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DECISION-PROBLEM STATE ANALYSIS METHODOLOGY

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SUMMARY

The objective of this effort was to establish a methodology for analyzing a decision-problem state. A decision-problem state is defined as a set of related problem and decision resolutions necessary to obtain a major goal. The increasing cost of resources both human and material accents the waste resulting from an aircraft accident. The expense incurred from accidents reduces the funds available for improvements. Reviews of accidents and analysis of groups of accidents indicate an increasing percentage of accidents is attributed to human error. However, there does not currently exist any systematic methodology to further analyze a "human error" cause. Extensive techniques have evolved to determine the exact failure of equipment, material, or the structure of aircraft but the human-error-related accident has defied further analysis. Unless a method can be applied to further isolate the human-error accident, no objective way exists to ensure against further occurrences. The reduction of human-error accidents will only occur when an improved method for identifying the cause source is obtained.

The methodology proposed and presented in this report is based on the analysis of an incident in terms of the set of decision-problem conditions encountered. By decomposing the events that preceded an unwanted outcome, such as an accident, into the set of decision-problem conditions that were resolved, a more comprehensive understanding is possible. All human-error accidents are not caused by faulty decision-problem resolutions, but it appears to be one of the major areas of accidents cited in the literature. A three-phase methodology is presented which accommodates a wide spectrum of events. It allows for a systematic content analysis of the available data to establish: (1) the resolutions made, (2) alternatives not considered, (3) resolutions missed, and (4) possible conditions not considered. The product is a map of the decision-problem conditions that were encountered as well as a projected, assumed set of conditions that should have been considered. The application of this methodology introduces a systematic approach to decomposing the events that transpired prior to the accident. The initial emphasis is on decision and problem resolution. The technique allows for a standardized method of accident into a scenario which may be used for review or the development of a training simulation.

To label an accident as caused by human error is no longer sufficient. More detail is demanded to further reduce the possibility of another accident of this type. To do this, an attempt must be made to be more specific about the categories of human-error accidents. To develop training programs to introduce corrective applications, more specific content must be available, such as decision-problem resolution. In order to improve the present level of analysis, a systematic content analysis technique was developed. The

methodology is based on the decision-problem state that precedes the accident. Although this approach is focused on an appropriate decision-problem resolution, it allows for a possible analysis of a major source of human-error accidents.

INTRODUCTION

Life is composed of an endless series of loosely related decision and problem conditions. Decisions are made. Problems are solved. As an individual encounters a decision or a problem condition, it is resolved. In many situations, the goal or objective is attained through the resolutions of several decision or problem conditions. The resolution of a set of decision-problem conditions is a more complex task than the resolution of one condition. Typically, there exists some relationship between the conditions, and the resolution of one condition has some effect on the remaining resolutions. Considerable research has been done in an effort to understand how to resolve a single decision-problem condition. Little research has been conducted to explore the more complex mechanism used to resolve a decision-problem condition set. In dealing with discrete sets of decision-problem conditions, the identification and management of the set becomes an important consideration (Dieterly, 1980c).

To manage a decision-problem set, some boundary must be identified. Some aspects of life may be isolated and thought of as a relatively unique set of decision-problem conditions that terminate at a fixed point. For example, a board meeting, an airline flight, or the evening are identifiable units of activity that may be decomposed into a set of decision-problem conditions. The board adjourns, the flight terminates, you go to bed; all these are expected end points that signal completion (Dieterly, 1973). In analyzing these units, in terms of the decisions and the problems that are encountered, a complex interaction pattern is revealed. This type of analysis is required to understand the process of resolving a decision-problem state. Because the literature seldom addresses this situation in specific terms, a systematic methodology is developed in this paper. Although other scientists have alluded to the situation (Lindberg, 1962; Green, 1972) and although Edwards (1962) discussed the concept of dynamic decision theory, no direct methodological approaches are available.

The purpose of this paper is to describe a methodology developed to analyze a decision-problem state. A decision-problem state, as defined in a previous work (Dieterly, 1980c), is a set of decision-problem conditions that must be resolved to attain a major end state (goal or objective). The decision-problem state is the type of situation faced in attaining major objectives. For example, to determine whether to start a new business requires an analysis of a set of decision-problem conditions. A decision-problem condition is a condition of the general form of $A \rightarrow B$, where A is an initial state, B is an end state, and the arrow indicates the transition. For example, if I am without money and wish to have some money, I may apply the transition of working to reach the desired end state. These concepts are used as the background for the methodology developed.

METHODOLOGY CONCEPT

The methodology represents a general systematic approach to analyzing the process that has occurred in resolving a decision-problem state. It could also be used to project the possible process used in an anticipated future decision-problem state. Therefore, the methodology is designed to apply to two types of studies: (1) to analyze the past decision-problem conditions, and (2) to provide a forecast of future decision-problem conditions.

In the first case, the methodology would be applied in an attempt to reconstruct a decision-problem state that has been resolved. The purpose for the reconstruction may be to identify errors, develop a training scenario, or increase understanding of how the outcome was attained. Training scenarios may be developed and trainees required to practice to ensure they are prepared to resolve all expected decision-problem conditions. The NASA space training program, for example, included this type of practice.

In the second case, a forecast map of potential decision-problem conditions that will be encountered is developed. The purpose of this type of analysis is to prepare or train an individual to be aware of the conditions that will be encountered and of the possible resolutions that may be applied. The methodology is flexible enough to allow its application to both of these situations. Additional concepts are required to comprehend the process that occurs in resolving a decision-problem state. The clarification process is a prescriptive model of how a single decision-problem condition is resolved (Dieterly, 1980c).

In studying the complex behavior that occurs in the resolution of a decision-problem state, the focus is on decomposition. The state is decomposed into a set of decision-problem conditions. The critical difference between the resolution of a single condition and a state is the ability to anticipate the condition set, clarify each condition to assign a priority, and resolve the necessary conditions in an efficient sequence. The process of state management is predominant. No matter how sufficient an individual may be in resolving a single condition, the resolution of a state requires an initial planning aspect not encountered in a single-condition resolution.

The methodology consists of three phases. Once the first phase has been applied, a diagram of the decision-problem sequence is developed to allow for an extensive review of the decision-problem choices made in the situation described. In the second phase, the diagram is expanded through assumptions. In the third phase, the diagram may be expanded to develop a complete hierarchical model of the decision-problem state (Dieterly, 1980c). The function of the hierarchical model is to completely decompose the decision-problem state into decision-problem conditions and to suggest the types of transitions and expected outcomes associated with each condition.

The methodology allows for the analysis of the decision-problem state to such a degree that the final product may be used to establish a scenario of the activity that took place. The scenario may be retained for further analysis, compared to other similar decision-problem states, or converted to use as a training aid within a training program. The evolved methodology concentrates on these basic concepts to allow for the understanding of the process of how to effectively manage the resolution of a decision-problem state.

INDIVIDUAL OR TEAM ANALYSIS

The methodology may be applied by an individual analyst or by a team of analysts to the data base selected. Dependent on the type of decision-problem state and the importance of the results, a decision should be made to determine the number of analysts necessary to apply the methodology. As the importance of the results increases, so should the number of analysts. Each analyst should work independently. Their results would be integrated into a joint product to provide the final analysis. A single analyst will provide an extensive amount of information about the decision-problem state. Several analysts working together will provide an even greater amount of detail. The advantages of several analysts are increased information, greater reliability, and more rapid analysis. The essential methodology is a form of content analysis that decomposes the information, and structures it into a series of decision-problem conditions to clarify the decision-problem state.

INFORMATION BASE

The methodology requires data input concerning the decision-problem state. To apply the methodology, two conditions must be considered. First, a clearly defined decision-problem state must be identified. The second condition is that an information source or sources must be available. This could be anything from sailing a ship from New York to San Francisco to a PTA meeting. Whatever the decision-problem selected, it must be bounded by a beginning point and end point. The type of state described is generally found in research about decisionmaking or problem solving in groups. It is a state that encompases a final resolution that has a major effect in terms of its environment.

The resolution is not expected instantly but will emerge with the passage of time or expenditure of effort. The end point of the state may be associated with an established time sequence or by an expected outcome. The time sequence and end point are frequently the agreed upon deadline. The board meeting will require 2 hr, the flight 4 hr, the evening 6 hr. Each could be ended earlier or later, but once the conditions have been identified and resolved, there is a clearly defined end. The end of the situation may not signal the end of the state. If the board ends after 2 hr, but must rediscuss the state at the next meeting, then the state still exists. If the board places a time constraint on the resolution so that the state is resolved at the end of the meeting, then both the state and the situation are terminated at the same time. Although frequently a decision-problem state is treated as a unique single event, it may be a generally repeated event. The examples mentioned certainly will recur. Different states may be resolved, during the time period, different individuals may participate, but the events will recur. To study the process of what occurs requires an analysis of each separate decision-problem condition and its relationship to the final conclusion. Essentially, when the state is identified, the second condition must be met.

The second condition is that some information source or sources is available for the analysis. The information may be extracted from a log, tape recording, report, letters, files, transcripts, film, video tape, or interview. The important point is to establish the type and source of data prior to analysis. In a projected situation, some documentation or estimate of what should take place would be required. As in all research, the information selected will determine the quality of the final analysis. The methods of recording the information were briefly alluded to, but of more importance is the kind of data that will be available. Since a decision-problem state is extremely generalizable, it allows for many types of data. An ideal situation is multiple sources of information. However, when multiple sources are available, they are frequently contradictory. For example, three eye witnesses to an event will usually report different information. If the multiple sources are not completely redundant, then some heuristic of credibility should be developed to consistently select the most credible information.

In most man-machine operations, performance data are attributable to two sources — people and equipment are analyzed. Again, in the examples, a board meeting will be dominated with data about people interacting, a flight will be dominated by a crew and aircraft interacting, an evening will be dominated by one person's behavior. The general kinds of data available from these two sources will, therefore, be behavioral, equipment-characteristic, and interactive (system performance). Behavioral data are those generated by an individual and displayed through his actions. Equipment-characteristic data are performed output from the machine. Interactive data are the result of an interaction between two independent units. The units may be people or machines, or a combination of the two. The number of voice responses made during the board meeting may be a useful measure of behavioral data that could be used in this type of analysis. The fuel consumption of an engine would be a possible machine characteristic of importance. The degree of error over a fixed driving course would be a measure of interactive data or systems performance data. This measure is derived from operator skill and the equipment control interaction. These three sources of performance data may be collected. Usually only one source is used; however, each source provides different degrees of information. The preferred technique would be to collect all three sources of performance data if possible. The characteristics of the state identified will limit the kinds of data available and may indicate the appropriate method of collection. Once these two conditions are satisfied, the methodology may be applied.

METHODOLOGY

The major purpose of the methodology is to analyze what occurred or would occur in a decision-problem state. The emphasis is on establishing the decision-problem conditions that encompass the state. The methodology consists of three phases: (1) data reduction, (2) interpretive analysis, and (3) the hierarchical model. To analyze the decision-problem state, two aspects of the situation must be isolated and specified. These aspects are the participants and information sources. The following paragraphs will expand on these aspects and phases.

Participants

In a decision-problem state, there is a unit that makes the decision-problem condition resolution. This unit solves the problem or makes a choice. The decision-problem state is compounded when multiple participants are introduced who may make resolutions. In this case, a participant refers to any source or possible choice of a decision-problem resolution. Therefore, the resolution of a decision-problem state by one unit or individual may be accomplished differently from that of a group or subset of units, for example, the process used by a crew. To resolve a decision-problem condition, one member, several members, or the entire crew may be necessary. In addition, decision-problem states that are associated with highly mechanized systems provide an automatic unit of choice, that is, the equipment may make the resolution. For example, in a cybernetic system of speed control, the resolution to alter the speed may be controlled by the machine. When a state is resolved by multiple units, a new dimension is introduced. The assignment of condition resolution control or responsibility for resolution becomes important. The delegation of responsibility is a primary aspect of multiple unit performance.

In this paper, the methodology will be oriented to one unit, an individual, resolving a decision-problem state. Although the methodology may be applied in the more complex situation, it will not be considered in detail in this paper.

The first step is to identify all the participant sources of resolution that may be interacted in the decision-problem state. If, for example, we are interested in the decision-problem conditions of a tennis match, the two immediate participant sources would be each player. The information provided by the judges as a group of individual judges in making calls may also be a participant source. Therefore, for this decision-problem state, three participants may be available: player A, player B, and the judging resolution. It should be noted, however, that an analysis of a tennis match introduces the competitive decision-problem state where a team is working toward a single goal. All participants are identified in making this type of analysis. The next step is to specify all potential information sources.

Information Sources

The identification of all available information sources is important. The information used for resolutions is a critical aspect of the decision-problem state methodology. An information source is any communication link, other than the participants, that provides additional data for use in condition resolution. For example, in the tennis situation, a coach would be an information source. An information source may provide or process information, but it does not make resolutions in the decision-problem state. If the coach made a resolution, such as telling the player to make a certain kind of serve, then the coach would no longer be an information source but also a participant. As can be seen in less complex cases of only one participant, there may be many information sources. In driving an automobile, the automobile is an information source; a passenger, a radio, a CB, or a telephone may also provide information. The availability of information may not be interpreted as an indication that it was used. If the driver does not scan his instruments, tunes out the passenger, does not turn on electronic communications devices, then he or she is not using these sources. After these two steps are completed, the first phase of the methodology may be applied.

First Phase

The analyst begins from the defined data base. Decisions and problems encountered within the state are the units to be identified. Clearly indicated resolutions signal a decision-problem condition. Resolutions made by individuals, groups, or subgroups are the first indication of the process of interest.

The information source is reviewed to isolate all the apparent decision-problem conditions that occurred during the period identified. What may key a decision-problem condition? Generally, some change in activity may signal a resolution. A statement of direction may signal a resolution. The use of the words, "solved" or "decided," that is, "I decided to go back" or "I solved that problem," indicates a resolution. Dependent on the previous activity within the state, four types of characteristics should be concentrated on: (1) change, (2) completion, (3) continuation, and (4) initiation.

Table 1 gives some examples of each of these, dependent on the sources of data collected. "Change" is the action of modifying existing output in level or direction; "completion" is ceasing output on a task; "continuation" is the maintenance of constant output in spite of some intervening occurrence, and "initiation" is the starting of output. All of these characteristics may signal a resolution of a decision-problem condition, but they must be evaluated within the context. A sequence diagram is developed indicating the participants, information sources, and the performance or activity taking place. This is diagrammed through time to establish the apparent actual sequence of decision-problem conditions that were resolved.

TABLE 1.- CHARACTERISTICS THAT MAY SIGNAL A DECISION-PROBLEM CONDITION

Kind of data	Change	Completion	Initiation	Continuation
Human behavior	Running faster	Stop running	Start running	Running at even pace
Interaction	Argue more violently	Stop arguing	Start arguing	Argue at a constant rate
System response	Increase speed	Engine fails	Start engine	Hold constant speed

The first phase is completed after the data source has been decomposed to a series of decision-problem conditions. These are then reviewed in terms of their relationships to each other. The use of certain standard symbols is shown in figure 1.

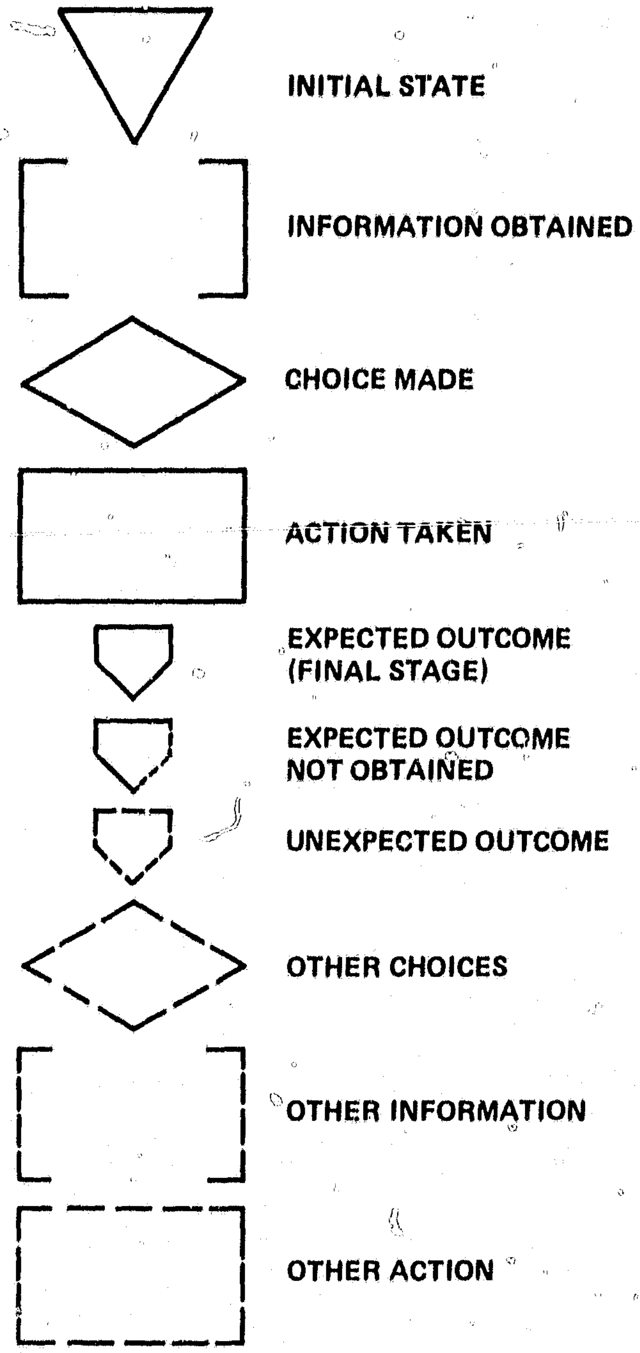

Figure 1.- Decision-problem state analysis symbols.

The product of this phase is a clarification of what took place or should have taken place during the resolution of the state. This phase is based entirely on the data resources. In addition to identifying all apparent decision-problem conditions, the participants and the information sources are clearly defined. At the conclusion of this phase, the availability of the individual concerned for purposes of reviewing the basic diagram would be invaluable.

Second Phase

In the second phase, the relationship of each resolution is clarified and the basic variables of each condition are established. The purpose is to take the conditions identified in the first phase and provide a pattern of relationship between them. At the same time, the sources of choice and the information sources are also linked to the state. The information sources are also indicated in terms of type and amount of information gained. The analyst has also introduced additional decision-problem conditions and indicated some of the resolutions that should have been considered but apparently were not.

Using the basic model of the decision-problem condition (Dieterly, 1980a), an initial state, final state, and a transformation are necessary for each condition. Frequently, the initial state is not clear except after some response is made. For example, a team member may say to his peers, "I think we need more statistics about the possible growth in the next 6 years which I will have the analysis staff prepare for us tomorrow." The initial state is no data; the transition is directing the data to be compiled, and the final state will be documented data. The decision-problem condition was recognized and clarified by one individual. Prior to his verbal response, however, the decision-problem condition may not have been considered by the other members.

This brief example also illustrates several other characteristics of the clarification process as it is applied by the individual. Whether the initial state was important to the total process is not clear. The other types of transitions are not identified and the final state may not be the optimum. This example also establishes an expectation: tomorrow the information will be available. What if it is not? What if the analysis staff calls back and says the information cannot be obtained or what if the information arrives but is not formulated as expected? Then the initial resolution must be reviewed and another resolution made.

The resulting set of decision-problem states is the approximation of what was or could be expected to be found. The resolutions selected will be indicated; however, those not selected but considered, and those not considered, may or may not be identified. The analyst, with the aid of an experienced operator, may begin to fill in the missing choices and expected outcomes. At this point, some indication may be made relative to an appropriate participant making a choice and whether the source of information could have been used more frequently.

The final product of the second phase is an amended statement of what occurred or what would be expected to occur for a specific decision-problem state. It is a diagrammatical interpretation of each condition, its initial state, the selected transition, final state, and expected outcome linked to the set of conditions.

Third Phase

With the sequence diagramed, the more complex analysis begins. A review of each decision is made by asking the series of questions shown in table 2. If this analysis is done by one or more analysts, a ranking scheme is appropriate so that an averaged score may be derived. Each resolution is analyzed in terms of the questions shown in table 2. After this is accomplished, a pattern may begin to emerge indicating possible sources of errors and conflicts which need clarification.

TABLE 2.- QUESTIONS TO ASK OF EACH DECISION-PROBLEM CONDITION

Question	Answer
1. Was this resolution necessary?	
2. Was this resolution necessary at this time?	
3. Should more information have been collected?	
4. Were there other acceptable transformations (choices) that were not considered?	
5. What were the possible outcomes?	
6. Should someone else make this resolution?	
7. Who was responsible for this resolution?	
8. Should another resolution have been made?	
9. What was the expected outcome?	
10. Was this expected outcome obtained?	

In Table 3, a list of characteristics is presented. The analyst uses the list to evaluate each decision-problem condition. If available, other individuals, preferably operators, may also rate each condition to obtain another vector of information. After the critical and crucial conditions are identified in this manner, they should be reviewed in more detail. Specific questions outlined in table 4 should be applied to each critical or crucial condition.

TABLE 3.- DECISION-PROBLEM CONDITION CHARACTERISTICS

Was the decision	Yes, highly		Moderately		No, not at all
1. Important	1	2	3	4	5
2. Critical	1	2	3	4	5
3. Crucial	1	2	3	4	5
4. Processed	1	2	3	4	5
5. Made under pressure	1	2	3	4	5
6. Programmed	1	2	3	4	5

TABLE 4.- SPECIFIC QUESTIONS OF IMPORTANCE

Question	Answer
1. What outcome was expected?	
2. What outcome was obtained?	
3. What alternative choices were there?	
4. Why was the choice selected?	
5. What was needed to change the choice?	
6. Given identical circumstances, would someone make same choice again?	
7. What price was paid for the outcome?	

After testing the resolutions, assumptions are made to establish what would be required to change a resolution. Then, any conditions that were available for resolution, but which were not evident from the basic data, are introduced. After this is completed, all missed resolutions or unknown resolutions will have been identified. These critical characteristics are introduced into the diagram. This activity transforms the sequence diagram from an analysis of what did happen to a statement of what could have happened if all aspects of each condition were known. This diagram is reviewed to determine what it would take to obtain a different end state or to insure that the end state obtained would always be obtained. Remember that for each decision-problem condition in the sequence, some amount of clarification processing was accomplished; however, initially, it is not suggested to delve to that level of analysis yet (Dieterly, 1980b). The final outcome may be judged and traced back through the diagram to locate any overlooked critical decision points. This diagram and analysis allow for the replaying of the situation with a more complete map of the decision-problem conditions. It is known that the activity that occurs during resolution may be dependent on arbitrary information with little logical support; however, the total process will reflect some pattern. At the completion of this phase, the analyst will have constructed a hierarchical model of the decision-problem state. The model will include many assumptions, generalizations, and "guesstimates" of aspects of the conditions that cannot be directly attributed to the data source.

DISADVANTAGES OF THE METHODOLOGY

The major disadvantages of the suggested methodology is that there are weaknesses in each phase. The first phase may be extremely limited by the data source. If the data are not available or in an unusable form, the first phase will not provide an adequate base for the following phases. The second phase is limited by the knowledge of the analyst and by that of any operators used to add details. The objectivity of this phase must be maintained, even though it is easy to introduce many unsupported assumptions. The third phase is confined by the set of conditions identified and the associated characteristics ascribed to each condition. All phases have a high potential for error, but if the analyst proceeds with caution, a useful product will emerge. The following example may better illustrate these points.

Using the state of "the evening," the following example is provided. The source of the information is Alice Johnson's letter written to her brother. The participant in this case is Alice. The information sources used are a TV schedule, movie schedule, and a bookcase. Alice finishes the dishes and decides to watch television. Searching on the coffee table, she finds the TV schedule. After reading the schedule, she decides to go to the movies. Locating the movie schedule in the evening paper, she determines she would only like to see "Saturday Night Fever", however, it is not playing close enough so she decides to read a book. She glances through her bookcase and thinks about going to bed. Since it is only eight o'clock and she feels like doing something, she decides to go to the bowling alley. On the way out of her driveway, she backs into a pole and is so mad she goes back to her apartment and goes to bed. An analysis of this example is shown in figure 2.

As can be seen in the diagram of the example, a series of conditions was apparently resolved. Prior to analyzing what occurred, it is important to

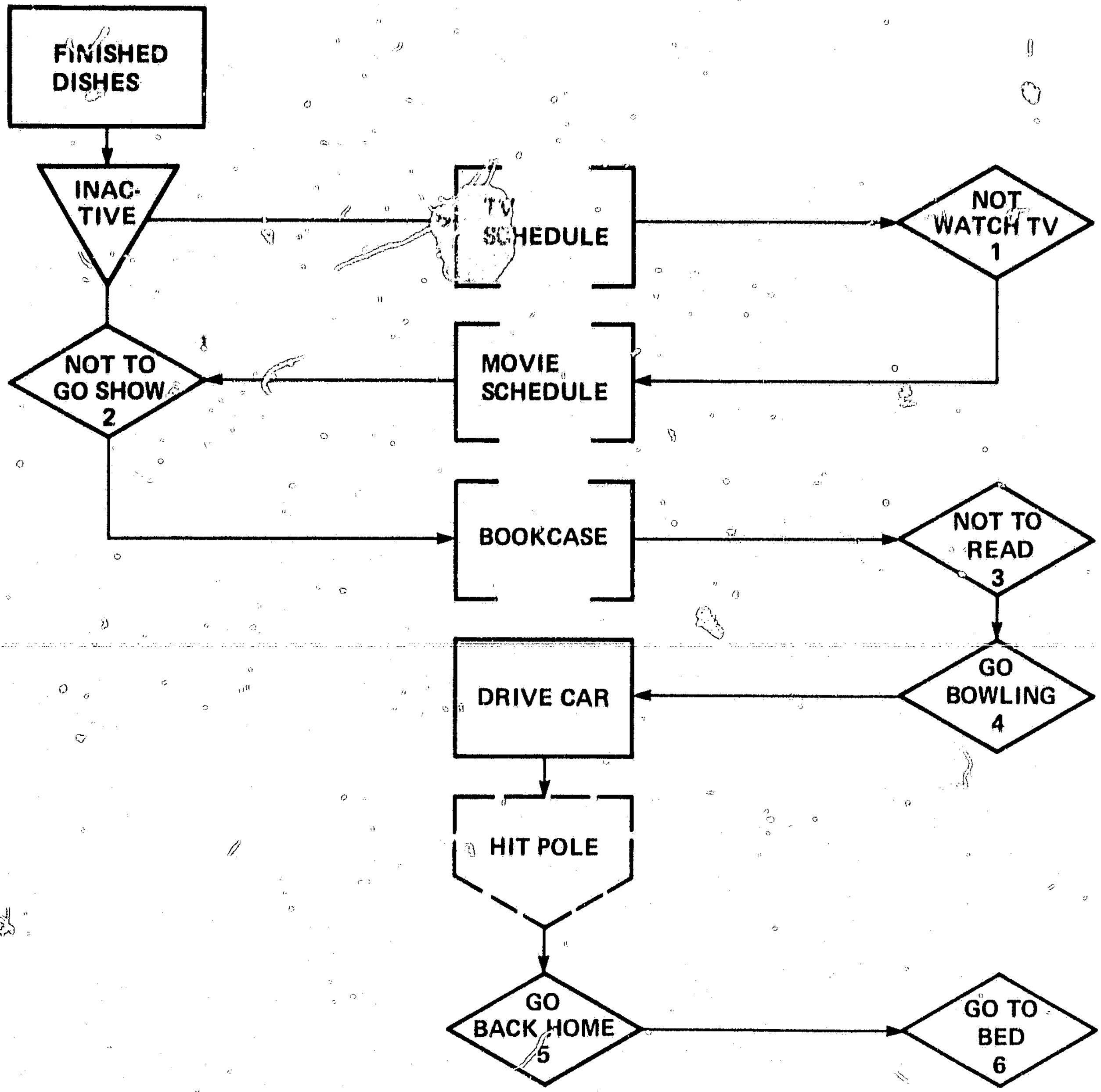

Figure 2.- Analysis of what has happened.

translate the action to a diagram, and then to review the basic data and diagram to ensure that all possible cues were picked up as to the decisions made. As can be seen, six decision-problem conditions were identified. The second phase requires further evaluation of what has occurred and that an expanded analysis be developed (fig. 3). In figure 3, assumptions are made relating to each condition in terms of transitions, outcome, and expectations.

These assumptions are in relationship to what was initially identified as the six conditions resolved. In each condition, a simple yes or no option is applied. Neither the criteria used to make the resolutions not what would

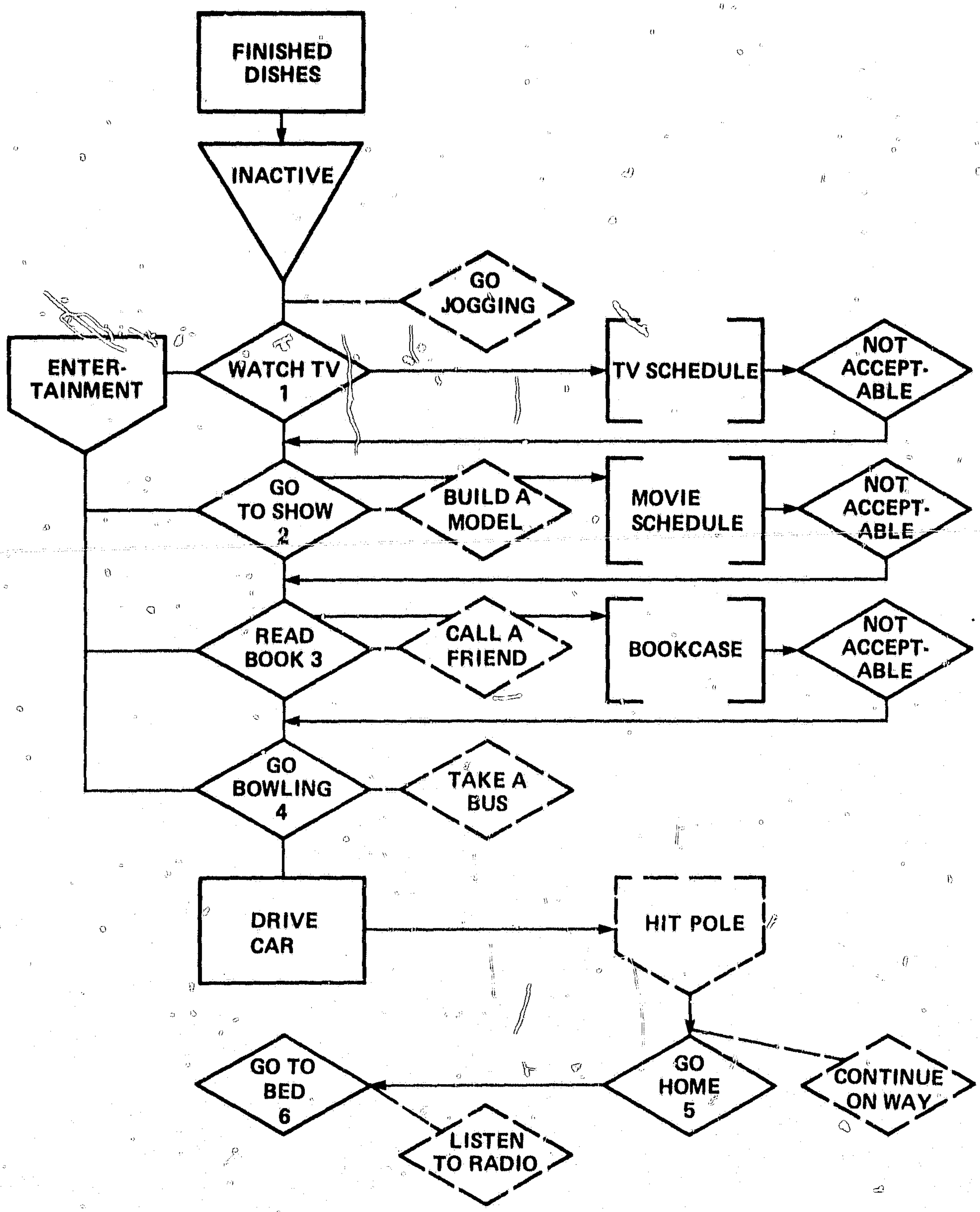

Figure 3.- Expanded analysis of what has happened.

have been necessary to make a different choice is known. In the third phase, a hierarchical model is developed. In figure 4, a hierarchical model is provided. The model shows that the six conditions represent a repeated resolution strategy, each requiring additional information. However, Alice could have more efficiently made one resolution given the basic decision-problem condition. Alice is using a "satisfying" strategy (Simon, 1957). A more appropriate approach would be the type suggested by the hierarchical model. In this case, management of the state would have reduced the time expended but would not have necessarily affected the outcome. There are conditions Alice did not resolve. For example, whether to write a letter or build a model. There is the critical condition of going bowling. The expectations in all cases were positive, but could have been negative.

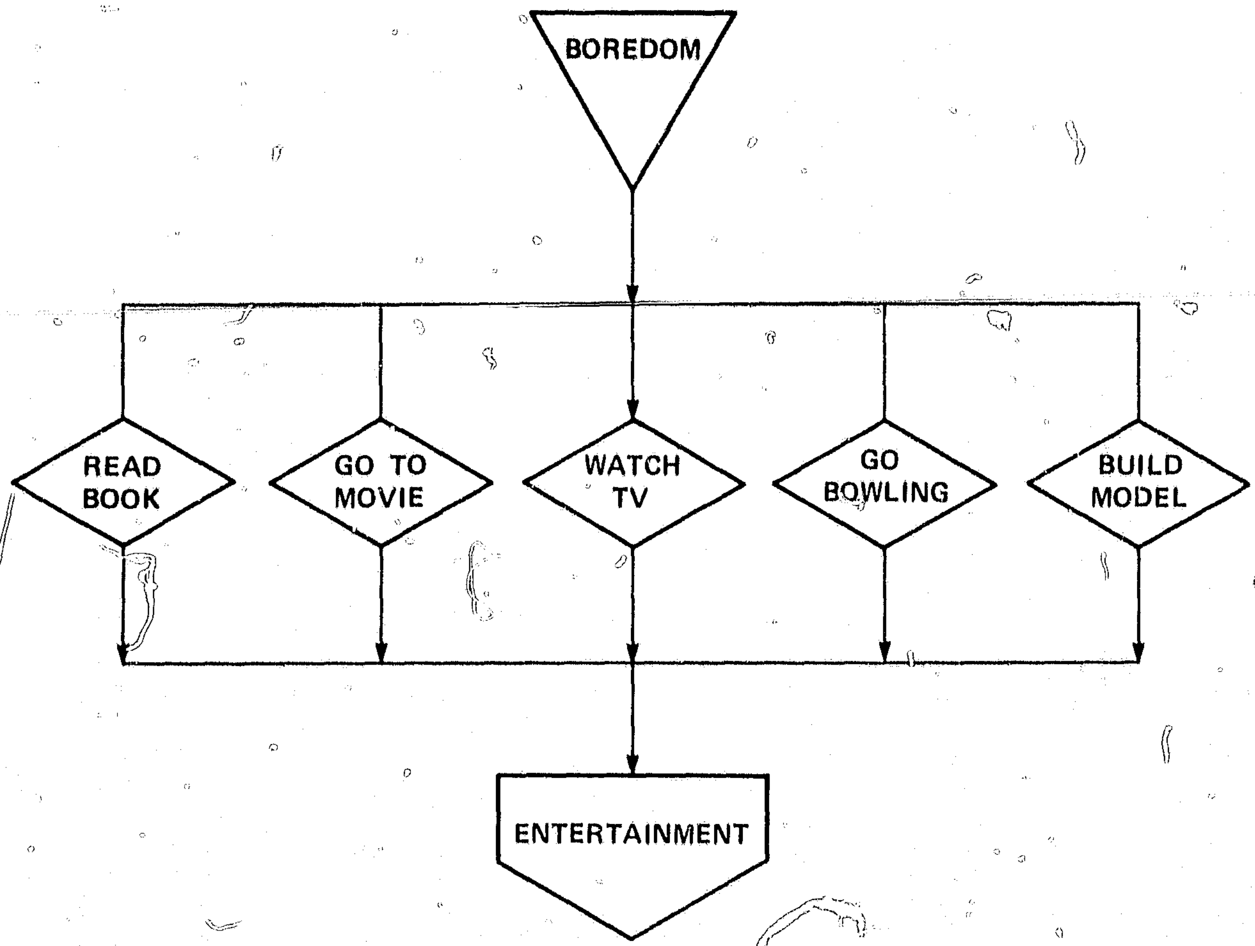

Figure 4.- General state analysis.

APPLICATION

For training purposes, a scenario may be developed and a similar group may be asked to resolve the conditions. This allows for a standardized scenario which can be used repeatedly. Variations of this form of approach are being used daily in a less systematic manner. Debriefings, "Monday morning" quarterbacking, reappraisals, and reviews are all examples. However, the full value is lost due to lack of a systematic method. Without adding the structure and formal analysis, the method only looks at part of what occurred and does not indicate the total pattern of activity. Those resolutions that preceded a critical condition are important in undertaking the resolution of concern.

In the example, Alice was bored and restless after wasting time deciding what to do. She was in a hurry and backed into a pole. This outcome so irritated her that she ceased her action to go bowling, essentially conceded and went to bed. If her commitment had been greater or her expectation higher, she would have proceeded to the bowling alley. Although the example reflects random, disjointed behavior, it emphasizes the point of the effect of relatively unimportant conditions in the final critical condition. If a management strategy had been employed to understand the total set of conditions and outcomes, other alternatives might have been selected. Since time is a factor, this should have been introduced sooner. The relative inefficient decision-problem strategy applied by Alice was adapted to emphasize the type of behavior that is normally applied. The lack of decision-problem management, goal clarification, and alternative options are only some of the pitfalls of ineffective decision-problem management.

CONCLUSION

The study of single decision-problem conditions and their resolutions does not adequately consider the decision-problem state. The decision-problem state is the type of situation that is of most practical interest to an individual making real-time resolutions. A major reason that analysis of the decision-problem state is seldom accomplished systematically is that no well-established method is available. In this paper, a methodology was developed and discussed that allows for a systematic analysis of a decision-problem state.

This type of methodology provides a content analysis of a decision-problem state that allows for additional evaluation by introducing possible alternatives not considered by the participant involved. After the fact, the individual could make a review of the alternatives and make some assessment of whether they were considered in the resolution of the decision-problem state. The use of a management strategy to control the decision-problem condition set is necessary, especially when the decision-problem set is large and associated with short time durations.

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