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Period Covering December 1, 1977
to May 31, 1978
Report Date June 1978

(6)

AUTOMATED COMPUTER SUPPORT OF C3 FUNCTIONS IN SMALL TACTICAL UNITS:

PART II - ADAPTIVE DECISION AIDING

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This report describes the first six-month effort of a three-year research and development project directed toward the development and transfer of advanced concepts in automated computer aiding to the tactical command functions of small military units, such as Marine Battalions. The report covers the first two phases of the project: Job analysis and decision task analysis of the Marine Battalion command and control environment. In this environment decision analysis techniques were used to (1) identify

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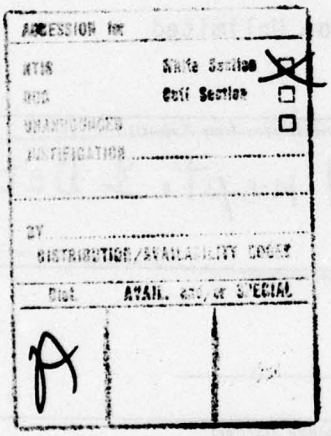
and select major decision situations during Marine Battalion operations, (2) define the frequent decision functions, major characteristics of decision tasks and basic decision aiding requirements, and (3) define decision aid design objectives for the Marine Battalion Tactical Combat Operations (TCO) environment.

Outlined in this report are the results of the first two phases of the research and development project. The Marine Battalion command environment was analyzed to identify and classify decision tasks. Preliminary planning detailed planning, intelligence planning, and tactical operations control constitute the major classes of identified decision tasks. The decision tasks were then analyzed to identify the requirements for automated decision aiding. To enhance the effectiveness of the ranking process, the decision task attributes were selected such that they highly represent the relevance in addressing the issue of automated decision aiding. These attributes include: computational complexity, proceduralizability, current automated aiding level in kCO, degree of impact on mission effectiveness, frequency of occurrence and time criticality. The linear mode was selected to aggregate the attribute values into a single value of merit. Based on the analysis, the high payoff decision tasks were identifed and the decision aid design objectives were defined.



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1. INTRODUCTION

1.1 Overview

This report describes the first six-month effort of a three year research and development project directed toward the development and transfer of advanced concepts in automated computer aiding to the tactical command functions of small military units, such as Marine Battalions. The overall program aim is to increase the combat effectiveness of small maneuver units through improvements in tactical decision aiding.

Within this area, the project transforms high payoff computerized aids from laboratory simulation concepts to operational systems. A demonstration is made of the feasibility of selected techniques through the use of the Marine TCO test facility. A methodology is established for the general utilization of the selected techniques in operational systems.

This report covers the first two phases of the project: Job analysis and decision task analysis of the Marine Battalion TCO command and control environment. The work accomplished during these two phases include:

(1) An analysis of the Marine Battalion/TCO decision making environment resulting in a list of decision tasks ranked by degree of merit for automated decision aiding.

(2) An analysis of the requirements for automated decision aiding of high payoff decision tasks.

1.2 Project Objectives

Specific objectives of the three-year project include the following:

(1) To analyze the operational command and control environment of the small unit tactical commander in terms of his command decisions, information needs, and operational objectives.

(2) To define the range of applicability of advanced decision aids for the tactical commander, and to select a number of high payoff approaches.

(3) To establish a system design concept for decision aiding in the Tactical Combat Operating system of the Marine Battalion commander.

(4) To design a software system for the simulation and demonstration of the TCO decision aids.

(5) To implement and demonstrate, on the Perceptronics PDP 11/45, the functional operation of the Marine TCO decision aids.

(6) To develop a plan for the transfer of the decision aids to the TCO operational environment in order to demonstrate and evaluate the decision aids using marine officers as simulated tactical operators.

1.3 Technical Approach

1.3.1 Automated Support Concepts. Modern tactical warfare presents a complex and dynamic environment, involving computerized weapons systems, fast ground and air vehicles, and most important, a surplus of incoming information. The battlefield of the mid-1980's will be characterized by a combat intensity never before seen. The performance of tactical

commanders in such an environment is highly dependent on their decision making behavior. This decision making behavior is defined as the ability to generate, evaluate, and select among alternative courses of action, for example, to allocate weapon assets, countermeasures, etc., while considering the specific situational constraints and payoffs. Decision making behavior is, in turn, largely dependent on the commander's ability to manage the ever-increasing information load under conditions of severe time constraints and environmental uncertainty.

The underlying emphasis of all automated computer support must be on critical decision making tasks. Tactical decision making condenses to the process of converting information and values into actions. The initial pressure for action comes from tactical mission objectives, which originate in the strategic plans. If comparison of moment-by-moment mission events and desired objectives were to show a discrepancy, then the decision maker would have to consider alternative actions. Such actions typically involve acquisition of relevant information and selection of tactical responses.

To make his choices logically, the decision maker must review his list of potential actions and consider the possible consequences of each alternative. He then selects the best course of action based on his own values and the information available. This decision is communicated and converted into action by his tactical forces. As the decision is implemented and resources are allocated, perceived results associated with the decisions are observed and reported back to the decision maker. This may consist only of information about the effectiveness of his current decision, or it may include other, by-product data. The decision maker then compares perceived results with desired results and again notices any apparent discrepancies. Discrepancies lead to pressure for new action, and the cycle repeats itself until the tactical situation is resolved.

The two key functions of an automated computer support system are therefore:

(1) Decision Aiding. The utilization of computers to assist the commander in establishing, evaluating, and selecting alternative courses of action.

(2) Decision Information Management. Methods for computer control of information flow by automatic message selection and distribution.

For a support system to be most useful, it must be adaptive, in the sense of keeping track of, and responding to, certain time/situation/user-dependent variations. By being adaptive it essentially provides the capability to call upon a variety of available information processing and decision aids. As each particular decision situation arises for a particular decision maker, the support system reacts "intelligently" by selecting and implementing the appropriate aiding technique or combination of techniques, in order to maximize the effectiveness of the man-computer interaction.

It is the objective of this program to provide solutions to the problems of information processing and decision making support in small units by applying the related concepts to a battalion-level C3 system. The program builds on these concepts, and is directed toward the accomplishment of further developments which are necessary to meet the requirements of operational tactical C3 systems.

1.3.2 Application Environment. The project focuses on implementation and evaluation of automated computer support of C3 functions within the environment of a Marine Battalion command. A detailed analysis of the

requirements of the TCO during the current effort has shown that aiding methods have direct application to critical functions at this level of command.

The project has focused on a realistic set of Marine Battalion problems through integration with the Marine TCO system. The U.S. Marine Corps Tactical Systems Support Activity (MCTSSA) is currently involved in the development of a battalion-oriented computerized C3 system termed Tactical Combat Operations (TCO) system. The TCO system will give the commander assistance in planning, controlling, and coordinating combat operations by providing the means through which timely and accurate decision information, in a usable form, is presented for his consideration. Utilizing equipment of modular design, TCO will be configured to support any task organization as dictated by mission requirements. TCO will be the focal point for integrating data from other systems within MTACCS (Marine Tactical Command and Control Systems) to support operational considerations. Integration of the present effort with TCO development has the following advantages:

(1) The TCO is directed toward small unit command.

(2) The TCO has specific functional requirements that can be met by automation, and specifically by adaptive techniques.

(3) The TCO simulation program provides an accessible computer test facility for project test and evaluation.

(4) The TCO provides a realistic C3 framework for bringing programs to operational use, in near term, since it is planned to field this system in the 1980's.

1.4 Accomplishments

During the first six months of the project, a functional analysis of the Marine/TCO decision making environment was performed. The following is a summary of the tasks performed (numerically indicated in Figure 1-1):

(1) A methodology for identification and classfication of decision tasks was developed. It provides for the separation of decision tasks from procedural non-decision tasks in the Marine Battalion/TCO environment together with the classification of the decision tasks.

(2) A visit to Camp Pendleton was organized to meet MCTSSA personnel in charge of the TCO project in order to investigate resources, in particular the Interim Test Facility in which the decision aid is to be implemented.

(3) A review of the available documentation was conducted. Three documents were selected for the decision task identification process:

(a) TCO System Description Document, 15 December 1977 (MCTSSA).

(b) Draft Report - TCO Functional Analysis and TCO Information Flow Analysis, 30 December 1977 (Computer Sciences Corporation).

(c) Information Requirements Analysis Marine Infantry Battalion - Final Report, 16 June 1976 (MCTSSA).

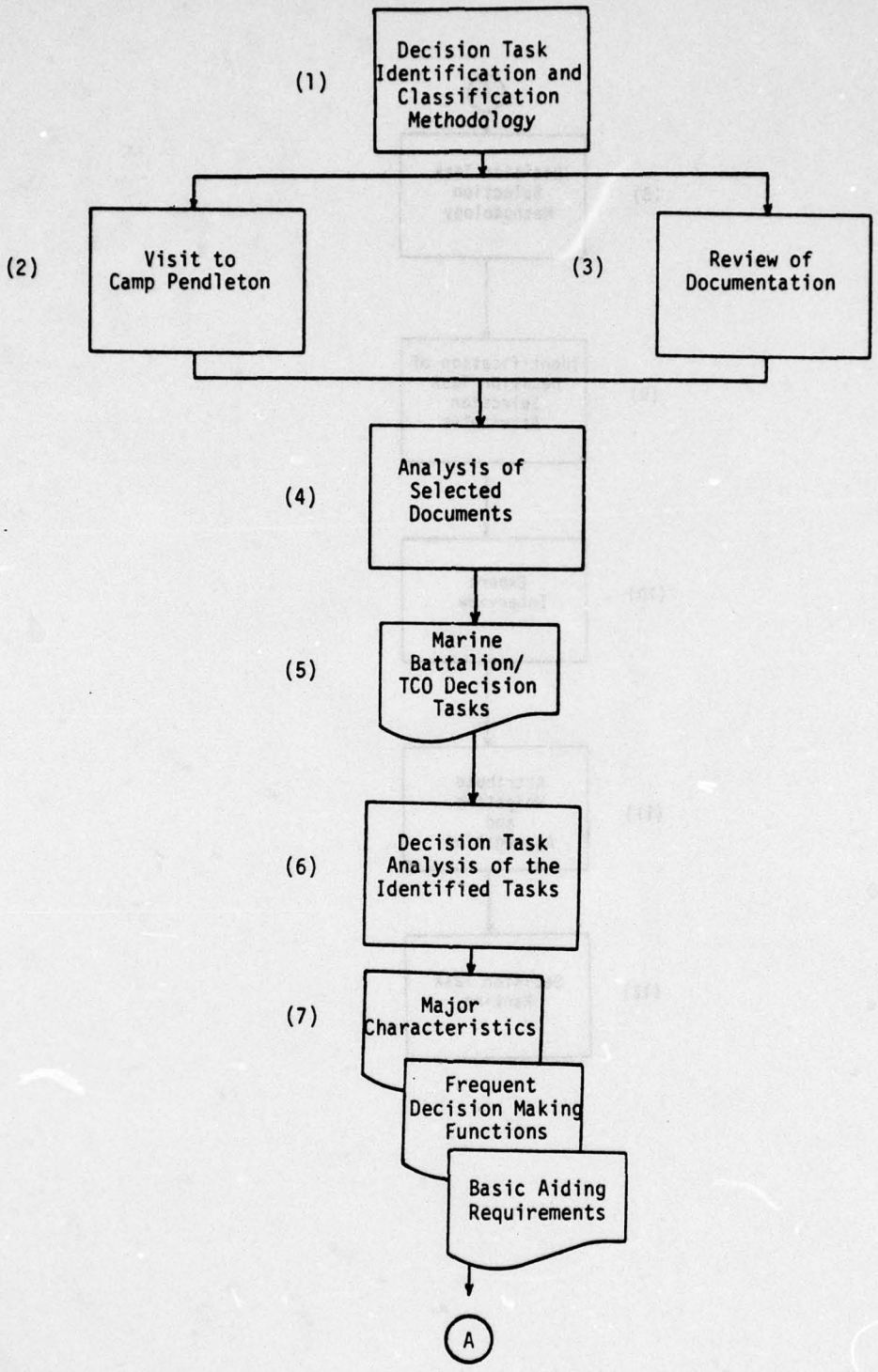

FIGURE 1-1
WORK FLOW

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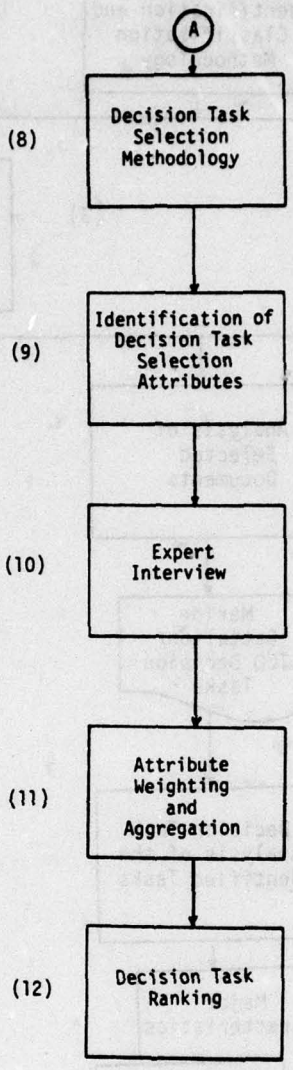

FIGURE 1-1
WORK FLOW (CONTINUED)

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(4) The selected documents were analyzed to obtain a workable list of the decision tasks pertaining to the Marine Battalion/TCO environment.

(5) The result of the analysis performed in (4) is the normalized list of the decision tasks presented according to the classification used in document (a) and in which each task is named using a decision task keyword.

(6) The decision tasks were then analyzed using their description in documents (a) and (c) for the purpose of identifying the requirements for automated decision aiding.

(7) The results of analysis (6) were the major characteristics and frequent decision making functions within the Marine Battalion/TCO decision making environment resulting in the identification of the basic aiding requirements.

(8) Multi-attribute utility analysis was selected as a methodology to rank the decision tasks by degree of merit for decision aiding.

(9) A number of decision task attributes were selected which showed relevance in addressing the issue of automated decision aiding.

(10) The attribute values were then elicited via questionnaire from a group of experts (MCTSSA personnel having experience in operations), together with their opinion about the attributes.

(11) The linear mode was selected to aggregate the attribute values into a single value of merit. The attributes were consequently weighted and the weighted average computed, providing a utility value for each decision task.

(12) The decision tasks were ranked by decreasing order of merit for automated decision aiding, yielding high payoff decision tasks for further study.

A detailed description of the major tasks accomplished during the report period appears in the following chapters.

1.5 Report Summary

This report outlines the results of the first six-month period of the project toward the development of decision aids for C3 functions in small tactical units. An overview of the analysis methodology is presented in the second chapter. The methodology for decision task identification and classification as well as decision task selection is presented in the same chapter. The Marine TCO Decision Function Analysis is the subject of the third chapter. The analysis tasks accomplished during the six month period is described in this chapter. The accomplished tasks include job analysis of the Marine Battalion/TCO command environment and decision task analysis of the identified decision tasks. The job analysis was conducted using two major sources of information: Marine/TCO documents and Marine/TCO experts. A complete list of the documents appear in Chapter 3. The result of the job analysis was a list of the major decision tasks in the Marine Battalion command environment. The identified decision tasks were subject to a detailed analysis which identified the major characteristics of the decision tasks, the basic aiding requirements, the frequent decision making functions at the battalion level, and a decision aid design/selection objectives for the Marine/TCO environment. The results of the analysis appear in Chapter 3.

2. ANALYSIS METHODOLOGY

2.1 Overview

The command, control, and communication functions in the Marine Battalion/TCO environment were the subject of the analysis performed in the first year of the project. A primary analysis of the functions specified the required steps in the technical approach. These steps consist of definition of decision tasks, classification of decision tasks, and identification of decision task areas. The performance of an operator in a decision/non-decision task-pool environment follows the scheme presented in Figure 2-1. As the input to this scheme, a set of tasks is introduced to the operator as part of the normal operational procedure. The set contains both decision and non-decision tasks. Processing of decision tasks is procedurally different from processing non-decision tasks. For this reason, the first responsibility of the operator is to identify the task as requiring either a decision or a non-decision. Block 1 (Figure 2-1) shows such a dichotomization. This block acts as a "filter" which identifies decision tasks and passes them to block 3 for classification.

Non-decision tasks will also be identified in block 1 and passed to block 2 for processing. It is assumed that block 2 contains a strict set of pre-defined procedures for processing non-decision tasks. The tasks identified as decision-related are input to block 3, where they are classified as type 1, 2, or 3. Processing of a type 1 decision task requires consideration of problem structuring. A type 2 decision task represents action selection. Type 3 decisions represent a combination of both type 1 and type 2 in which both problem structuring and action selection must be considered. Block 1 and 3 form part of the methodology for the identification and classification of decision tasks in the job analysis phase.

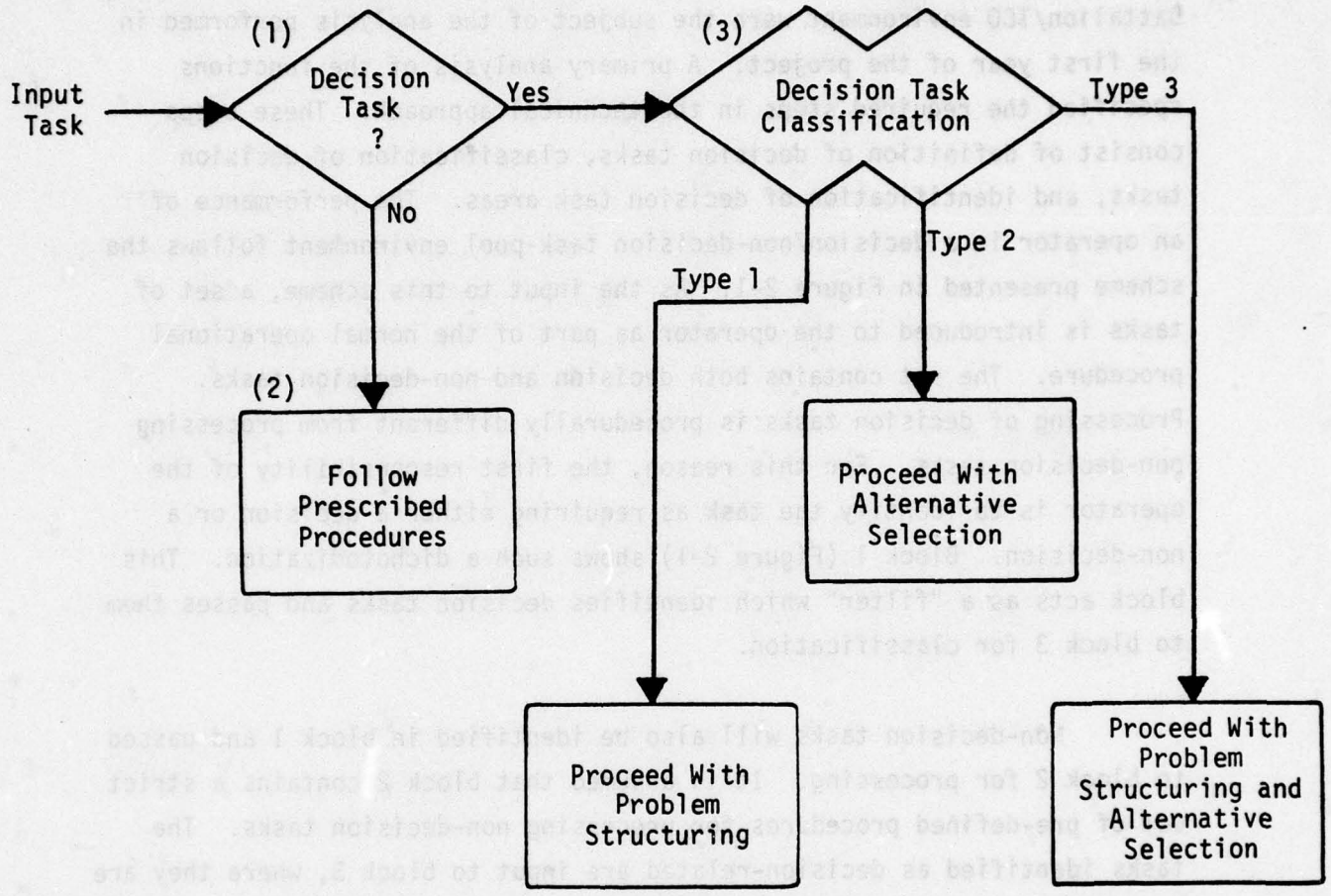

FIGURE 2-1
TASK PROCESSING SCHEME

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2.2 Decision Task Definition and Classification

The mechanism of decision task identification is similar to that of a "filter" which passes all, and only, decision tasks. The characteristics of such a filter are described by the definition of a decision task:

(1) The objective of a decision task is to select an alternative from a specified set of alternatives.

(2) This selection may require the formulation of alternatives (problem structuring).

(3) There is a lack of completely specified criteria for either alternative formulation or alternative selection.

The operator actions necessary for processing a generalized decision task may involve considerations such as establishing possible outcomes and consequences of each alternative, determining utilities and probabilities of the various outcomes, evaluating major attributes of each available alternative, and applying established decision rules for selecting the best course of action. Some of these operator actions are shown in Figure 2-2 with their relationships to problem structuring and alternative selection. In general, the actions of alternative formulation and outcome formulation are related to the action selection process.

Since there is a considerable distinction between the two tasks of problem structuring and alternative selection, there is a plausible classification scheme for decision tasks. Such a scheme is created by representing a boundary between the decision tasks requiring problem structuring and the ones requiring alternative selection. The boundary

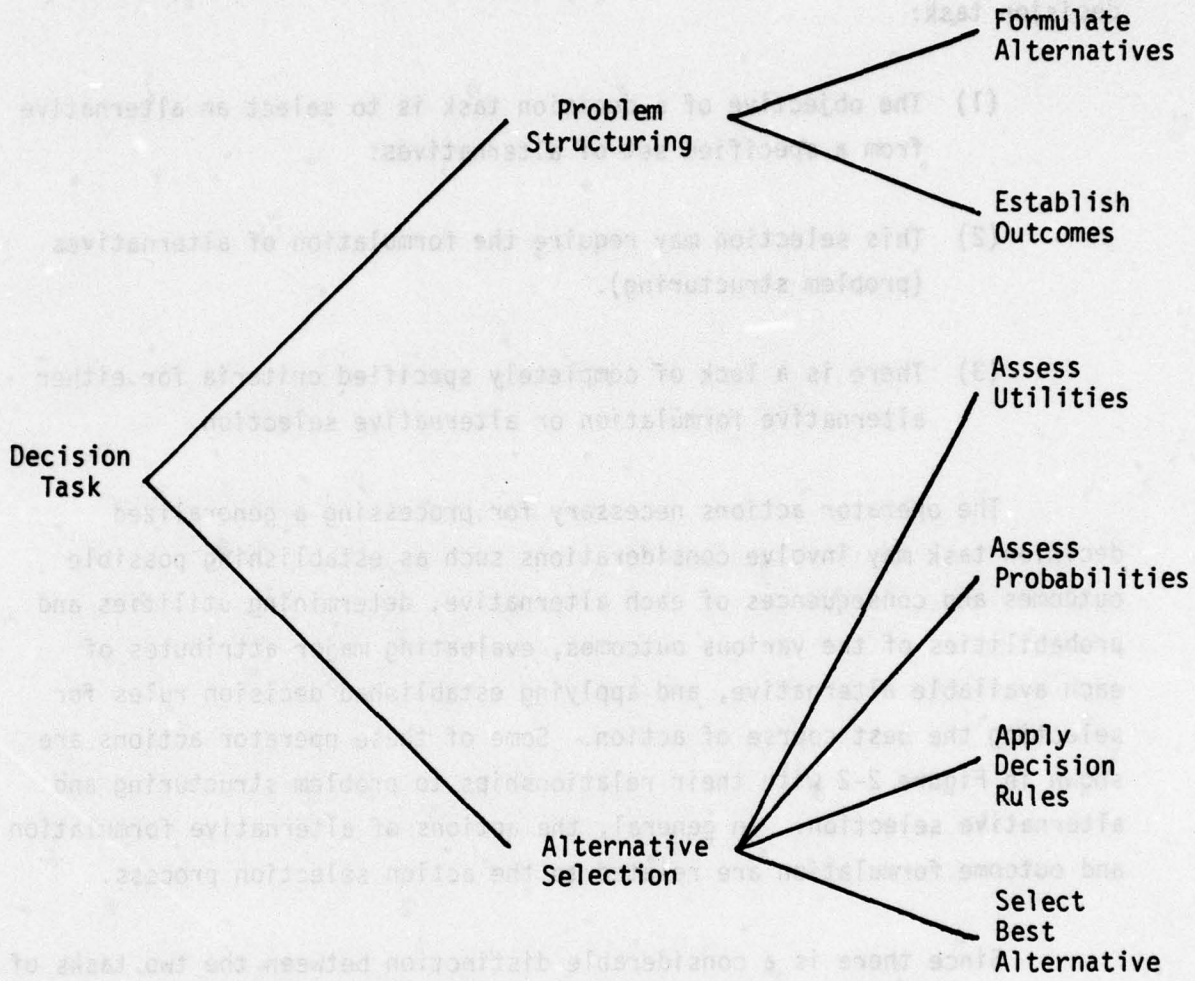

FIGURE 2-2
DECISION TASK COMPONENTS

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is defined by the types of operator actions necessary to process the decision task. It is this distinction which is used to identify and classify specific tasks in the Marine Battalion/TCO environment.

2.3 Decision Task Selection Methodology

Multi-attribute utility (MAU) analysis was chosen as methodology to select decision tasks for future study. Attributed to Benjamin Franklin (see for example Dawes, 1977), this simple method provides a very useful framework to choose among various alternatives. The degree of promise for automated decision aiding of each task is measured via multiple attributes of value which are aggregated yielding a single value of merit:

(1) Definition of task attributes
The attributes bearing on task candidacy for automated decision aiding must be identified.

(2) Definition of attribute scale
Each attribute must be measured according to the same scale.

(3) Determiniation of attribute weights
The degree of impact w_i of each attribute i must be estimated. w_i can be either positive (for attributes contributing favorably) or negative (for attributes contributing unfavorably).

(4) Elicitation of attribute values
A figure of merit a_i for each attribute may be directly elicited or a ranking of the tasks followed by a mapping into the selected range.

(5) Aggregation of attribute values

For each task the quantity $\Sigma w_i a_i$ will be computed. Other aggregation methods are available but the linear form appears to be both simple and robust.

(6) Ranking

From the single value of merit obtained at step 5, a composite ranking of tasks is easily obtained.

3. MARINE TCO DECISION FUNCTION ANALYSIS

3.1 Overview

The Marine TCO command and control environment was analyzed. The analysis identified the decision tasks encountered at battalion level. A detailed decision analysis was performed on the decision tasks to identify the major characteristics and frequent decision making functions within the Marine Battalion/TCO decision making environment resulting in the specification of the basic aiding requirements. The major activities of the marine TCO decision function analysis is described in this chapter.

3.2 Information Sources

The main information sources used in the decision task analysis originated from two main categories:

(1) Marine/TCO documents

(2) Marine/TCO experts

The first category includes the following documents:

(a) TCO System Description Document, 15 December 1977 (MCTSSA).

(b) Draft Report - TCO Functional Analysis and TCO Information Flow Analysis, 30 December 1977 (Computer Sciences Corporation).

(c) TCO Overview, 18 February 1977 (MCTSSA).

(d) Information Requirements Analysis Marine Infantry Battalion - Final Report, 16 June 1976 (MCTSSA).

(e) Functional Description of the Marine Tactical Command and Control Systems (MTACCS) Test Bed, 26 August 1977 (MCTSSA).

(f) Analysis of Functions and Information Requirements of the Operations and Intelligence Officers, Marine Division Command Element, Final Report, 31 May 1977 (CSC).

(g) Infantry Battalion Concept for TCO - Draft, 4 April 1977.

(h) TCO Maneuver Control - Concept Paper - Fourth Draft.

3.3 Decision Task Identification

A review of the available documentation was conducted. Three documents were selected for the decision task identification phase:

(a) Draft Report - TCO Functional Analysis and TCO Information Flow Analysis, 30 December 1977 (Computer Sciences Corporation).

(b) TCO System Description Document, 15 December 1977 (MCTSSA).

(c) Information Requirements Analysis Marine Infantry Battalion - Final Report, 16 June 1976 (MCTSSA).

These documents were analyzed in detail to isolate the decision tasks pertaining to the Marine Battalion/TCO environment. "The TCO Functional Analysis" and "TCO Information Flow Analysis" produced a list of tasks performed at Battalion level. After screening, a preliminary list of decision tasks was obtained. The two documents, "TCO Description" and "Information Requirement Analysis Marine Infantry Battalion", were then utilized to find confirming evidence as whether or not the classification was correct.

3.3.1 Preliminary Decision Task Identification. The "TCO Functional Analysis and TCO Information Flow Analysis" describes TCO functions and subfunctions together with the TCO/Marine echelon they involve. Analysis of this document resulted in a preliminary list of decision tasks. This list was then screened using the notion of decision making and non-decision making keywords. These keywords are listed in Table 3-1. Tasks identified with a decision making keyword were labeled as decision tasks. For example "Establish Information Requirements" or "Identify critical items of required intelligence for EEI designation" were classified as decision tasks while "Review the Planning Framework Display from data Base" or "Display and Review proposed diagram" were classified as non-decision tasks. In certain cases the main element in the task description was not the verb itself. For instance for "Prepare plan for supporting fires" the essential element is "plan" and the task is classified accordingly. In other cases the description of a task was incomplete. For instance "Enemy Capabilities" was viewed as a subtask of "Analyze situation and courses of action" and consequently classified as a decision task using the keywork "Analyze". Finally, it was noticed that certain decision tasks were labeled using non-decision making keywords and the situation was corrected. In spite of certain inaccuracies the methodology based on decision and non-decision keywords provided a good starting point for the decision task analysis and yielded a preliminary list of tasks pertaining to the Marine Battalion/TCO environment.

3.3.2 Final Decision Task Identification. Using the two documents, "TCO System Description Document" and "Information Requirements Analysis Marine Infantry Battalion", the preliminary list of decision tasks was screened and amplified. The "TCO System Description Document" containing a general description of the tasks contained in the document "TCO Functional Analysis and TCO Information Flow Analysis" provided confirming evidence as to whether or not the tasks identified in the preliminary process were correctly classified. Moreover, certain of the decision tasks incompletely specified in the "TCO Functional Analysis and TCO Information Flow Analysis"

TABLE 3-1

TCO FUNCTIONAL ANALYSIS KEYWORDS

DECISION MAKING KEYWORDS

ADJUST	IDENTIFY
ANALYZE	INTEGRATE
APPROVE	MODIFY
CONTROL	PLAN
DETERMINE	PREDICT
ESTABLISH	REVISE
ESTIMATE	SELECT
FINALIZE	

NON-DECISION MAKING KEYWORDS

ALERT	OUTLINE
BRIEF	PERFORM
COLLECT	PREPARE
CONDUCT	RECALL
*COORDINATE	RECEIVE
DEVELOP	RECORD
DISPLAY	REPORT
DEBRIEF	REQUEST
DISSEMINATE	RETRIEVE
ENTER	REVIEW
*GENERATE	SEND
INITIATE	STORE
INCORPORATE	SEARCH
OBTAIN	TRANSMIT
	UPDATE

*DECISION-MAKING KEYWORD USED FOR NON-DECISION MAKING TASKS

were relabeled using decision making keywords. For example "Enemy Capabilities" was relabeled "Appraise enemy Capabilities". "The Information Requirement Analysis Marine Infantry Battalion" describes hypothetical yet typical tactical situations occuring at battalion level. Although the emphasis is placed on the information requirements, it is possible, from this document, to get insight about the nature of tactical operations at battalion level. For instance, it was possible to distinguish two distinct subprocesses in the Commander's Analysis of the Mission: situation assessment and establishment of goals. The final output of the analysis is a list of decision tasks and subtasks (Table 3-2) pertaining to the Marine Battalion/TCO decision making environment. To see how this list compares with TCO Functional Analysis and TCO Information Flow Analysis, Figure B2-8 of this document depicting the important decision-task "Develop Operations Estimate" has been reproduced in Figure 3-1 together with the new decision tasks labels.

3.4 Expert Interview

An interview of TCO Project Team members with field operations experience was conducted (a sample questionnaire is given in Table 3-3). The interview consisted of three parts:

. part 1 - Task-related questions

Two out of the six participants were asked to describe the identified decision tasks in terms of six keywords describing six different levels of cognitive domains: Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation. A definitiсn of these keywords adapted from Gronlund (1970), was given. The scope of this interview was to confirm the nature of the identified decision tasks as indeed decision tasks considering that a task can be classified as a decision task if it is described by

TABLE 3-2

LIST OF THE DECISION TASKS
IDENTIFIED WITHIN THE MARINE BATTALION/TCO ENVIRONMENT

1. PRELIMINARY PLANNING
   - 1.1 COMMANDER'S ANALYSIS OF THE MISSION
     - 1.1.1 SITUATION ASSESSMENT
     - 1.1.2 ESTABLISHMENT OF GOALS
   - 1.2 OPERATIONS ESTIMATE DEVELOPMENT
     - 1.2.1 MISSION ANALYSIS
     - 1.2.2 ANALYSIS OF COURSES OF ACTION
       - 1.2.2.1 GENERATION OF POSSIBLE COURSES OF ACTION
       - 1.2.2.2 ANALYSIS OF FACTORS AFFECTING COURSES OF ACTION
       - 1.2.2.3 APPRAISAL OF ENEMY CAPABILITIES
       - 1.2.2.4 SELECTION OF COURSE OF ACTION (FOR BRIEFING)
         - 1.2.2.4.1 ASSESSMENT OF OUTCOME LIKELIHOOD
         - 1.2.2.4.2 COMPARISON AND SELECTION
   - 1.3 DEVELOPMENT OF PERSONNEL ESTIMATE
   - 1.4 DEVELOPMENT OF LOGISTICS ESTIMATE
   - 1.5 DEVELOPMENT OF FIRE SUPPORT ESTIMATE
   - 1.6 DEVELOPMENT OF COMMUNICATION-ELECTRONICS ESTIMATE
     - 1.6.1 ESTIMATION OF PROPOGATION
     - 1.6.2 ESTIMATION OF ECM CAPABILITIES
   - 1.7 COMMANDER'S SELECTION OF COURSE OF ACTION
     - 1.7.1 DEVELOPMENT OF COMMANDER'S ESTIMATE AND DECISION
     - 1.7.2 INVESTIGATION OF CHANGES TO COURSES OF ACTION
2. DETAILED PLANNING
   - 2.1 PREPARATION OF SCHEME OF MANEUVER
     - 2.1.1 PREPARATION OF PLAN FOR SUPPORTING FIRES
     - 2.1.2 PREPARATION OF LANDING PLAN
   - 2.2 INTELLIGENCE PRODUCTION
     - 2.2.1 ANALYSIS OF INCOMING INFORMATION

TABLE 3-2 (Cont.)

- 2.2.2 UPDATING OF INTELLIGENCE WORKSHEET AND EEI's LIST
- 2.2.3 UPDATING OF COLLECTION PLAN
- 2.2.4 REVISION OF INTELLIGENCE ESTIMATE
  - 2.2.4.1 REVISION OF PROBABILITY ESTIMATES

3. INTELLIGENCE PLANNING
   - 3.1 COLLECTION PLAN DEVELOPMENT
     - 3.1.1 DETERMINATION OF INFORMATION REQUIREMENTS
     - 3.1.2 IDENTIFICATION OF EEIs AND OIRs
     - 3.1.3 ESTIMATION OF INFORMATION DELAY AND LIKELIHOOD
   - 3.2 DEVELOPMENT OF INTELLIGENCE ESTIMATE
     - 3.2.1 ANALYSIS OF AOA
     - 3.2.2 ANALYSIS OF ENEMY FORCES
       - 3.2.2.1 APPRAISAL OF ENEMY CAPABILITIES
       - 3.2.2.2 APPRAISAL OF ENEMY VULNERABILITIES
     - 3.2.3 GENERATION OF POSSIBLE ENEMY RESPONSES
     - 3.2.4 ESTIMATION OF LIKELIHOOD OF POSSIBLE RESPONSES

4. TACTICAL OPERATIONS CONTROL
   - 4.1 TACTICAL OPERATIONS CONTROL
     - 4.1.1 IDENTIFICATION OF MISSION PROBLEMS AND CONFLICTS
     - 4.1.2 APPRAISAL OF NEED FOR ADJUSTMENT
   - 4.2 GROUND OPERATIONS CONTROL
     - 4.2.1 ANALYSIS OF TACTICAL SITUATION AND AVAILABLE RESOURCES
     - 4.2.2 APPRAISAL OF NEED FOR ACTION
     - 4.2.3 APPRAISAL OF NEED FOR INFORMATION
   - 4.3 INTEGRATION OF FIRE AND MANEUVER
     - 4.3.1 CORRELATION OF CURRENT STATUS AND MISSION REQUIREMENTS
     - 4.3.2 EVALUATION OF RATE AND DIRECTION ON PLANNED AND IN-PROGRESS FIRES
       - 4.3.2.1 MANEUVER ELEMENTS
       - 4.3.2.2 ENEMY FORCES

TABLE 3-2 (Cont.)

4.4 MODIFICATION OF SCHEME OF MANEUVER

4.4.1 CORRELATION OF CURRENT STATUS AND REQUIREMENTS

4.4.2 EVALUATION OF RATE AND DIRECTION ON PRESENT SCHEME OF MANEUVER

4.4.3 APPRAISAL OF NEED FOR SCHEME OF MANEUVER MODIFICATION

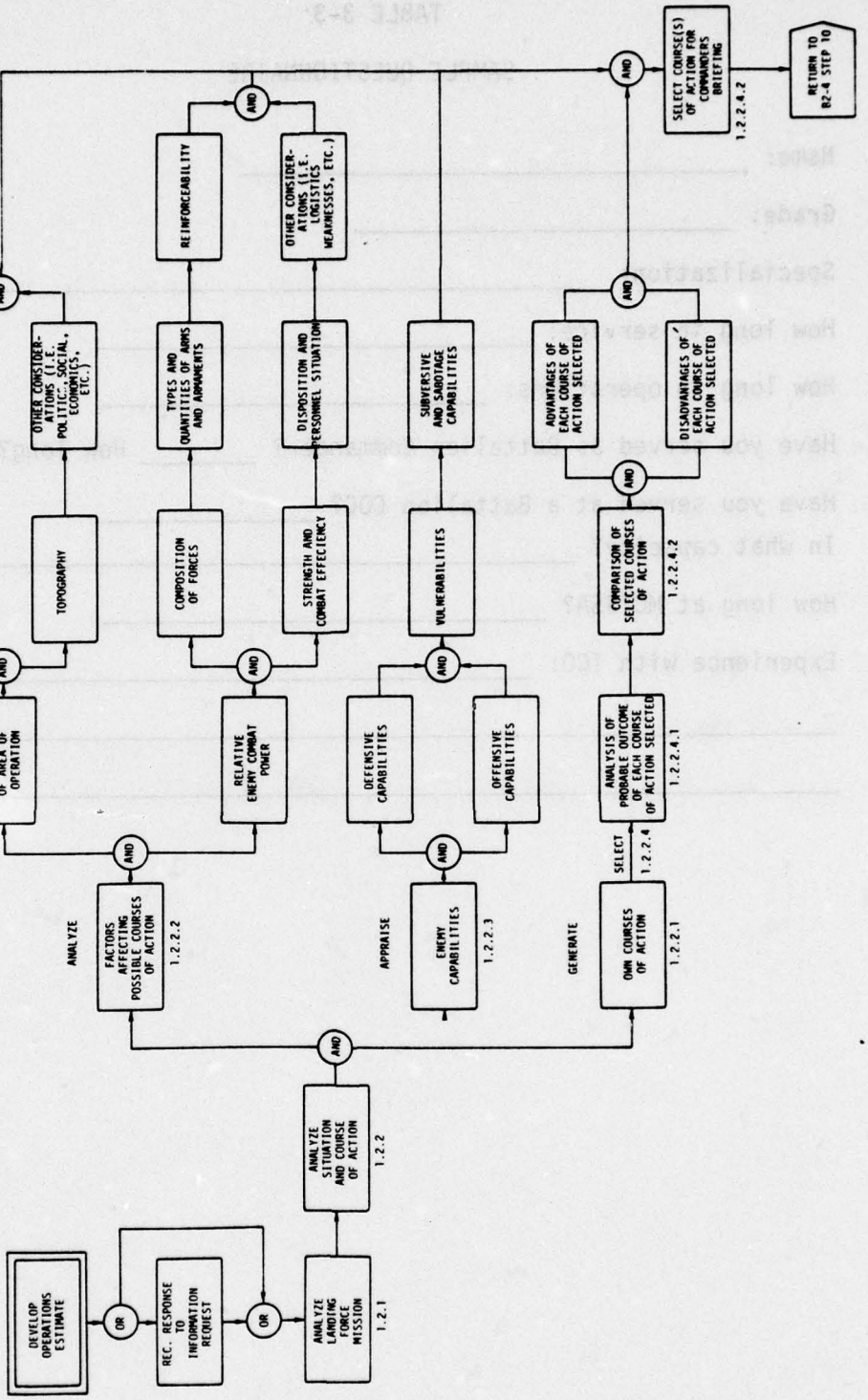

FIGURE 3-1
DEVELOP OPERATIONS ESTIMATE

PERCEPTRONICS

TABLE 3-3

SAMPLE QUESTIONNAIRE

1. Name: _____

2. Grade: _____

3. Specialization: _____

4. How long in service: _____

5. How long in operations: _____

6. Have you served as Battalion Commander? _____ How long? _____

7. Have you served at a Battalion COC? _____
   In what capacity? _____

8. How long at MCTSSA? _____

9. Experience with TCO: _____

_____

_____

TABLE 3-3 (Cont.)
INSTRUCTIONS

Part I: Task-related questions

- Go through the list and shortly describe each task using one of the six following keywords.
  - Knowledge
  - Comprehension
  - Application
  - Analysis
  - Synthesis
  - Evaluation

  (A definition of these keywords is given in Appendix A)
- Can you think of any other decision task at Battalion level?

_____

_____

_____

Part II: Attribute-related questions

- A definition for each attribute is given in Appendix B. Make sure that each definition is understood and do not hesitate to ask questions.
- Can you think of other "important" attributes?

_____

_____

_____

- Can you think of any deletion?

_____

_____

TABLE 3-3 (Cont.)
INSTRUCTIONS

. What does "important" mean?

_____

_____

_____

Part III: Attribute evaluation

. Complexity - For each task affect a value between 0 and 10 (0 for lowest, 10 for highest).

. Proceduralizability - For each task give a value between 0 and 10 representing to which extent this task can be procedurized (0 for lowest, 10 for highest).

. Degree of Impact on Mission Effectiveness - Rank the tasks by decreasing value for this attribute.

. Frequency of Occurrence - Rank the tasks by decreasing value for this attribute.

. Current automated aiding level in TCO - Evaluate the tasks according to this attribute in the scale 0-10. If you do not feel comfortable to answer for certain tasks, leave a blank.

. Time Criticality - For each task provide a value (possibly an integer from 0 to 10) indicating how you feel about the frequency of occurrence of the time-stress factor. Focus your attention on the relative importance of the values i.e. on the values as they relate to one another not the absolute values.

TABLE 3-3 (Cont.)
APPENDIX A*

Knowledge is defined as the remembering of previously learned material. This may involve the recall of a wide range of material, from specific facts to complete theories, but all that is required is the bringing to mind of the appropriate information.

Comprehension is defined as the ability to grasp the meaning of material. This may be shown by translating material from one form to another (words to numbers), by interpreting material (explaining or summarizing), and by estimating future trends (predicting consequences or effects).

Application refers to the ability to use learned material in new and concrete situations. This may include the application of such things as rules, methods, concepts, principles, laws, and theories.

Analysis refers to the ability to break down material into its component parts so that its organizational structure may be understood. This may include the identification of the parts, analysis of the relationships between parts, and recognition of the organizational principles involved.

Synthesis refers to the ability to put parts together to form a new whole. This may involve the production of a unique communication (theme or speech), a plan of operations (research proposal), or a set of abstract relations (scheme for classifying information).

Evaluation is concerned with the ability to judge the value of material (statement, novel, poem, research report) for a given purpose. The judgments are to be based on definite criteria. These may be internal criteria (organization) or external criteria (relevance to the purpose) and the student may determine the criteria or be given them.

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* from Gronlund, N. E., Stating Behavioral Objectives for Classroom Instruction, New York: The MacMillan Company, 1970.

TABLE 3-3 (Cont.)
APPENDIX B

- Complexity - Complexity has two aspects

  - computational complexity

  - storage complexity

  A complex task involves rapid and accurate computations or retaining large amounts of quantitative information or both.

- Proceduralizability - A task involving problem-solving which can be procedurized is said to be proceduralizable (for example if a well-defined set of subproblems has to be solved), this attribute captures to what extent it is true.

- Degree of Impact of Mission Effectiveness - This attribute measures how an erroneous decision for the particular task might affect the overall mission.

- Frequency of Occurrence - This attribute measures how often the particular task is performed within all conceivable Marine operations.

- Current TCO Automated Aiding Level - This attribute measures to what extent the particular task receives automated aiding (displays, simulations, automated computations, system-based generated lists, etc...). It refers to the operational system as projected, not the Interim Test Facility.

- Time Criticality - A particular task may appear under time stress or not. The present attribute measures how often.

Analysis, Synthesis or Evaluation. Confirming evidence about the nature of the tasks was needed since the list of decision tasks was obtained via another analysis. The interviews confirmed the nature of the tasks identified as decision tasks.

. part 2 - Attribute-related questions

All six participants were asked to think about the list of attributes in order to add or subtract from this list. They were finally asked for a definition of the work "important". The scope of this last question was to assess what is the main feature in the Marine Battalion decision making environment. The consensus was that "important" means "which has an important impact on the mission accomplishment" and no deletion or addition was suggested.

. part 3 - Attribute evaluation

All six participants were asked to assess a value for each task-attribute pair. For the attributes Complexity, Proceduralizability, and Current Automated Aiding Level in TCO, a value between 0 and 10 was elicited. For the attributes "Degree of Impact on Mission Effectiveness" and "Frequency of Occurrence", it was asked to the participant if he felt comfortable in ranking the tasks for each attribute or if he would rather directly assess a value between 0 and 10. When the ranking was selected, he was asked to rank the tasks within each phase of the process (preliminary planning, detailed planning, intelligence planning, control of tactical operations) then to either rank the processes between them or to directly rank the tasks by insertion. The results are summarized in Table 3-4. The last attribute "Time Criticality" was treated in a different manner. For each task it was asked "how often does this task appear under time pressure of less than 1 minute (very high pressure), 1 to 5 minutes (high), 6 to 15 minutes

TABLE 3-4. EXPERT INTERVIEW RESULTS: AVERAGE ATTRIBUTE VALUES

	COMPUTATIONAL COMPLEXITY	PROCEDURALIZABILITY	IMPACT ON MISSION EFFECTIVENESS	FREQUENCY OF OCCURRENCE	CURRENT AUTOMATED AIDING LEVEL
1.1.1	2.5	1.7	7.0	5.8	1.8
1.1.2	2.0	2.8	6.6	5.8	1.3
1.2.1	1.5	2.8	6.8	5.8	3.7
1.2.2.1	3.7	4.5	6.0	5.5	5.0
1.2.2.2	6.5	4.5	5.4	5.5	6.0
1.2.2.3	7.5	6.2	6.6	6.5	6.8
1.2.2.4.1	6.5	5.0	3.6	4.3	5.5
1.2.2.4.2	6.2	4.2	5.2	4.5	5.5
1.3	6.2	8.2	4.6	5.0	4.2
1.4	7.0	7.3	4.8	5.3	4.0
1.5	7.0	7.8	6.0	4.8	4.7
1.6.1	6.2	8.3	3.6	3.0	4.2
1.6.2	6.8	7.0	3.8	2.8	4.0
1.7.1	6.3	6.2	7.0	5.3	5.3
1.7.2	4.5	3.3	4.4	3.0	5.8
2.1.1	7.8	8.2	6.8	6.8	6.2
2.1.2	8.5	8.0	5.6	5.5	9.0
2.2.1	7.2	6.0	5.2	8.0	6.0
2.2.2	5.2	7.8	4.2	6.2	8.0
2.2.3	4.5	7.8	3.2	6.0	8.3
2.2.4.1	4.7	5.5	4.0	6.5	6.8
3.1.1	6.2	7.5	5.6	5.2	9.3
3.1.2	4.3	6.7	3.8	5.5	7.3
3.1.3	3.8	4.8	3.6	5.5	2.8
3.2.1	6.0	5.2	5.8	7.2	7.7
3.2.2.1	7.0	6.8	7.0	8.0	7.3
3.2.2.2	7.2	6.0	6.2	7.2	6.5
3.2.3	5.7	6.2	5.2	6.0	5.8
3.2.4	6.2	6.8	4.2	6.0	5.0
4.1.1	3.8	4.0	8.4	9.0	6.8
4.1.2	4.0	3.7	7.8	7.5	6.7
4.2.1	6.2	4.0	8.8	7.7	7.3
4.2.2	3.8	3.0	7.6	8.2	5.2
4.2.3	4.7	5.0	6.8	7.7	6.2
4.3.1	7.2	6.7	6.8	7.5	7.3
4.3.2.1	7.3	7.0	6.8	9.0	5.8
4.3.2.2	5.7	6.3	7.4	9.0	5.2
4.4.1	6.5	5.5	7.2	7.2	7.5
4.4.2.1	7.2	6.5	6.4	7.7	7.8
4.4.2.2	6.3	6.5	6.8	7.7	6.7
4.4.3	6.3	4.2	7.6	7.5	6.3

(average), and more than 15 minutes (low)?" A value between 0 and 10 was elicited for each category and the instruction was to focus one's attention on the numbers as realted to one another not the absolute value. In spite of this recommendation certain participants actually preferred to assess directly the proportions. The results are portrayed in Table 3-5, where for each task, the time criticality representing the consensus of the interviewees is given.

3.5 Selection Criteria and Analysis

Six attributes were chosen for the MAU analysis on the decision tasks previously identified. They are:

(1) Complexity
(2) Proceduralizability*
(3) Degree of Impact on Mission Effectiveness
(4) Frequency of Occurrence
(5) Current TCO Autmated Aiding Level
(6) Time Criticality

Attributes (1), (2), (3), and (4) are affected with a positive weight, since for them a high attribute value means strong candidacy for automated decision aiding. Attribute (5) means measures how much of automated decision aiding already exists in the system, and is therefore affected with a negative weight. Attribute (6) plays a particular role since time criticality ultimately determines the kind of automated decision aiding which can be used. In the following the attributes are listed with their definition elicitation.

---

* Proceduralizability captures to what extent problem-solving can be procedurized.

TABLE 3-5. EXPERT INTERVIEW RESULTS:
TIME CRITICALITY

	Time Criticality
1.1.1	average to low
1.1.2	low
1.2.1	low
1.2.2.1	low
1.2.2.2	average to low
1.2.2.3	average to low
1.2.2.4.1	average to low
1.2.2.4.2	average to low
1.3	low
1.4	low
1.5	low
1.6.1	low
1.6.2	low
1.7.1	average to low
1.7.2	average to low
2.1.1	average to low
2.1.2	low
2.2.1	average to low
2.2.2	average to low
2.2.3	average to low
2.2.4.1	low
3.1.1	average to low
3.1.2	average to low
3.1.3	average to low
3.2.1	average to low
3.2.2.1	low
3.2.2.2	low
3.2.3	low

TABLE 3-5 (Cont.)

	Time Criticality
3.2.4	low
4.1.1	high
4.1.2	high
4.2.1	high
4.2.2	high
4.2.3	high
4.3.1	high
4.3.2.1	high
4.3.2.2	high
4.4.1	high
4.4.2.1	high
4.4.2.2	high
4.4.3	high

3.6 Decision Task Analysis

An analysis os the decision tasks followed the functional analysis of the Marine TCO decision making environment. The result of the functional analysis identified major decision tasks at battalion level. The aiding requirements were analyzed and a number of decision tasks with high payoff were selected. An in-depth analysis of the decision tasks, in light of decision analytical methods, identified the major characteristics of the Marine decision environment:

(1) More than one person may be involved.

(2) The commander is the ultimate decision maker.

(3) The staff provides information-hased support for:

  (a) alternative generation
  (b) alternative evaluation

(4) Other sources of information support the decision making activity.

The basic aiding requirements that resulted from the analysis are:

(a) Structuring of relevant knowledge of each staff member
(b) Aggregation of individual knowledge
(c) Generation of alternatives based on aggregated knowledge
(d) Evaluation of each alternative based on aggregated knowledge and commander judgment
(e) Selection of the most promising alternative in light of mission objectives.

Furthermore, the frequent decision making functions at battalion level were identified:

(1) Formulation of alternative friendly courses of action.

(2) Establishment of possible enemy responses.

(3) Assessment, aggregation, and updating of possible losses due to alternative actions.

(4) Assessment, aggregation and updating of probabilities of enemy responses.

(5) Evaluation of alternative friendly courses of action.

(6) Selection and implementation of the most promising friendly course of action.

3.7 Conclusion

The analysis of the Marine Battalion/TCO decision environment identified major characteristics of decision tasks, basic aiding requirements, and frequent decision making functions at battalion level. Based on these findings, the decision aid design/selection objectives for the Marine/TCO environment were established. These objectives include:

(1) A system which provides a decision aid, not a replacement, for the decision maker.

(2) Aid to formalize the staff members' relevant knowledge.

(3) Aid to incorporate the relevant staff's knowledge into the decision making process.

(4) Aid that is adaptive to different commanders and staff.

(5) Aid that is adaptive to different mission objectives.

(6) A summary of aggregated staff knowledge for the commander's use.

(7) An evaluation of the alternative friendly course of action based on the summary and the commander's evaluation of different staff members' expertise.

The design of the specific decision aid will be based on the above objectives.

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