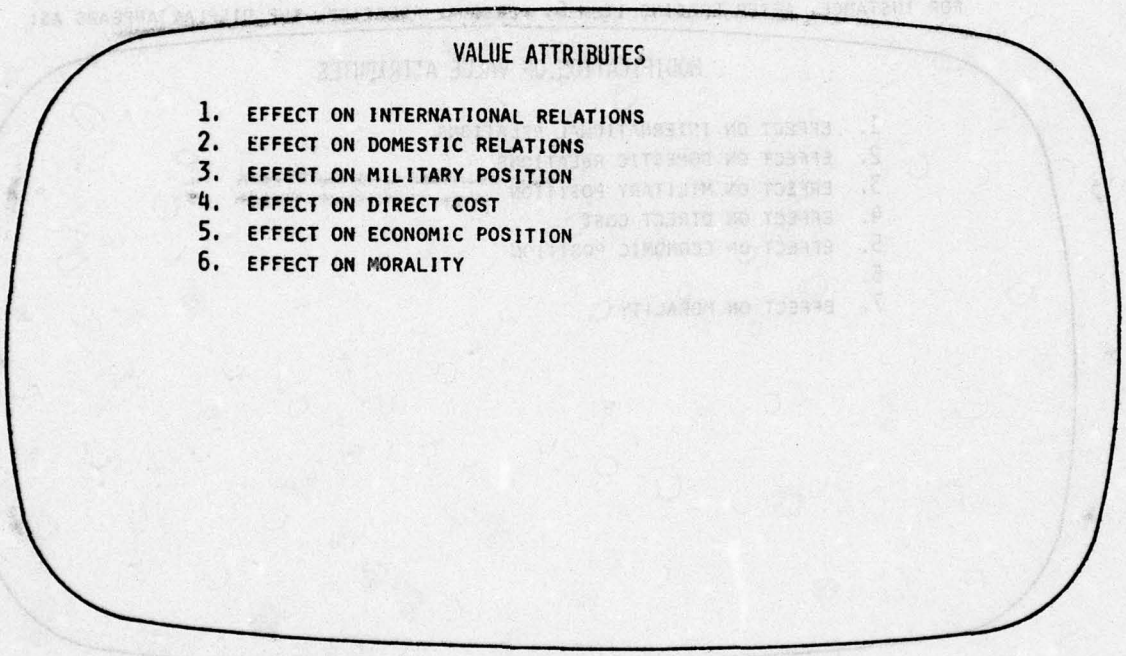


AS A RESULT OF THE PREVIOUS VOTE THE GROUP PROCEEDS TO MODIFY THE LIST OF VALUE ATTRIBUTES. MODIFICATIONS ARE MADE BY THE INTERMEDIATOR AND THE CHANGES APPEAR ON THE GROUP DISPLAY. THE DISPLAY IS TREATED LIKE A BLACKBOARD WITH ENTRIES BEING ERASED, ADDED, AND CHANGED.

FOR INSTANCE, AFTER ERASING ITEM 6, PERSONAL PRESTIGE, THE DISPLAY APPEARS AS:

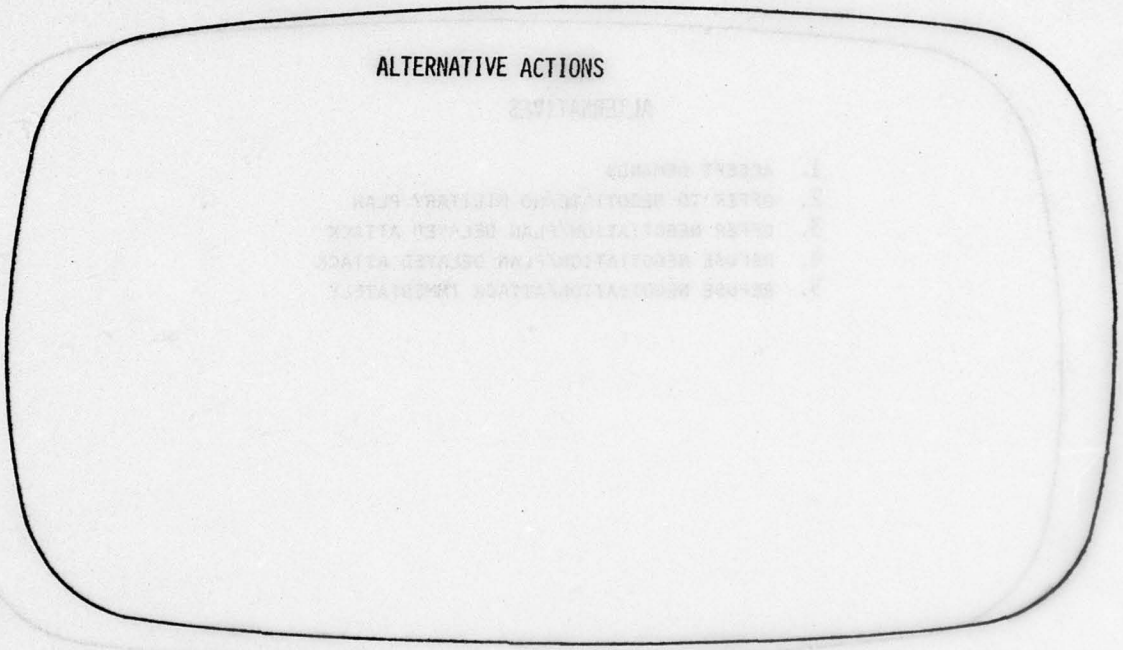


THE INTERMEDIATOR CAN CONTROL THE PLACEMENT OF NEW ITEMS INTO THE LIST (SEE INTERMEDIATOR: LIST MODIFICATIONS). WHEN MODIFICATIONS TO THE LIST ARE COMPLETE THE DIRECTOR TELLS THE PROGRAM TO PROCEED. A REWRITTEN "CLEANED-UP" LIST IS FIRST SHOWN TO THE GROUP.

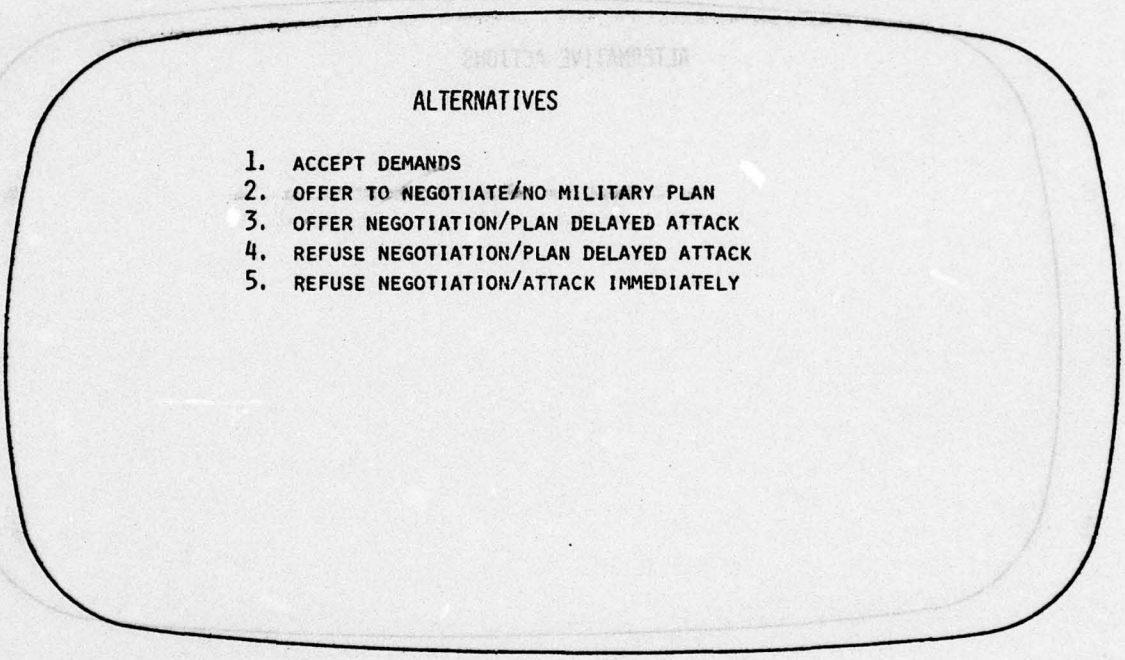


THE MAIN ELICITATION PROCEDURE NOW COMMENCES.

THE DIRECTOR ASKS THE GROUP TO GENERATE A LIST OF ALTERNATIVE ACTIONS THAT COULD BE TAKEN AT THE POINT IN TIME UNDER CONSIDERATION. THE INTERMEDIATOR EDITS THE ALTERNATIVE LIST WITH THE SAME PROCEDURES USED WHEN MODIFYING THE LIST OF VALUE ATTRIBUTES.



THE PARTICIPANTS SUGGEST A LIST OF ALTERNATIVES. ALTERNATIVES ARE ENTERED AND EDITED BY THE INTERMEDIATOR WHILE BEING DISPLAYED TO THE GROUP.

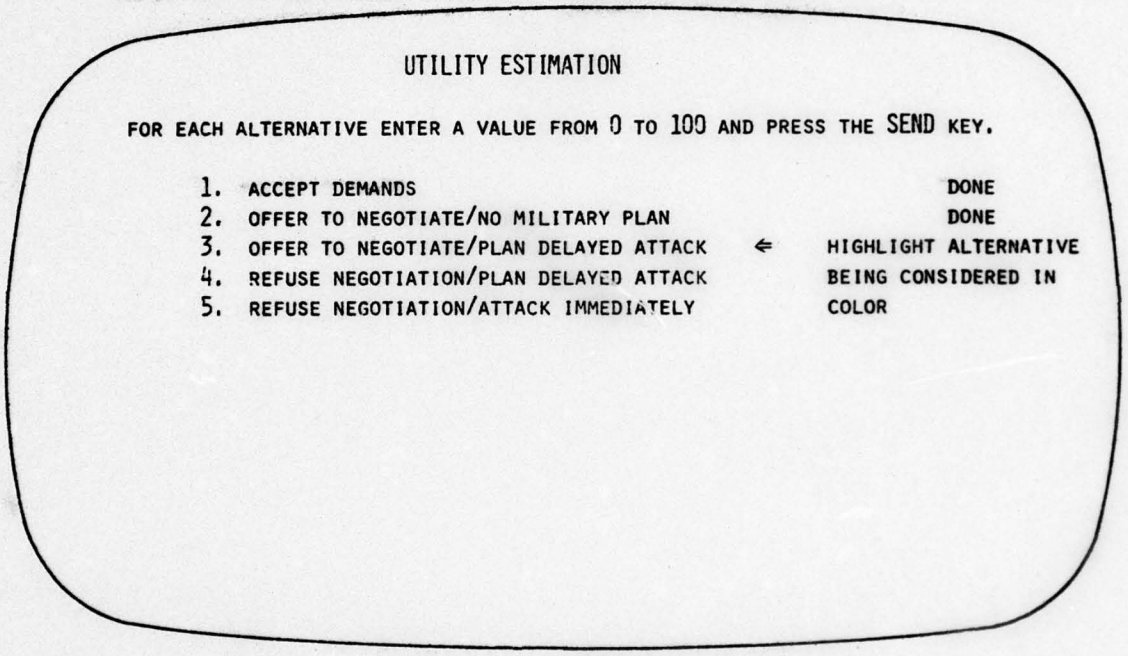


THE GROUP DISCUSSES THE LIST OF ALTERNATIVES. ANY CHANGES TO THE LIST ARE MADE BY THE INTERMEDIATOR.

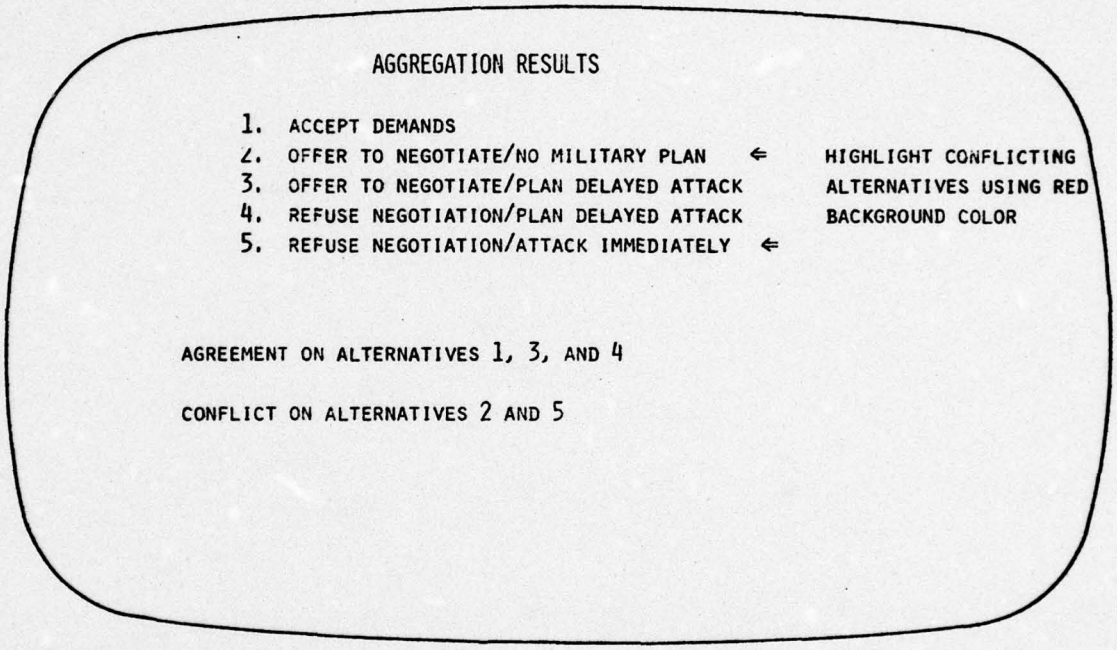
WHEN THE LIST IS COMPLETE, THE DIRECTOR TELLS THE PROGRAM TO PROCEED. THE DIRECTOR HAS THE RESPONSIBILITY OF INSURING THAT THE ALTERNATIVES ARE MUTUALLY EXCLUSIVE.

THE PARTICIPANTS MUST NOW ASSIGN HOLISTIC VALUES TO THE ALTERNATIVES. IF NECESSARY, THE DIRECTOR EXPLAINS THE PROCEDURE.

THE COMPUTER STEPS THROUGH THE ALTERNATIVE LIST REQUESTING THE GROUP (EACH PARTICIPANT) TO ENTER A UTILITY VALUE FOR THE INDICATED ALTERNATIVE. THE SCALE IS THE PREVIOUSLY ESTABLISHED 0-100 UTILITY SCALE.



AFTER UTILITIES HAVE BEEN ELICITED FROM EACH PARTICIPANT FOR ALL OF THE ALTERNATIVES THE COMPUTER TELLS THE GROUP FOR WHICH ALTERNATIVES THERE IS CONSENSUS OR CONFLICT.



SINCE THERE IS CONFLICT ON ONE OR MORE ALTERNATIVES A MULTI-ATTRIBUTE UTILITY PROCEDURE IS USED TO RESOLVE THE CONFLICTS.

THE GROUP'S ATTENTION IS FIRST DIRECTED TO RESOLVING THE CONFLICT ON ALTERNATIVE 2, "OFFER TO NEGOTIATE/NO MILITARY PLAN."

IF NECESSARY, THE DIRECTOR EXPLAINS THE MAUM PROCEDURE AND THEN INSTRUCTS THE PROGRAM TO PROCEED.

AS THE FIRST PART OF THE MAUM PROCEDURES, EACH PARTICIPANT IS ASKED TO WEIGHT THE VALUE ATTRIBUTES.

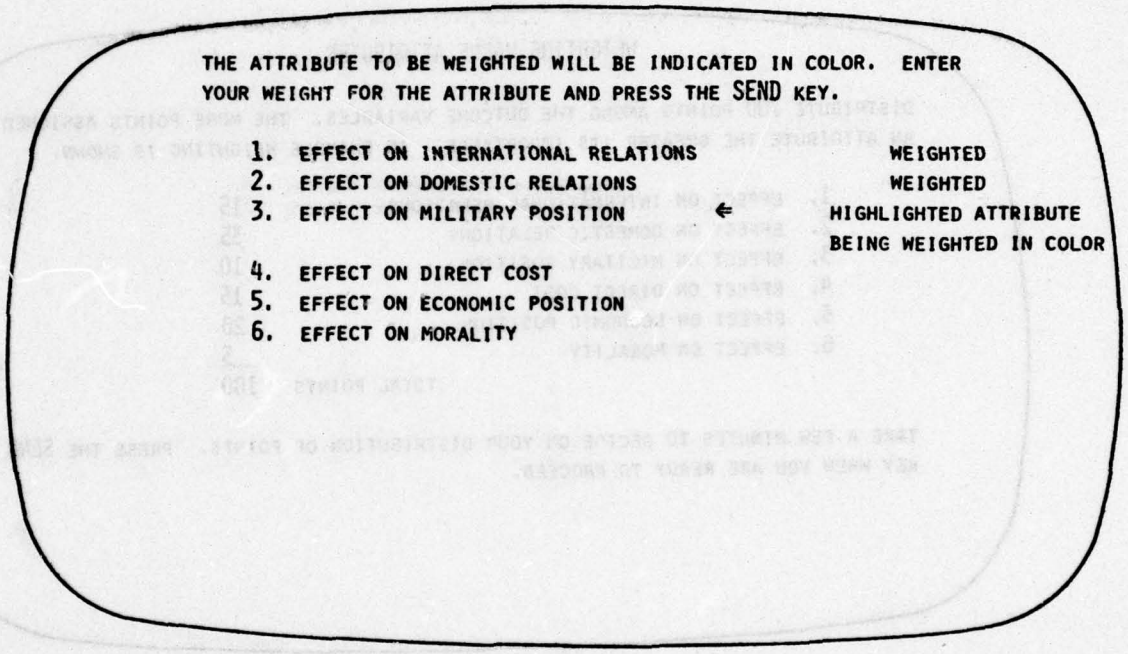
WEIGHTING VALUE ATTRIBUTES

DISTRIBUTE 100 POINTS AMONG THE OUTCOME VARIABLES. THE MORE POINTS ASSIGNED AN ATTRIBUTE THE GREATER ITS IMPORTANCE. AN EXAMPLE WEIGHTING IS SHOWN.

1.	EFFECT ON INTERNATIONAL RELATIONS	15
2.	EFFECT ON DOMESTIC RELATIONS	35
3.	EFFECT ON MILITARY POSITION	10
4.	EFFECT ON DIRECT COST	15
5.	EFFECT ON ECONOMIC POSITION	20
6.	EFFECT ON MORALITY	5
	TOTAL POINTS	100

TAKE A FEW MINUTES TO DECIDE ON YOUR DISTRIBUTION OF POINTS. PRESS THE SEND KEY WHEN YOU ARE READY TO PROCEED.

WHEN THE PARTICIPANTS ARE READY, THE COMPUTER STEPS THROUGH THE LIST OF VALUE ATTRIBUTES WAITING UNTIL ALL PARTICIPANTS HAVE ENTERED A WEIGHT FOR EACH ATTRIBUTE. THE ATTRIBUTE BEING WEIGHTED IS HIGHLIGHTED IN COLOR. THE WORD "WEIGHTED" APPEARS BY EACH ATTRIBUTE AFTER ALL PARTICIPANTS HAVE ENTERED A VALUE.



THE COMPUTER THEN PROMPTS THE PARTICIPANTS TO ENTER A UTILITY VALUE FOR EACH VALUE ATTRIBUTE.

CONFLICT RESOLUTION

FOR THE ACTION

OFFER TO NEGOTIATE/NO MILITARY PLAN

ESTIMATE THE EFFECT OF THIS ACTION ON EACH VALUE ATTRIBUTE.
ENTER A VALUE (0-100) AND PRESS THE SEND KEY.

0 = WORST POSSIBLE EFFECT 100 = BEST POSSIBLE EFFECT

1.	EFFECT ON INTERNATIONAL RELATIONS		DONE
2.	EFFECT ON DOMESTIC RELATIONS		DONE
3.	EFFECT ON MILITARY POSITION		DONE
4.	EFFECT ON DIRECT COST	⇐	HIGHLIGHT VARIABLE
5.	EFFECT ON ECONOMIC POSITION		BEING EVALUATED IN
6.	EFFECT ON MORALITY		COLOR

THE COMPUTER CALCULATES AN OVERALL BRANCH UTILITY FOR EACH GROUP MEMBER USING A SIMPLE WEIGHTED AVERAGE. IF THE NEW BRANCH UTILITIES ARE CLOSE ENOUGH (REDUCED VARIANCE) THEN FURTHER DISCUSSION IS NOT NEEDED. THE GROUP IS INFORMED ON THE RESULTS OF THE CONFLICT PROCEDURE.

CONFLICT RESOLUTION

FOR THE ACTION

OFFER TO NEGOTIATE/NO MILITARY PLAN

ESTIMATE THE EFFECT ON THIS ACTION ON EACH VALUE ATTRIBUTE.
ENTER A VALUE (0 TO 100) AND PRESS THE SEND KEY.

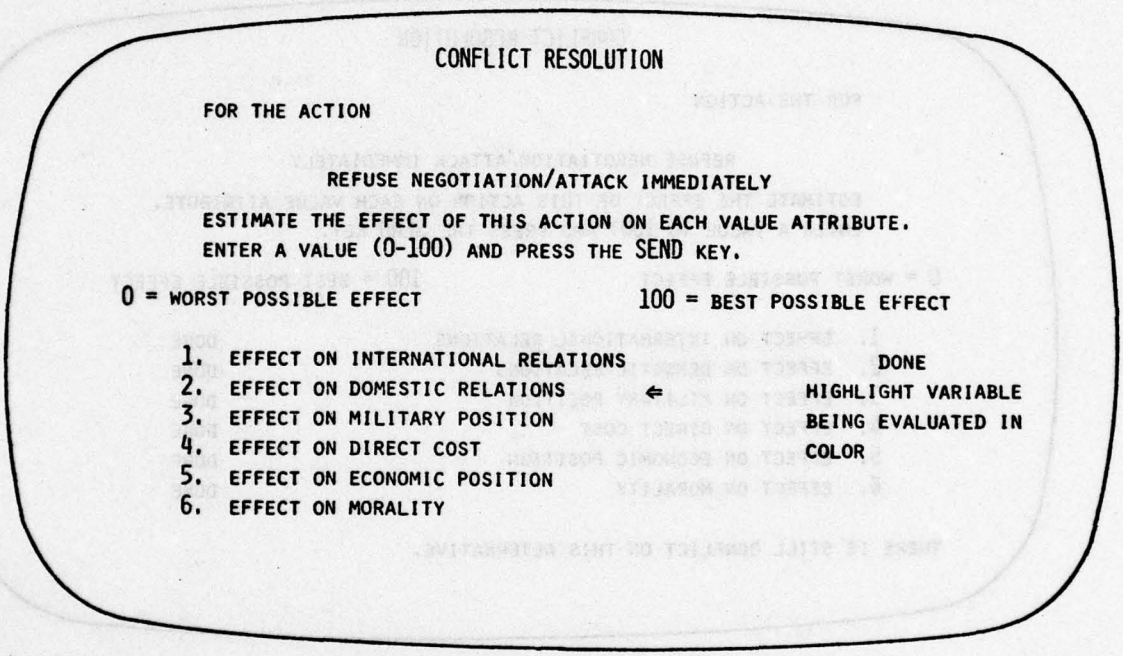
0 = WORST POSSIBLE EFFECT 100 = BEST POSSIBLE EFFECT

1.	EFFECT ON INTERNATIONAL RELATIONS	DONE
2.	EFFECT ON DOMESTIC RELATIONS	DONE
3.	EFFECT ON MILITARY POSITION	DONE
4.	EFFECT ON DIRECT COST	DONE
5.	EFFECT ON ECONOMIC POSITION	DONE
6.	EFFECT ON MORALITY	DONE

AGREEMENT ON THIS ALTERNATIVE. NO FURTHER DISCUSSION IS NEEDED.

THE GROUP'S ATTENTION IS NEXT DIRECTED TO RESOLVING THE CONFLICT ON ALTERNATIVE 5, "REFUSE NEGOTIATION/ATTACK IMMEDIATELY."

THE PREVIOUS MAUM PROCEDURE IS REPEATED.



AS BEFORE A NEW OVERALL BRANCH UTILITY IS CALCULATED AND THE RESULTS COMMUNICATED TO THE GROUP.

THIS TIME THE CONFLICT REMAINS UNRESOLVED AND NOW THE COMPUTER IS USED TO IDENTIFY THE MAJOR POINTS OF DISAGREEMENT.

CONFLICT RESOLUTION

FOR THE ACTION

REFUSE NEGOTIATION/ATTACK IMMEDIATELY

ESTIMATE THE EFFECT OF THIS ACTION ON EACH VALUE ATTRIBUTE.
ENTER A VALUE (0-100) AND PRESS THE SEND KEY.

0 = WORST POSSIBLE EFFECT 100 = BEST POSSIBLE EFFECT

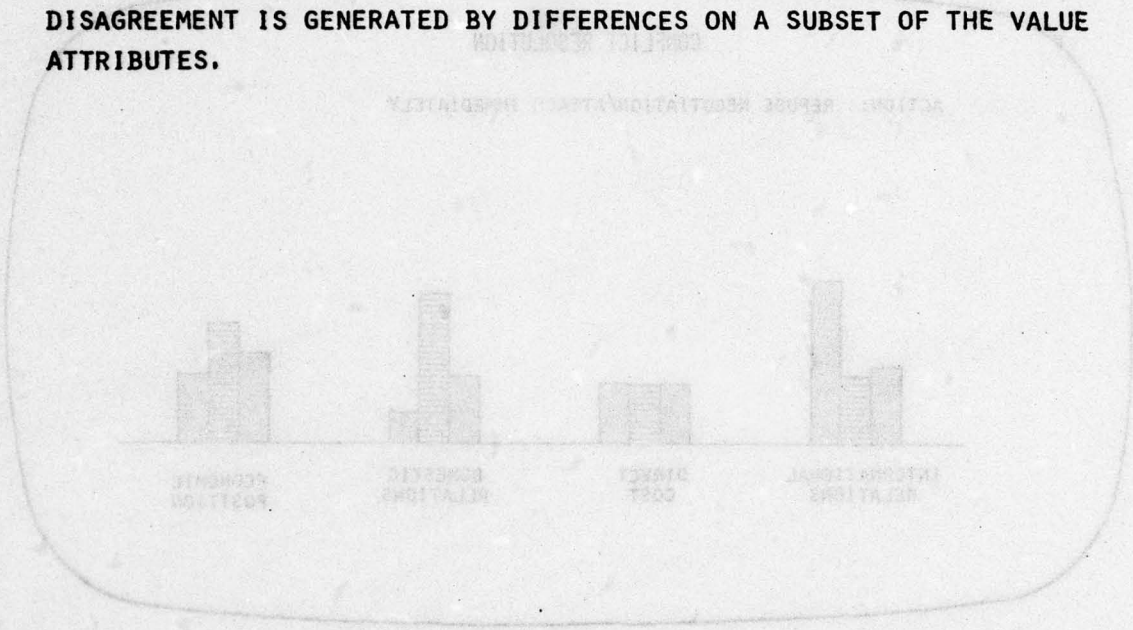
1.	EFFECT ON INTERNATIONAL RELATIONS	DONE
2.	EFFECT ON DEMOSTIC RELATIONS	DONE
3.	EFFECT ON MILITARY POSITION	DONE
4.	EFFECT ON DIRECT COST	DONE
5.	EFFECT ON ECONOMIC POSITION	DONE
6.	EFFECT ON MORALITY	DONE

THERE IS STILL CONFLICT ON THIS ALTERNATIVE.

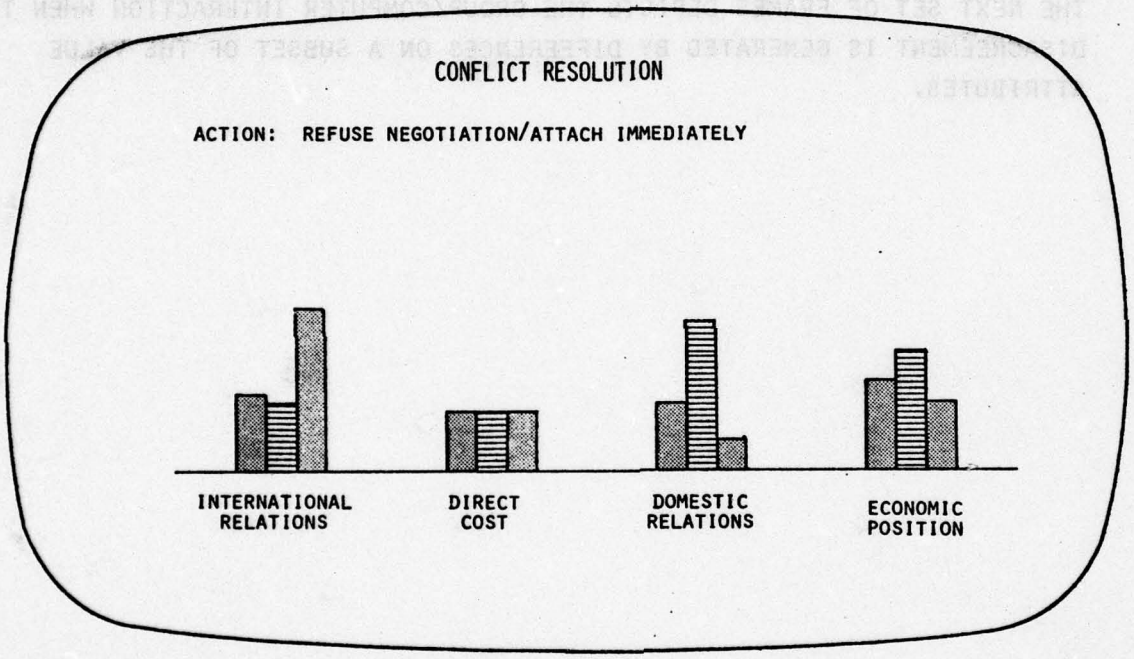
THE COMPUTER ANALYZES THE ATTRIBUTE INFORMATION ELICITED FROM THE GROUP, IDENTIFIES THE TYPE OF CONFLICT, AND SUGGESTS TO THE DIRECTOR THE APPROPRIATE RESOLUTION PROCEDURE.

THE DIRECTOR EXERCISES FINAL CHOICE OVER THE COMPUTER'S SUGGESTIONS AND CHOOSES ONE OF THE PRESENTED OPTIONS. IN GENERAL, THE DIRECTOR WILL BE EXPECTED TO INTERPRET DIFFERENT GROUP DISPLAYS THAT WILL BE USED TO SHOW THE TYPE AND EXTENT OF GROUP CONFLICT.

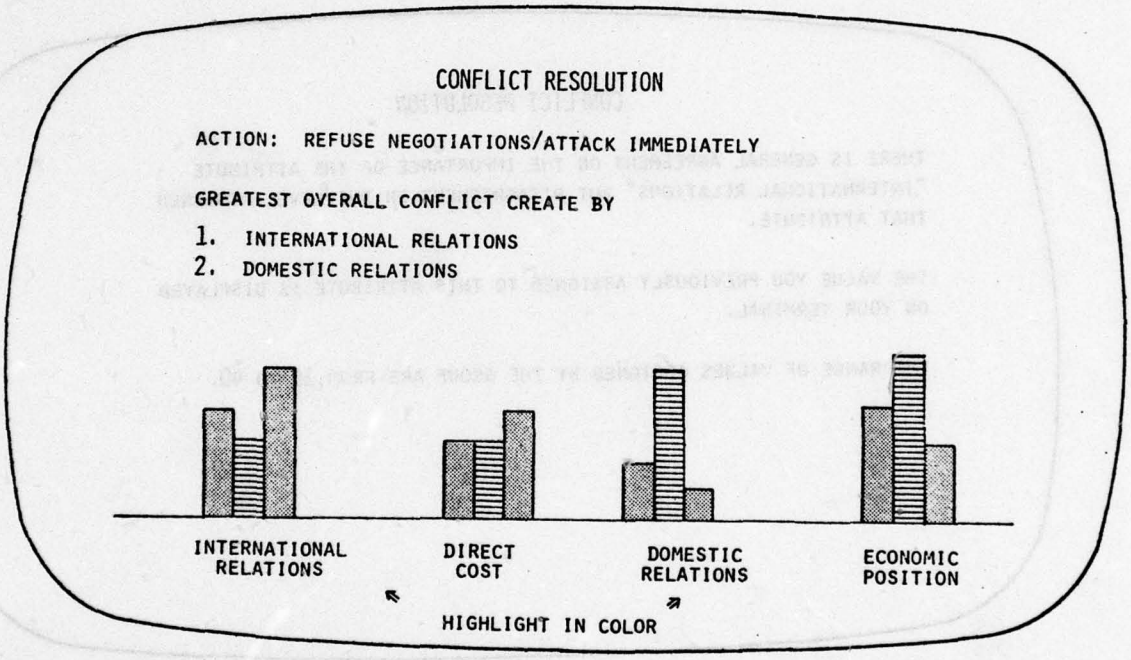
THE NEXT SET OF FRAMES DEPICTS THE GROUP/COMPUTER INTERACTION WHEN THE DISAGREEMENT IS GENERATED BY DIFFERENCES ON A SUBSET OF THE VALUE ATTRIBUTES.



THE COMPUTER FIRST DISPLAYS BAR CHARTS SHOWING INDIVIDUAL UTILITY POSITIONS BY ATTRIBUTE. VIA THE BAR CHARTS, THE GROUP SEES GRAPHICALLY THE CONSTITUENTS OF THE DISAGREEMENT. COLORED BAR CHARTS (USING A UNIQUE COLOR FOR EACH PARTICIPANT) DEPICT RELATIVE POSITIONS ON EACH ATTRIBUTE. DEPENDING UPON THE NUMBER OF ATTRIBUTES, IT MAY BE POSSIBLE TO ONLY DISPLAY THE MOST SIGNIFICANT DISAGREEMENTS.



THE COMPUTER TELLS THE GROUP ON WHAT ATTRIBUTE(S) THERE IS GREATEST DISAGREEMENT. IF POSSIBLE, THE COMPUTER TELLS THE GROUP OR THE DIRECTOR WHAT IS THE BASIS FOR THE DISAGREEMENT (E.G., DIFFERING OUTCOME MODELS, GOAL STRUCTURES, ETC.)



THE GROUP'S ATTENTION IS DIRECTED BY THE DIRECTOR AND THE COMPUTER TOWARDS DISCUSSING EACH OF THE ATTRIBUTES IN TURN. FURTHER INFORMATION ON THE EXACT NATURE OF THE DISAGREEMENT IS SUPPLIED TO THE GROUP IF AVAILABLE.

CONFLICT RESOLUTION

THERE IS GENERAL AGREEMENT ON THE IMPORTANCE OF THE ATTRIBUTE "INTERNATIONAL RELATIONS" BUT DISAGREEMENT ON THE LEVEL ASSIGNED THAT ATTRIBUTE.

THE VALUE YOU PREVIOUSLY ASSIGNED TO THIS ATTRIBUTE IS DISPLAYED ON YOUR TERMINAL.

THE RANGE OF VALUES ASSIGNED BY THE GROUP ARE FROM 10 TO 40.

THE DIRECTOR SUGGESTS THAT THE GROUP DISCUSS AND THEN REASSESS THEIR PREVIOUS ESTIMATES OF THE ATTRIBUTES LEVEL. THE DIRECTOR TELLS THE COMPUTER WHEN TO PROCEED AND ELICIT NEW ASSESSMENTS. THE COMPUTER ALSO LIGHTS THE DISPLAY PANEL ON THE INDIVIDUAL DATA ENTRY TERMINALS TO PROMPT FOR A DATA ENTRY.

CONFLICT RESOLUTION

THERE IS GENERAL AGREEMENT ON THE IMPORTANCE OF THE ATTRIBUTE "INTERNATIONAL RELATIONS" BUT DISAGREEMENT ON THE LEVEL ASSIGNED THAT ATTRIBUTE.

THE VALUE YOU PREVIOUSLY ASSIGNED TO THIS ATTRIBUTE IS DISPLAYED ON YOUR TERMINAL.

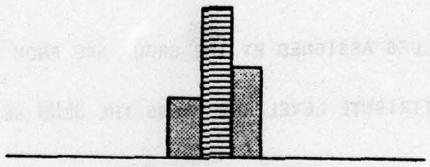
THE RANGE OF VALUES ASSIGNED BY THE GROUP ARE FROM 10 TO 40.

ENTER REVISED ATTRIBUTE LEVEL AND PRESS THE SEND KEY.

THE COMPUTER CALCULATES NEW UTILITY VALUES FOR THE ATTRIBUTE, AGGREGATES THE VALUES AND WEIGHTS INTO UTILITIES, AND PROCEEDS TO RESOLVE ANY REMAINING ATTRIBUTE CONFLICTS.

CONFLICT RESOLUTION

ENTER REVISED ATTRIBUTE LEVEL AND PRESS THE SEND KEY. THE NEXT DISAGREEMENT IS ON THE ATTRIBUTE "DOMESTIC RELATIONS."



DOMESTIC RELATIONS

THE GROUP DISCUSSES THIS DISAGREEMENT. AFTER THE DIRECTOR SIGNALS THE COMPUTER TO PROCEED, A NEW SET OF ATTRIBUTE LEVELS ARE ELICITED FROM THE PARTICIPANTS.

CONFLICT RESOLUTION

ENTER REVISED ATTRIBUTE LEVEL AND PRESS THE SECOND KEY.

THE NEXT DISAGREEMENT IS ON THE ATTRIBUTE "DOMESTIC RELATIONS."

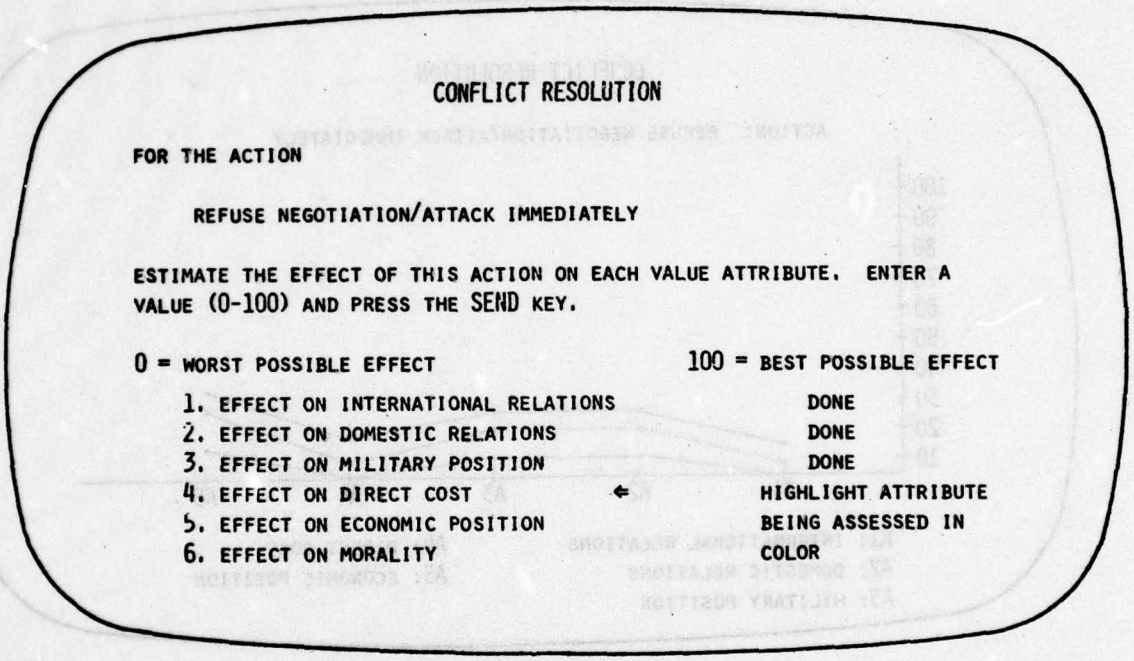
THE VALUE YOU PREVIOUSLY ASSIGNED TO THIS ATTRIBUTE IS DISPLAYED ON YOUR TERMINAL.

THE RANGE OF VALUES ASSIGNED BY THE GROUP ARE FROM 5 TO 35.

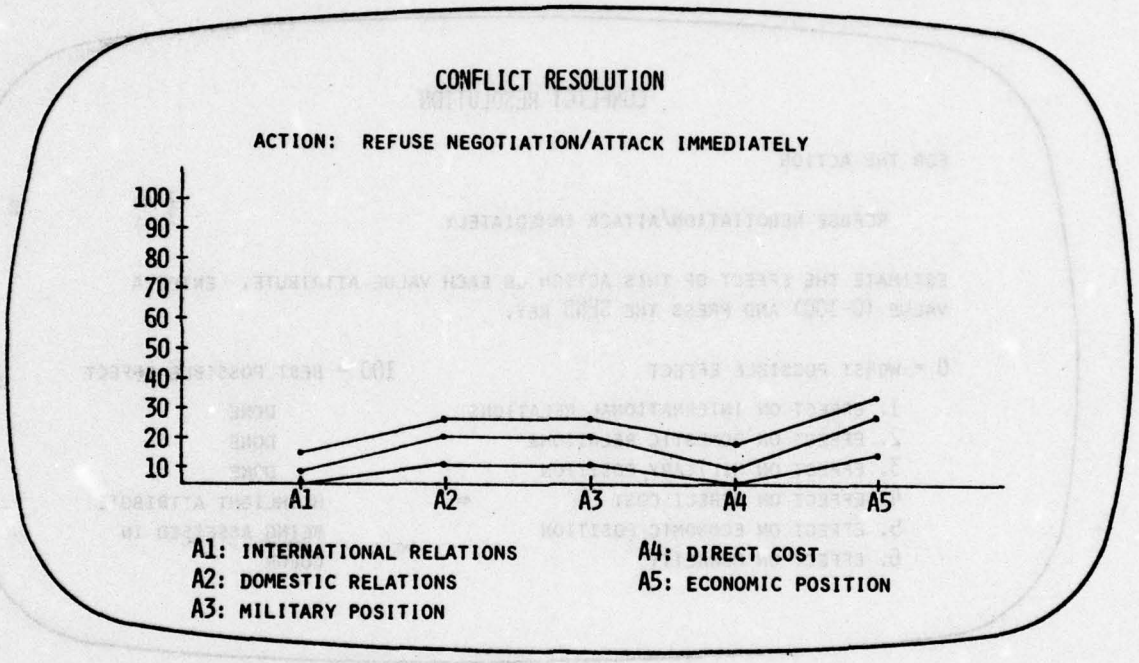
ENTER REVISED ATTRIBUTE LEVEL AND PRESS THE SEND KEY.

SOMETIMES DISAGREEMENTS ARE CAUSED BY INDIVIDUAL DIFFERENCES ACROSS GROUP MEMBERS, AS OPPOSED TO DIFFERENCES ON PARTICULAR ATTRIBUTES. THE NEXT TWO FRAMES SHOW HOW THE CONFLICT FOR THE ACTION "REFUSE NEGOTIATION/ATTACK IMMEDIATELY" WOULD BE RESOLVED FOR INDIVIDUAL-BASED DISAGREEMENTS.

THE COMPUTER PROMPTS FOR A NEW LEVEL ESTIMATE BY HIGHLIGHTING ON THE GROUP DISPLAY THE ATTRIBUTE BEING ASSESSED, AND DISPLAYING EACH INDIVIDUAL'S PREVIOUS LEVEL ON THEIR DATA ENTRY TERMINALS.



THE DISAGREEMENT IS DISPLAYED TO THE GROUP BY PLOTTING EACH GROUP MEMBER'S ATTRIBUTE UTILITIES. THE DIRECTOR INTERPRETS THE DISPLAY. IN THIS FRAME THE PLOT REVEALS A CONSTANT INDIVIDUAL BIAS AMONG GROUP MEMBERS ACROSS ALL ATTRIBUTES. THE DIRECTOR STIMULATES A DISCUSSION AND THEN SIGNALS THE COMPUTER TO ELICIT NEW ATTRIBUTE LEVELS FROM THE GROUP ON ALL ATTRIBUTES.

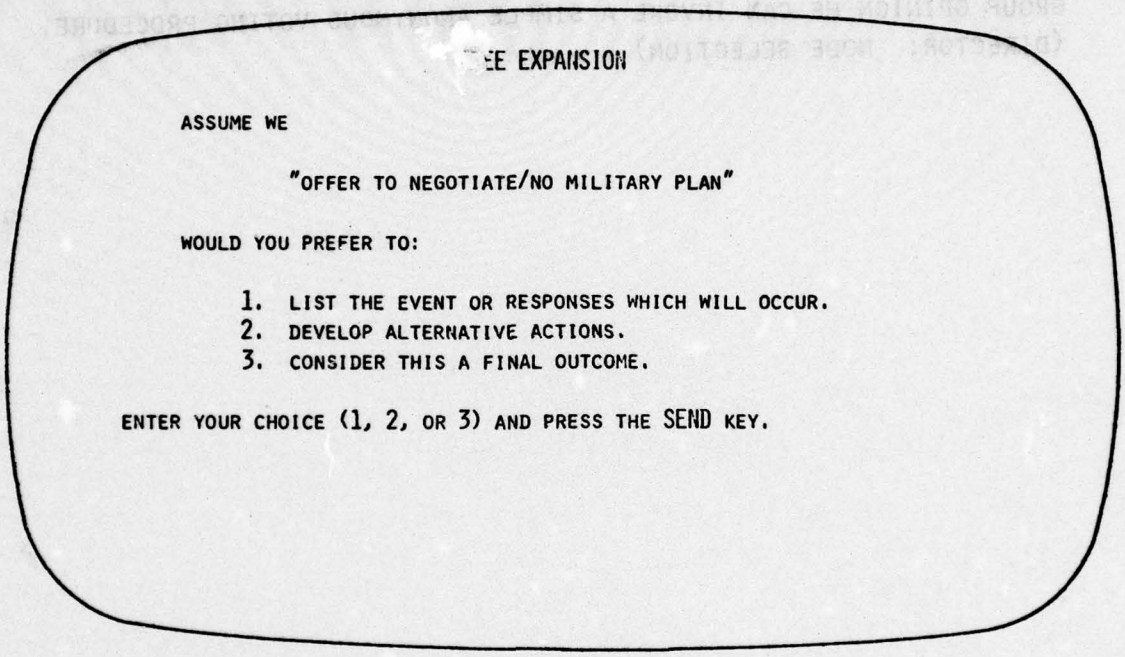


A GROUP UTILITY HAS BEEN ASSIGNED TO EACH DECISION BRANCH AND THE COMPUTER SELECTS THE NEXT NODE TO EXPAND.

THE PATH THE COMPUTER CHOSES TO EXPAND AT THIS TIME IS ARBITRARY BECAUSE THE PROGRAM ALWAYS EXPANDS THE TREE TO TWO LEVELS BEFORE MAKING NODE EXPANSION A FUNCTION OF THE SENSITIVITY ALGORITHM.

THE DIRECTOR/INTERMEDIATOR IS GIVEN THE OPTION OF OVER-RIDING THE COMPUTER'S CHOICE IN FAVOR OF ANOTHER PATH. IF THE DIRECTOR DESIRES A GROUP OPINION HE CAN INVOKE A SIMPLE ANONYMOUS VOTING PROCEDURE. (DIRECTOR: NODE SELECTION)

THE COMPUTER SELECTS A NODE (ACTUALLY A PATH TO A NODE), AND DISPLAYS THAT NODE (PATH) TO THE GROUP, AND THEN ASKS THE GROUP WHAT THEY WOULD LIKE TO DO NEXT.



THE GROUP VOTES ITS CHOICE AND THE COMPUTER DISPLAYS THE RESULTS.

TREE EXPANSION

ASSUME WE

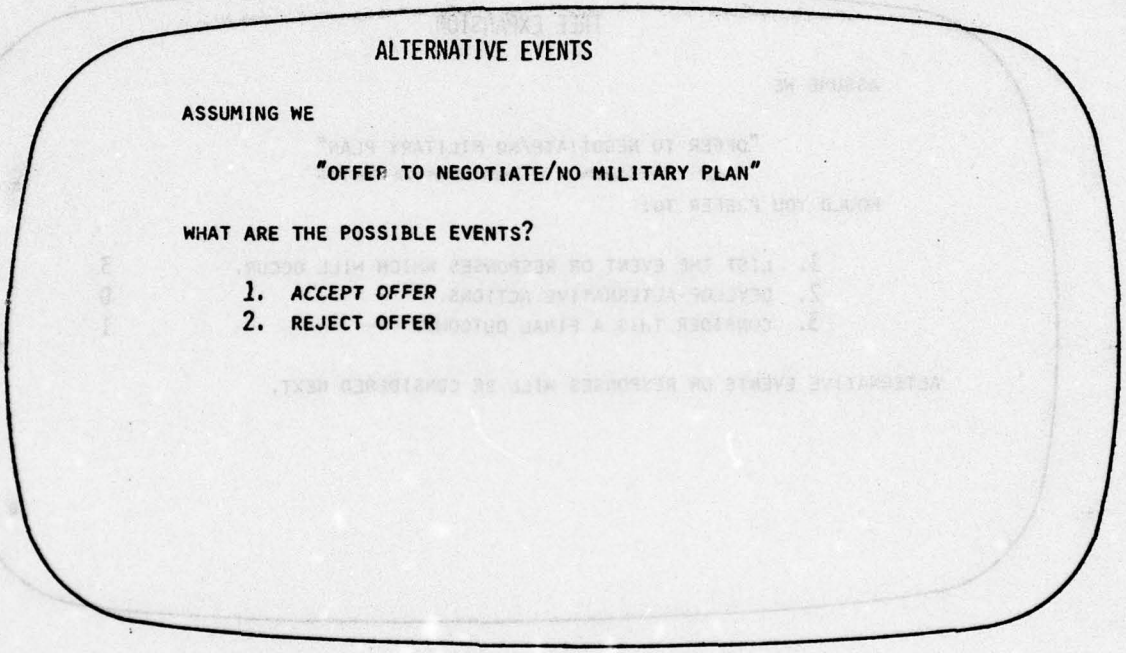
"OFFER TO NEGOTIATE/NO MILITARY PLAN"

WOULD YOU PREFER TO:

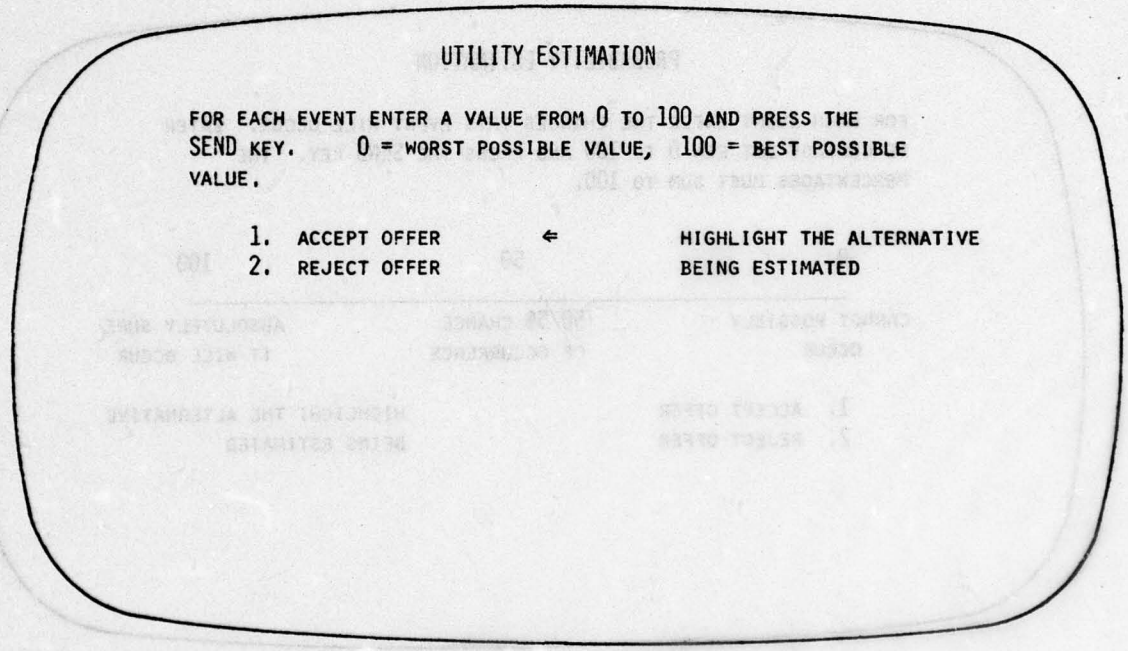
1.	LIST THE EVENT OR RESPONSES WHICH WILL OCCUR.	3
2.	*DEVELOP ALTERNATIVE ACTIONS.*	0
3.	CONSIDER THIS A FINAL OUTCOME.	1

ALTERNATIVE EVENTS OR RESPONSES WILL BE CONSIDERED NEXT.

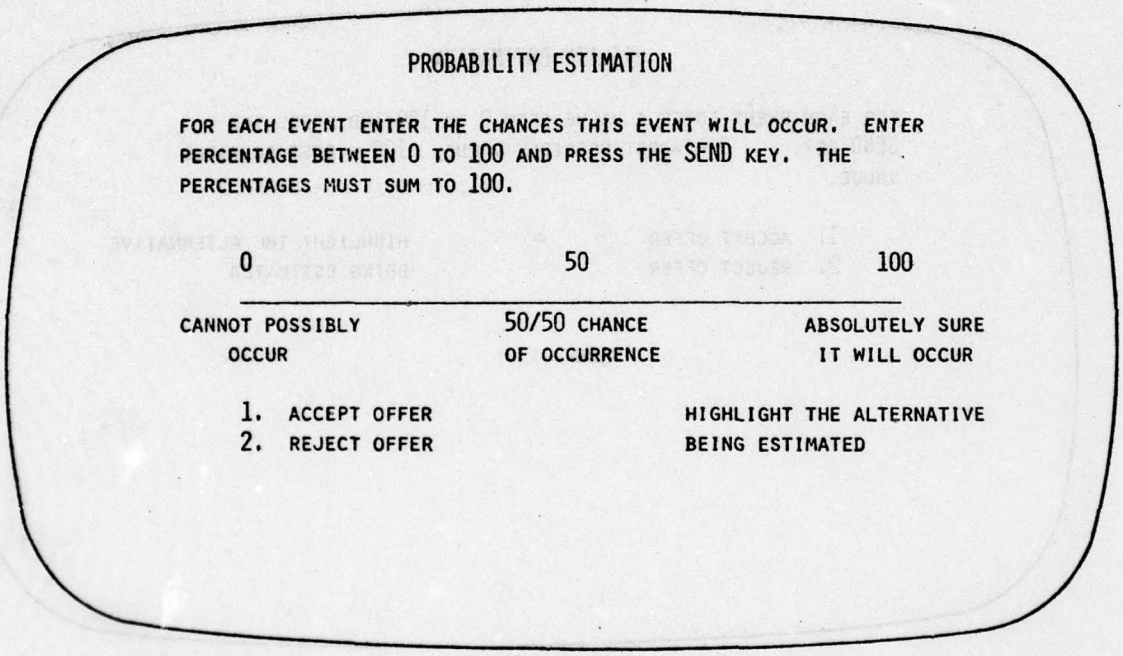
THE DIRECTOR ASKS THE GROUP TO GENERATE A LIST OF ALTERNATIVE EVENTS THAT COULD OCCUR. PREVIOUS INTERMEDIATOR PROCEDURES FOR HANDLING LISTS OF ALTERNATIVES ARE USED. IT MAY BE USEFUL TO DISPLAY ALL OR PART OF THE CURRENT DECISION TREE AT THIS TIME.



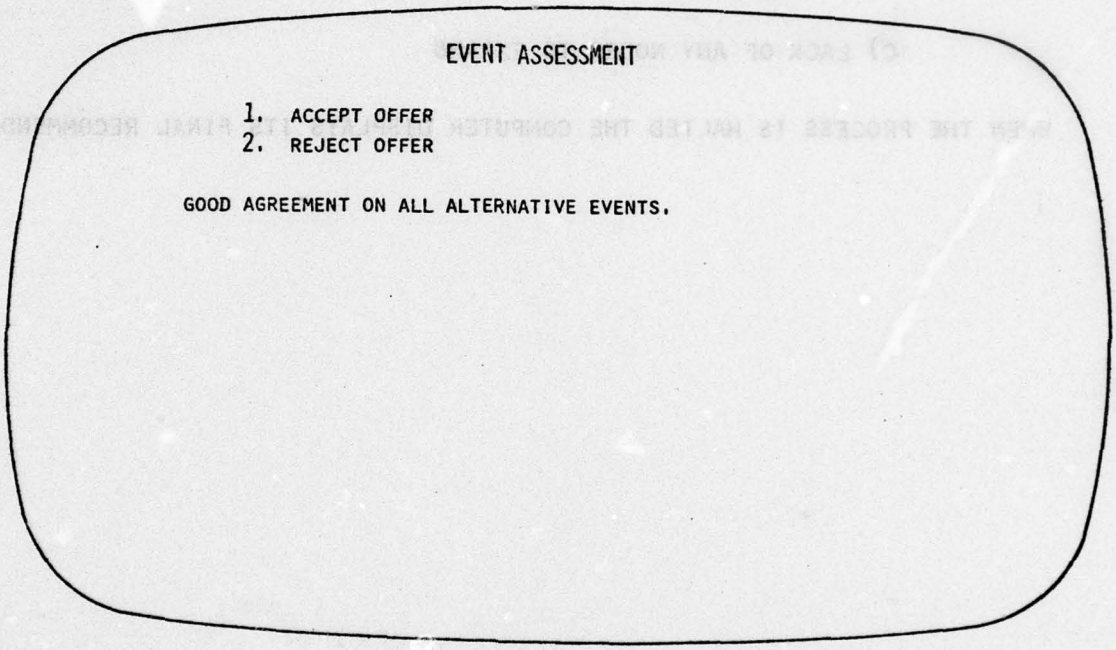
THE PARTICIPANTS ARE ASKED TO ASSIGN UTILITIES AND PROBABILITIES TO THE ALTERNATIVE EVENTS. FIRST, ALL UTILITIES ARE ASSIGNED AND THEN PROBABILITIES.



PROBABILITY ESTIMATES FOR EACH EVENT ARE THEN ELICITED FROM EACH PARTICIPANT.



THE COMPUTER ANNOUNCES THE RESULTS VIA THE GROUP DISPLAY.



AS WITH CONFLICTING UTILITY ESTIMATES ON ACTIONS THE SAME MAUM PROCEDURE IS INVOKED FOR VALUE CONFLICTS ON EVENTS.

THE BASIC NODE SELECTION/EXPANSION PROCESS CONTINUES UNTIL HALTED BY:

A) GROUP VOTE

B) THE DIRECTOR

C) LACK OF ANY NODES TO EXPAND

WHEN THE PROCESS IS HALTED THE COMPUTER DISPLAYS ITS FINAL RECOMMENDATION.

5.5 Intermediator/Machine Interface Description

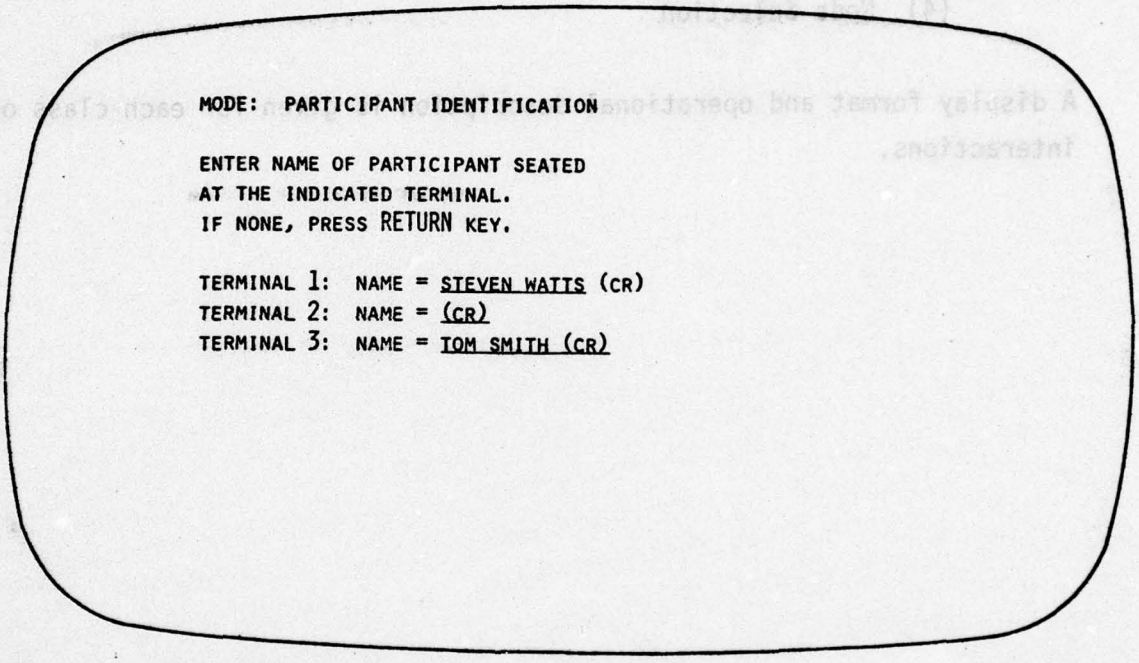
This section presents a series of frames that describe the display formats and interactions of the intermediator and the decision aiding system.

(1) Identification of Participant
(2) Entry and Editing of Lists
(3) System Pacing
(4) Node Selection

A display format and operational description is given for each class of interactions.

PARTICIPANT IDENTIFICATION: DISPLAY FORMAT

THE COMPUTER STEPS THROUGH THE LIST OF TERMINAL NUMBERS (PARTICIPANT POSITIONS) AND HAS THE DIRECTOR/INTERMEDIATOR ENTER THE PARTICIPANTS NAME.



PARTICIPANT IDENTIFICATION: OPERATIONAL DESCRIPTION

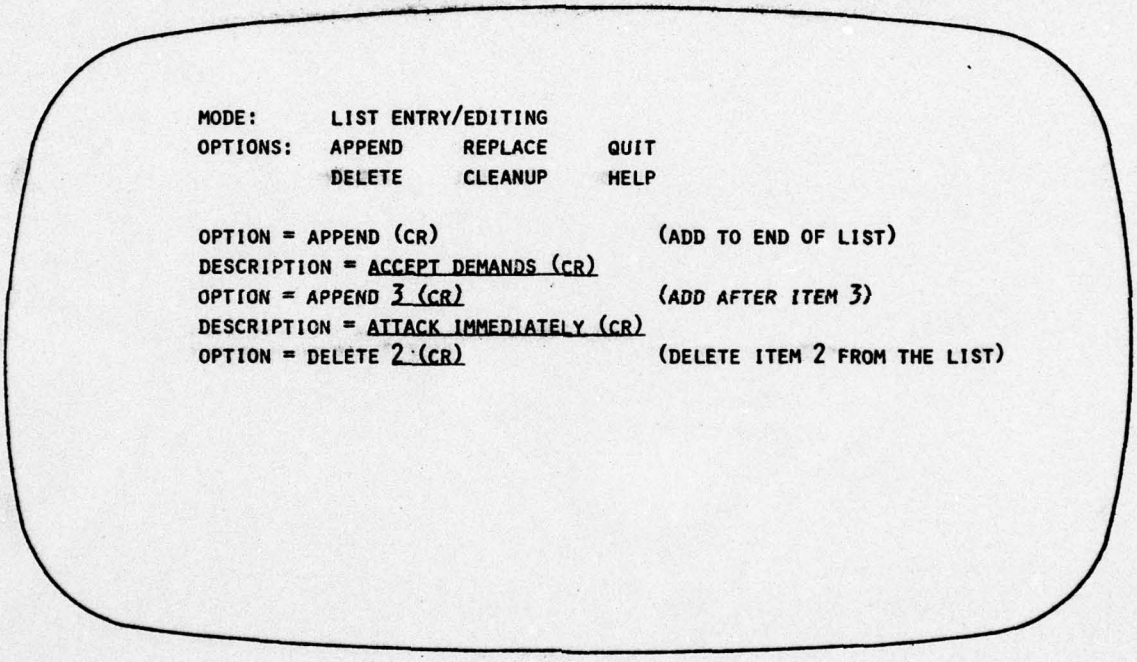
FOR EACH AVAILABLE PARTICIPANT TERMINAL, PROMPT FOR AN ACCOMPANYING NAME. IF NO NAME IS ENTERED, ASSUME THERE IS NO ONE AT THAT TERMINAL.

CONTROL CHARACTERS FOR DELETING A CHARACTER OR RE-ENTERING A LINE ARE PROVIDED.

SCREEN SHOULD BE CLEARED FOR THIS PROCEDURE.

LIST ENTRY/EDITING: DISPLAY FORMAT

WHENEVER THE GROUP IS CALLED UPON TO GENERATE A LIST OF ALTERNATIVE ACTIONS OR EVENTS, THE INTERMEDIATORS TERMINAL IS PUT INTO A MODE FOR THE ENTRY AND EDITING OF ALTERNATIVES.



LIST ENTRY/EDITING: OPERATIONAL DESCRIPTION

THE COMMAND OPTIONS ARE: APPEND, REPLACE, DELETE, CLEANUP, QUIT, AND HELP.

AFTER THE FIRST LETTER OF THE COMMAND IS TYPED, THE REST OF THE COMMAND IS PRINTED AND FOLLOWED BY A SPACE. THE COMPUTER WAITS FOR THE USER TO CONFIRM THE COMMAND, I.E., A CARRIAGE RETURN. SOME COMMANDS REUQIRE A NUMERIC ARGUMENT, I.E., DELETE (ITEM NUMBER).

THE MODE HEADING AND OPTIONS LIST ARE NOT CHANGED OR SCROLLED OFF THE SCREEN, INSTEAD THE BOTTOM HALF OF THE DISPLAY IS USED AS A WORK AREA. THE CAPABILITY TO ERASE CHARACTERS AND WHOLE LINES SHOULD BE PROVIDED.

INDIVIDUAL COMMANDS PERFORM AS FOLLOWS:

APPEND — ADDS A NEW ITEM TO THE END OF THE CURRENT LIST. IN THEORY A CHECK SHOULD BE MADE FOR TOO MANY ITEMS BUT FOR NOW, FORGET IT.

APPEND N — ADDS A NEW ITEM AFTER ITEM N IN THE CURRENT LIST. IF N = 0 ADD THE ITEM AT THE FRONT OF THIS LIST. IF N > LENGTH OF THE LIST THEN ADD THE ITEM AT THE END OF THE LIST.

LIST ENTRY/EDITING: OPERATIONAL DESCRIPTION (CONT'D - 2)

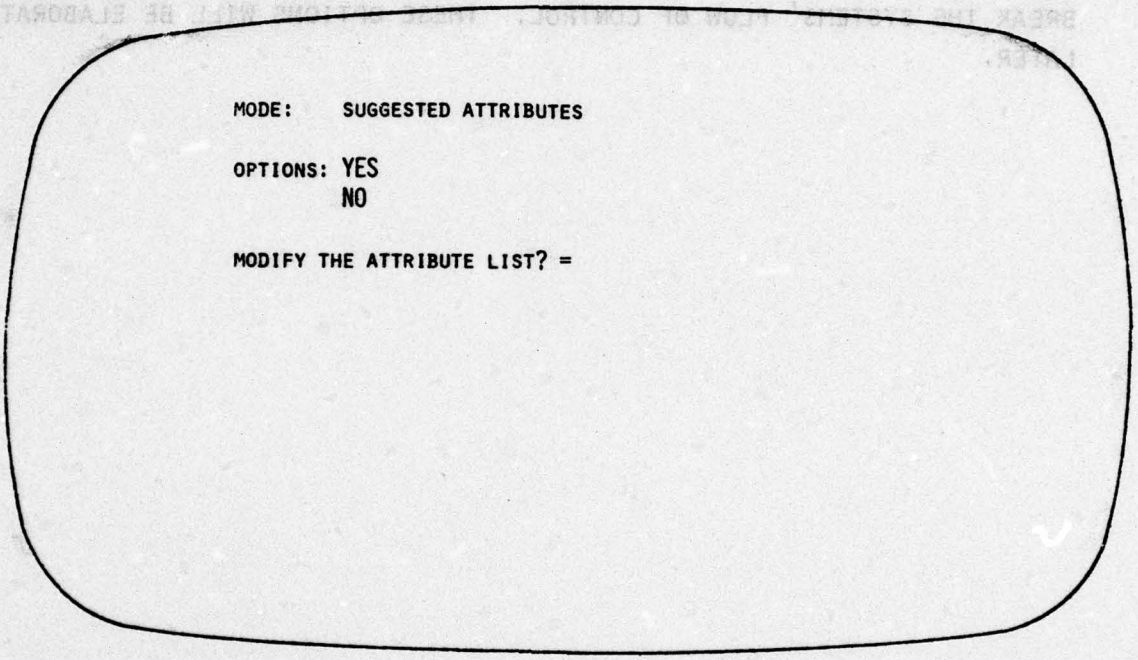
REPLACE N	REPLACES ITEM N IN THE LIST WITH ANOTHER ITEM. N MUST BE A LEGAL ITEM NUMBER.
DELETE N	DELETES ITEM N FROM THE CURRENT LIST. N MUST BE A LEGAL ITEM NUMBER.
CLEANUP	RENUMBERS AND CONDENSES THE LIST DISPLAYED ON THE LARGE SCREEN GROUP DISPLAY.
QUIT	THE LIST EDITING SESSION IS COMPLETED. IF THE EDITING HAS BEEN TO A LIST OF ACTIONS OR EVENTS, THE USER IS PROMPTED TO CONFIRM THAT THE ITEMS IN THE LIST ARE MUTUALLY EXCLUSIVE. THE USER PRESSES THE YES KEY OR THE NO KEY IN RESPONSE.

SYSTEM PACING: DISPLAY FORMAT

THE RATE AT WHICH THE SYSTEM MOVES FROM DISPLAY TO DISPLAY IS A SHARED RESPONSIBILITY--PARTLY THE DIRECTORS AND PARTLY THE SYSTEMS. WHEN THE DIRECTOR IS PROVIDING INSTRUCTIONS TO THE GROUP OR MEDIATING A CONVERSATION, THE COMPUTER WILL WAIT BEFORE PROCEEDING WITH THE PROMPT "TYPE RETURN TO PROCEED." AT OTHER TIMES, THE WAIT PERIOD BEFORE PROCEEDING WILL BE PRESET. IF THE DIRECTOR TYPES SOMETHING OTHER THAN RETURN, THEN THE PROGRAM WILL PROMPT HIM WITH A SET OF ACTIONS THAT BREAK THE SYSTEMS' FLOW OF CONTROL. THESE OPTIONS WILL BE ELABORATED LATER.

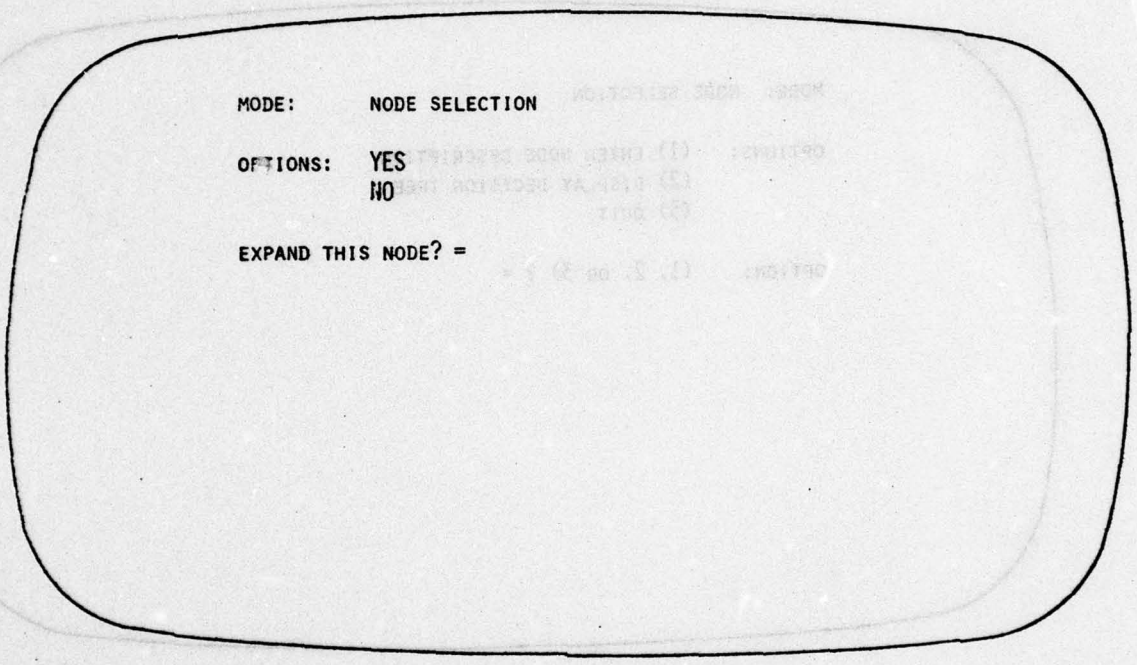
SUGGESTED ATTRIBUTES: DISPLAY FORMAT

AFTER EXPLAINING THE MEANING OF ASSIGNING HOLISTIC VALUES TO ACTIONS OR EVENTS THE GROUP VOTES ON WHETHER TO MODIFY THE ATTRIBUTE LIST. THE DIRECTOR IS GIVEN THE FINAL DECISION ON WHAT TO DO.



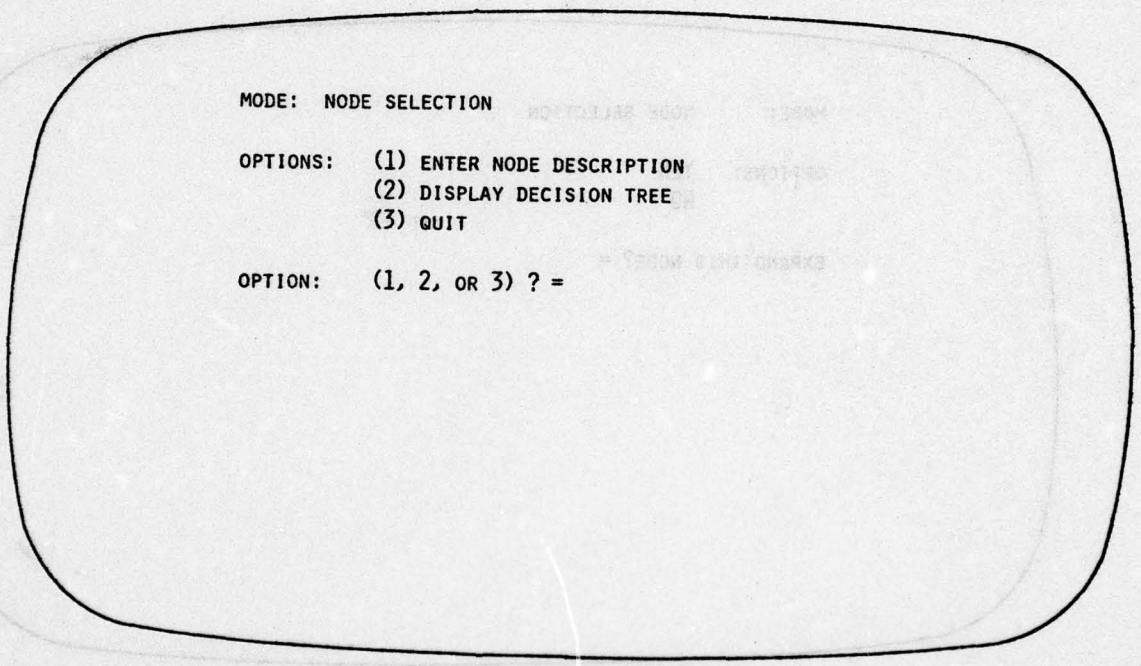
NODE SELECTION: DISPLAY FORMAT - 1

WHEN THE PROGRAM SELECTS A MODE TO EXPAND, THE DIRECTOR IS GIVEN THE OPTION OF OVER-RIDING THE COMPUTER.



NODE SELECTION: DISPLAY FORMAT - 2

IF THE DIRECTOR WANTS TO EXPLICITLY SELECT ANOTHER NODE, THEN HE IS ASKED IF HE WANTS TO TYPE IN A NODE DESCRIPTION OR SEE THE TREE.



NODE SELECTION: OPERATIONAL DESCRIPTION - 2

OPTION = 1 USER ENTERS A LINE OF TEXT AND PROGRAM SEARCHES TREE DOING PATTERN MATCHES FOR A MATCHING NODE. UPON A MATCH THE USER IS ASKED FOR CONFIRMATION. IF NOT THE NODE, THE SEARCH CONTINUES.

OPTION = 2 ENTER TREE DISPLAY MODE.

OPTION = 3 RETURN TO PREVIOUS STATE.

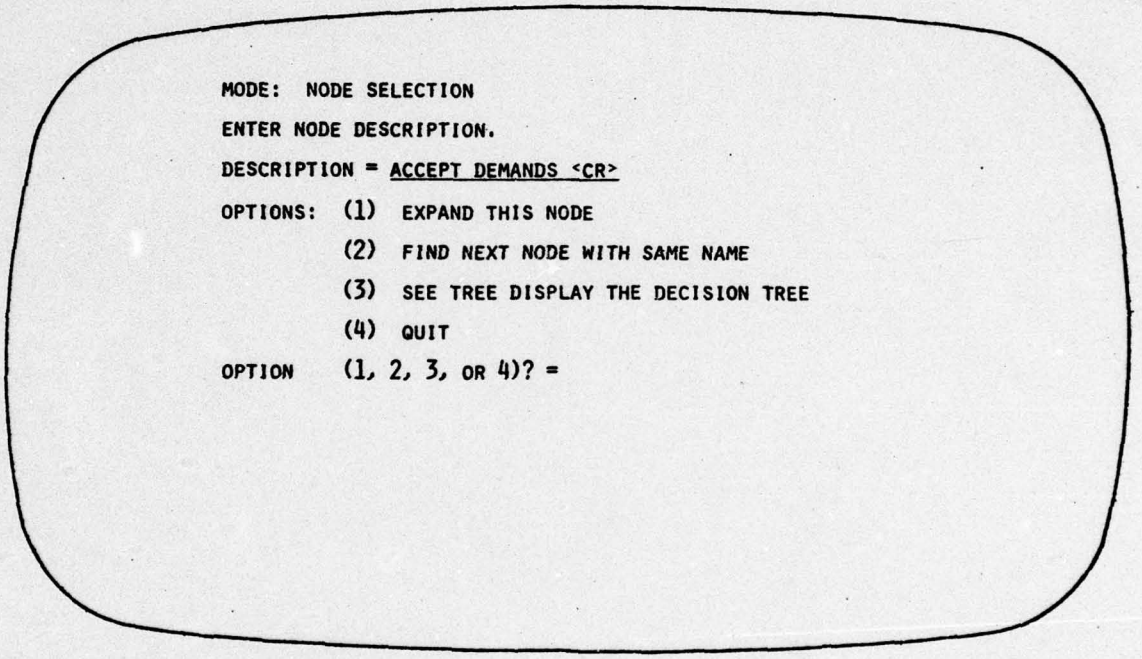
NODE SELECTION: DISPLAY FORMAT - 3

SELECTS OPTION 1: ENTERS DESCRIPTION THAT DOES NOT HAVE A MATCHING NODE.

```
MODE:  NODE SELECTION
ENTER NODE DESCRIPTION
DESCRIPTION?  ATTACK TOMORROW <CR>
NO EXPANDABLE NODES WITH THAT DESCRIPTION
OPTIONS:  (1) ENTER ANOTHER DESCRIPTION
          (2) DISPLAY DECISION TREE
          (3) QUIT
OPTION    (1, 2 OR 3)? =
```

NODE SELECTION: DISPLAY FORMAT - 3A

SELECTS OPTION 1: ENTERS A DESCRIPTION HAVING A MATCHING NODE. THE PATH TO THE MATCHING NODE IS DISPLAYED ON THE GROUP DISPLAY.



6. SCENARIO DEVELOPMENT

6.1 Introduction

Empirical evaluations of the group aiding system will require a realistic problem situation that can be posed to the group as the central decision making task. Such a problem situation is called a "scenario" and is usually chosen to be compatible with as many system features as possible. The scenario being used for the group decision making environment is that of counter-terrorist actions. A terrorist scenario has a number of advantages with respect to the objectives of the current research:

(1) Decisions concerning counter-terrorist actions are normally made by a group.

(2) There is usually a time limit on discussion.

(3) By nature, the decision is very critical, often involving possible loss of life.

(4) Members of the group generally represent different interests and are thus more likely to have conflicts on value.

(5) The group members may have personal biases such as political image, etc.

The scenario is based on a hypothetical seizure by terrorists of an oil refinery and a subsequent group meeting of officials to develop a plan to resolve the situation. The crisis occurs in Shamba, a fictitious region of military, economic, and political unrest developed by Struefert

(June, 1967) as part of the Tactical Negotiations Game (TNG). Shamba and the TNG offers several advantages as a context for the problem situation:

(1) A large body of information has been written as context for the TNG game.

(2) Establishing the problem situation in a hypothetical region avoids conflicts with any on-going real-world events.

(3) Computer-based TNG materials (i.e., messages) have already been developed and can be adapted for use in the current, as well as subsequent, evaluations.

6.2 Scenario Briefing Booklet

Information on the terrorist problem confronting the group will be provided to each group member in a briefing booklet. The booklet will contain a brief summary of the current situation and a chronological file of messages covering the time from the start of the crisis to the beginning of the group's meeting. An initial timetable of events and a preliminary message file for the booklet is presented in Appendix A.

The message file consists of a series of short reports that could realistically have been received or gathered over the short three hour time period from the incident's initiation to the group's meeting. Each message is identified by type (i.e., phone call, telex, interview), source (i.e., guard, terrorist, etc.), to whom the message was sent, and the message's origination time.

To increase the authenticity of the scenario, the physical form of the booklet will be as realistic as possible. For example, messages will

be typed using different type fonts on several types of paper to simulate multiple information sources, some messages will be handwritten, and so on.

7. SOFTWARE DEVELOPMENT

7.1 System Configuration

The participants (i.e., the decision makers) and the intermediator/director are seated at a conference table facing an Advent large screen display system. Situated in front of each participant is an Interface Technology 732 data entry terminal (DET) which is used for entry of numeric values and voting. The DET's have an eight digit LED display, numeric keypad, function keys, and eight indicator panels that are under computer control.

The intermediator/director has an Informer D301 terminal equipped with a 16 line by 32 character CRT, full alphanumeric keyboard, and function keys. Using the Informer terminal, the intermediator/director can enter and edit lists of alternatives, query and direct the system, and receive reports from the computer aiding system on group performance.

The Advent projection system is driven by a Genisco 3000 programmable color graphics system. Perceptronics' current Genisco system is 512 x 512 resolution, has a video lookup table for displaying up to 4096 colors, and can generate a wide range of alphanumeric, as well as graphic material. In a separate room, a 19" Mitsubishi high resolution color monitor can be used to unobtrusively monitor what the group is doing.

7.2 Software Design

Software for the group decision aiding system is being designed and implemented under the UNIX operating system, using the C programming language. During the second contract period covered by this report, a detailed software design was produced for the major system components.

Interface software for the Informer terminal and the participants' data entry terminals was written and tested. The latter provides general system capabilities for reading, writing, and polling the Informer terminal and the participants' terminals.

While simulating typical group displays it was determined that the size of the original 5 x 7 software characters generated by the Genisco system were inadequate for extended viewing. This situation was remedied by designing and installing a larger 7 x 9 alphanumeric character set. The Genisco software character generation routines were modified accordingly.

8. REFERENCES

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Levin, S.L., Leal, A., and Saleh, J. An Interactive Computer Aiding System for Group Decision Making. Perceptronics, Inc. (Woodland Hills, CA) Technical Report PTR-1046-77-6, MDA903-77-C-0184, Defense Advanced Research Projects Agency, May 1977.

Sheridan, T.B. and Sicherman, A. Estimation of A Group's Multi-Attribute Utility Function in Real Time by Anonymous Voting. IEEE Special Issue on Decision Making, May 1977.

Streufert, S., Castore, C.H. and Kilger, S.C. A Tactical and Negotiations Game: Rationale, Method and Analysis. Rutgers University (New Brunswick, NJ) ONR Technical Report No. 1, AD654-921, Contract No. N00014-67-A-0115-0002, Office of Naval Research, Code 455, June 1967.

APPENDIX A

SCENARIO TIMETABLE

AM		ITEM
9:20	Terrorists enter oil refinery perimeter	--
9:33	Security guard calls police and ambulance	PHONE
9:42	Police and ambulance arrive with anti-terrorist unit	--
9:48	Elevator operator reports	MESSAGE
9:55	Security guard reports	REPORT
10:00	Police commissioner notifies Shambian Internal Security Agency	--
10:15	Fire department notified	--
10:24	Fire department arrives	--
10:35	Oil refinery employee reports	MESSAGE
10:40	S.I.S.A. Chief calls terrorists	PHONE
10:45	Hostage brings list of demands	2 NOTES
10:50	Hostage interviewed by press	INTERVIEW
10:55	Commander of anti-terrorist unit reports	REPORT
11:00	Police commissioner reports	REPORT
11:15	Interview with a fire fighter	INTERVIEW
11:30	Interview with Shambian Minister of Defense	INTERVIEW
11:45	Psychologist's report	REPORT
12:00	Report from president of oil refinery	REPORT
PM		
12:15	Shambian President calls meeting	--
1:00	Group meets	--

ITEM: Phone Call

FROM: Oil Refinery Security Guard

TO: Shambian Police Department

TIME: 9:33 am

Five terrorists have broken into the oil refinery. They have shot the elevator operator and gone to the control room on the 4th floor of Building 6. They have pistols and machine guns and there's some VIP up there. Call an ambulance.

ITEM: Message

FROM: The Wounded Elevator Operator

TO: The Commander of Anti-Terrorist Unit

TIME: 9:48 am

About 9:30, burglars with machine guns came in. Before I could push the emergency key, they shot me, threw me out, and went into the elevator. They're maniacs, all of them!

ITEM: Report

FROM: Security Guard

TO: Commander of the Anti-Terrorist Unit

TIME: 9:55 am

Five men in business clothes drove up to the west security gate at about 9:20 this morning. They signaled for me to come over to the car and when I did, they pointed a machine gun at me and told me to get into the car. They held the gun at my head and forced me to direct them to Building 6 where the control room is. There is only one guard at each gate, so no one knew that anything was wrong. They all spoke Shambian.

When we reached Building 6, they all got out and told me to stay in the car. They took my gun. They entered the building and then I heard a shot. I jumped out of the car and ran into the building and found the elevator operator lying on the floor. That's when I called the police and the refinery President.

ITEM: Message

FROM: Oil Refinery Employee

TO: A Member of the Anti-Terrorist Unit

TIME: 10:35 am

I was checking the pressure of number 32 tank near the control room, when three or four men burst into the control room and started yelling for everyone to lie down. I ran downstairs and they didn't see me. I saw they had machine guns. There's an important guy there visiting from the U.S.A. If they blow up that control room, the whole refinery could go.

ITEM: Phone Call

FROM: Shambian Internal Security Agency Chief

TO: Control Room of Oil Refinery

TIME: 10:40 am

Terrorists: We've got 10 hostages and the U.S. Ambassador here. If you don't do what we want, we will blow up the refinery.

Chief: Let me talk to the Ambassador.

Ambassador: You better do what they want. They mean what they say.

Chief: What do you want?

Terrorists: A hostage will come out with our list of demands.

ITEM: Note

FROM: Terrorists

TO: Government of Shamba

TIME: 10:45 am

The Free Front of the People of Shamba demand that the following concessions be made:

(1) Release of all political prisoners.

(2) Two million dollars in Pound Sterling to be deposited in a private Swiss Bank Account.

(3) A 707 jet with pilot and crew ready for a long distance flight.

(4) An armed car for transportation to the airport.

(5) Publication of our communiqué in largest Shambian newspapers.

ITEM: Note

FROM: Terrorists

TO: Government of Shamba

TIME: 10:45 am

THE FREE FRONT OF THE PEOPLE OF SHAMBA

In the name of the struggles of the enslaved people of Shamba:

Today's action against the government of Shamba is a reminder to the world that the days of slavery are coming to an end. The brave people of Shamba have decided to put a stop to the inhuman conducts of the organized butchery called the government of Shamba. The enslaved people of Shamba are ready to defend their stand against slavery. Freedom is what we need; freedom is what we fight for; victory to the brave people of Shamba.

ITEM: Interview

FROM: Released Hostage

TO: Shambian News Reporter

TIME: 10:50 am

I am from the Shambian government. We were showing the visiting American Ambassador the controll room when these armed men broke in and took over. After a phone call, one of them gave me two papers and told me to bring them out. I thought they were going to shoot me.

This is very bad. You know it was the U.S. that built this refinery for Shamba as a good will gesture. This will cause grave international repercussions, and perhaps, a crisis.

ITEM: Report

FROM: Commander of Anti-Terrorist Unit, Mandero City Police Department

TO: Police Commissioner

TIME: 10:55 am

At 9:33 am, we received a call from the security personnel of the new Shambian Oil Refinery about the on-going terrorist activity. The anti-terrorist unit was at the scene in 9 minutes. The neighboring building is being used as a surveillence point. The activities on the fourth floor can be monitored from this point. The behavior of the terrorists indicates that they are professionals. They are never in the same area at the same time. They have installed wired boxes in different places in the building. The majority of the hostages are being kept in one of the rooms. The terrorists seem to have a good control over the entire floor. Anti-terrorist units are now stationed at the scene and they are closely monitoring the situation. The terrorists cannot move without our knowledge.

ITEM: Report

FROM: Police Commissioner

TO: Shambian Government

TIME: 11:00 am

REPUBLIC OF SHAMBA, MANDERO CITY POLICE DEPARTMENT

Police Commissioner Report

At approximately 9:30 am, Monday, June 27, a group of five terrorists occupied the fourth floor of Building 6 of the Shambian Oil Refinery on the outskirts of Mandero City. At 10:00 am, I notified the Shambian Internal Security Agency about the incident by telephone. At 10:45 am, one of the hostages carried the list of terrorist's demands to the police forces at the scene. The list includes:

- Release of 20 convicted criminals with charges ranging from treason to arson.
- 2 million dollars ransom in British currency, deposited in a specific account in a Swiss Bank.
- A 707 jet with pilot and crew for escape.
- An armed car for transportation to the airport.
- Publication of their propaganda in the three largest Shambian newspapers.

At the time of this report (11:00 am), the 4th floor of the building seems to be under absolute control of the terrorists. The counter-terrorist division of the Mandero City Police Department, and the Mandero City Fire Department are monitoring the incident closely.

ITEM: Interview

FROM: A Fire Fighter

TO: Shambian Broadcasting Company Reporter

TIME: 11:15 am

We received an emergency message from the commander of the anti-terrorist unit at 10:15. Three fire fighter companies and two paramedic units were dispatched and arrived at the scene at 10:24. We are stationed at a nearby street where we don't attract the attention of the terrorists and, at the same time, are ready for a fast respond to possible incidents. At present, the fire fighters and paramedic units are in complete readiness to respond to any situation that may require them. The oil refinery is very dangerous and could explode very easily. We recommend that as many people as possible be evacuated.

ITEM: Report

FROM: The Shambian Minister of Defense

TO: Shambian President

TIME: 11:30 am

The criticality of the Refinery incident should not be overlooked. Any delay in responding to a handfull of criminals and adventurers might open up a new era of terrorism and anarchism in our country. This means playing with the life, freedom, and security of the people, as well as the integrity of our nation; two things that we cannot and should not allow to be the subject of any kind of negotiation.

As you well know, I have been the architect of new legislation on counter-terrorist actions. The reaction of the public to this legislation is a valid indication of our great need to take a solid and strong stand against any form of terrorism. Our representative to the United Nations has already submitted a version of this legislation to the members of the U.N. for approval as an international counter-terrorist act. I am sure that you are very well aware of the high price we might have to pay for weakness. Employment of any passive reaction not only will result in great international embarrassment, but also might very well cause the death of the last chance for establishing an international regulation against all terrorists and murderers. As a representative of the people of Shamba, I consider it my responsibility to stand behind the rights of the people. In this case, as well as any other, I will only defend those actions which will provide freedom, security, and peace of mind for our people. I consider it morally wrong to do otherwise.

ITEM: Report

FROM: A Psychologist at the Scene

TO: Commander of Anti-Terrorist Unit

TIME: 11:40 am

Although the conduct of the terrorists suggests their strong confidence, the nature of such terrorist activities always creates a nervous reaction to any event of suspicious nature. Therefore, any type of action on the part of the anti-terrorist forces which might be interpreted by the terrorist as an evidence confirming the possibility of an attack against them, will be a direct threat against the hostages' lives. In any terrorist activity, especially its early stages, there is a high degree of tension and suspicion. Early stages of the activity creates the most unstable psychological state in the terrorists, and as a result, provides the worst time for a physical attack. The best policy at this stage, will be to avoid any conflict and let the terrorists regain their rational psychological state.

ITEM: Report

FROM: President of Oil Refinery

TO: Shambian President

TIME: 12:00 noon

There is no need to restate that this is a grave situation for the country of Shamba, as well as our relations with other nations of the world. As you know, the U.S. has given us this refinery with the hopes of establishing mutual trust and good will. The fact that one of their ambassadors is being held hostage, jeopardizes this good will.

It took four years to build the refinery and at great expense. The loss to Shamba would be incalculable.