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POLICY CAPTURING OF MANAGEMENT PERSONNEL THROUGH PROJECT-SELECTION DECISION MAKING IN AN AIR PORCE RESEARCH AND DEVELOPMENT LABORATORY

THESIS

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POLICY CAPTURING OF MANAGEMENT PERSONNEL THROUGH PROJECT-SELECTION DECISION MAKING IN AN AIR FORCE RESEARCH AND DEVELOPMENT LABORATORY

THESIS

Presented to the Paculty of the School of Engineering
of the Air Force Institute of Technology
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Master of Science

by

Terry L. Brooks, B.S. Captain USAP

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Preface

This research effort would not have been possible without the tremendous support by a large Mid-Western Air Force
Research and Development Laboratory. I wish to personally
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I also wish to express my appreciation to three of the Air Force Institute of Technology professors: Capt. Michael J. Stahl, my advisor, for his encouragement and untiring efforts; Lieutenant Colonel Adrian M. Harrell, my reader, for his continued support and statistical background; and Lieutenant Colonel Charles W. McNichols for his ability to produce the right computer program for any problem area.

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Terry L. Brooks

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Abstract

Policy capturing was used in this research to model the project-selection decision making behavior of individual managers in an Air Force R&D Laboratory environment. The managers were partitioned by management level, division, and type of laboratory project. Models were formulated for these groups to determine if consensus existed among them.

The policy capturing instrument was constructed based on six factors that were identified by interviews with the laboratory managers. These factors were Cost-Benefit Ratio, Technical Merit, Resource Availability, Likelihood of Success, Time Period, and Air Force Need. The instrument required the managers to make 32 decisions concerning his/her support or non-support of 32 hypothetical R&D projects.

The results were a positive indication of the successful use of policy capturing technique. It was determined that the simple linear model (the 6 additive factors) of the decision process was as representative of the individual managers as the interactive model (the 6 additive factors plus the 15 interactive terms). Therefore, the simple model was used for the data analysis. Technical Merit and Air Force Need accounted for approximately 75 to 80% of individual and group models. The 6.2 project management level models were determined to be the same, whereas the 6.3 project management level models were different. The 6.2

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division models were different as were the 6.3 division models. In comparing the management levels and divisions of the projects, the lack of consensus was attributed primarily to no more than three factors (Cost-Benefit Ratio, Technical Merit, and Air Force Need). Also, the individual managers of the projects were unable to accurately specify their personal models although they were consistent in their decision making behavior. The suggested employment of the Delphi technique should be more effective in attaining consensus among the management levels and divisions of the laboratory.

POLICY CAPTURING OF MANAGEMENT PERSONNEL THROUGH PROJECT-SELECTION DECISION MAKING IN AN AIR FORCE RESEARCH AND DEVELOPMENT LABORATORY

I. Introduction

One of the essential inputs for a modern manager, so that he may perform in that role, is information. However, in most cases the wealth of information can easily overwhelm the manager. For example, the complex environment of a Research and Development(R&D) manager involves search of that environment for opportunities, generation of options (projects), sequential evaluation at different levels of the organization, project-selection, and implementation (Schwartz and Vertinsky, 1977:285). The project-selection decision includes generating new alternatives, determining the appropriate time to make a decision, collecting the data, specifying constraints and criteria, and recycling, as well as selection of projects and allocation of resources (Baker, 1974:166). This decision process depends on the organizational framework.

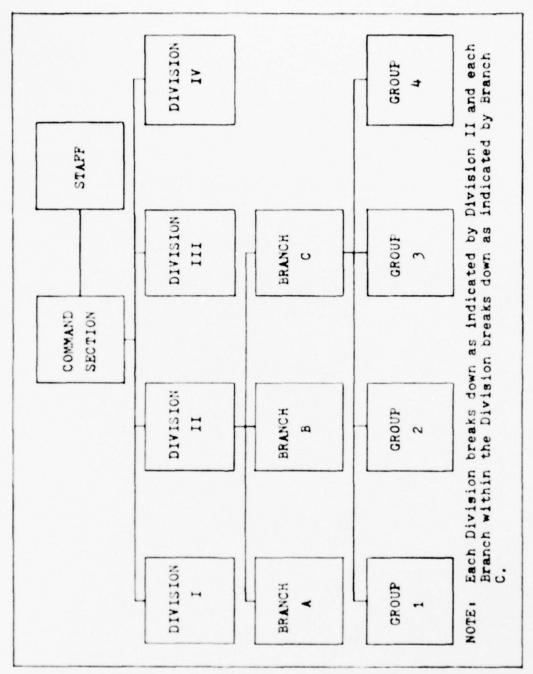
Statement of Research Problem

The management of a particular Air Force R&D Laboratory has indicated that there exist some problem areas in determining the selection of the specific R&D projects. The problem is the variation in the weightings for key factors

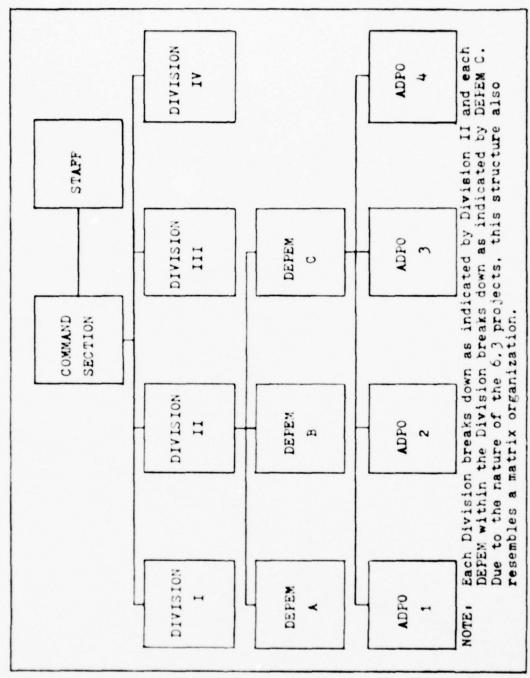
(attributes) that are used as inputs for the R&D projectselection process. These variations are encountered within
the organization as a whole, management levels, and divisions. The laboratory has to do with two types of R&D projects, 6.2 and 6.3. The 6.2 projects (programs) primarily
explore feasibility and practicability of proposed solutions
to specific military problems. These programs range from
studies and fundamental technical development to sophisticated breadboard hardware. On the other hand, the 6.3 projects are characterized by the fabrication of experimental
hardware to demonstrate projected capabilities by testing
under environmental or operational conditions (DoD Handbook
7045.7-H, May 1977).

The 6.2 project decisions are determined at all levels of management (Command, Division, Branch, and Group; Pigure 1-1), whereas 6.3 projects are determined only within the upper echelons of the management structure (Command, Staff, Division, Deputy Program Element Monitors(DEPEM), and Advanced Development Project Office Managers(ADPO); Pigure 1-2). The inconsistencies can be noted on either 6.2 or 6.3 projects.

This research effort investigates the weights for key factors used by members of the various management levels while pursuing decisions concerning the R&D project-selection. In order to accomplish this type of research, the judgement policies of the members of the different management levels regarding these decisions were identified using the research



Pigure 1-1. General Structure of Management Levels for 6.2 Programs.



Pigure 1-2. General Structure of Management Levels for 6.3 Programs.

approach known as policy capturing (Reference Chapter II).

Objectives of the Research

The fundamental objective of this research effort was to model R&D project-selection decisions at the different levels of management within the organization. The empirical data collected from the laboratory were used to examine the following research hypotheses:

- H1: Managers combine the R&D project-selection criteria in essentially a linear fashion while rendering a judgement.
- H2: The average individual manager's R^2 (\overline{R}^2) is higher than the R^2 s of the different levels of management ($\overline{R}^2 > R_{CS}^2 > R_S^2 > R_D^2 > R_B^2 > R_G^2 > R_{Tot}^2$). R^2 is a measure of the consistency with which the attributes are entered into the determination of the overall decision.

CS = Command Section

S - Staff

D = Division

B = Branch

G = Group

Tot = Entire Laboratory

- H3: Managers incorporate available information in their R&D project-selection decisions by utilizing the selected R&D factors in the R&D project-selection decision process.
- H4: Each manager places the same relative weights upon the criteria used for R&D project-selection decisions. (Judgement policies are homogeneous among all managers.)
- H5: Each management level places the same relative weight upon the criteria used for R&D project-selection decisions. (Homogeneity exists among the levels of management.)

- H6: Each division places the same relative weight upon the criteria used for R&D project-selection decisions. (Homogeneity exists among the divisions.)
- H7: Managers accurately specify the relative weights they place upon the criteria used to render the R&D project-selection decisions.
- H8: Managers of both 6.2 and 6.3 projects place the same relative weight upon the criteria used for R&D project-selection decisions. (Homogeneity exists among the 6.2 and 6.3 managers.)

NOTE: H1, H2, H3, H6, and H7 were tested for both 6.2 and 6.3 projects.

Scope and Limitations of the Study

This study was conducted among a selected group of individuals (an Air Force R&D Laboratory). Therefore, it would be very unlikely that generalization could be made about all Air Force R&D Laboratories. As a result, caution should be exercised before applying the findings of this study to other R&D laboratories.

The R&D project-selection decision making exercise included six attributes that were molded into a decision making instrument with 32 simulated projects by Drs. M.J. Stahl and A.M. Harrell (1978). These attributes were determined by personal interviews with the management personnel within the R&D laboratory and it is assumed that these attributes are representative of the information available to the management personnel during the decision making process in the laboratory environments.

Subsequent Chapters

Chapter II of this study discusses goal congruence, consensus, policy capturing, social judgement theory, and the Delphi technique in conjunction with formulating a decision model. Chapter III describes the research methodology, including the instrument used, and the way the data were collected and analyzed. The research results are presented in Chapter IV, and Chapter V summarizes the key findings and indicates the conclusions from the study.

II. Extensive Literature Review

In order to understand the decision making process in an organization through a technique called policy capturing, it is paramount to understand the inner workings of the organizational structure. Srinivasan (1974) refers to this organizational structure as goal-directedness. Goal-directedness encompasses all aspects of purposeful system behavior (i.e., adaptation, learning, and control).

In theory, organizations (systems) are considered to be oriented toward goals and objectives (Porter, Lawler, and Hackman, 1975:78). The goal set-up of this type of system can be viewed in two ways: 1) The system operates towards a definite goal. This goal requires the system to accept a certain normative framework; however, this framework may be rejected if a different goal is sought. 2) The system is involved in an evolutionary process (dynamic organization). The organization is thus viewed as going through a continuous process of goal-setting (problem posing) and goal-seeking (problem solving) behavior (Srinivasan, 1974:105-106).

Importance of Organizational Goals

Basically, goals are defined as desired future states of affairs. The organizational goals serve several important functions. The goals focus attention to the actions that need to be carried out. They tell what "should be" done.

A source of legitimacy is provided by goals in that there exists justification for actions or decisions. Goals in conjunction with other measures serve as a standard for the organizational member to assess his/her ability to perform his/her duties or carry out certain actions. The structure of the organization and organizational goals interact, each affecting the other. Additionally, goals provide clues about the organization. In many cases, they are key parts of an organization and essentially express what the organization is really like (Porter, et al., 1975:78-79).

Expectation affects the perceptions and behavior of an individual and others (Goldstein, 1962). Individuals experience the group atmosphere in individual ways. Therefore, it would be reasonable to assume that goals and expectations will affect an individual's group experience. Consequently, the importance of finding effective ways of identifying goals and expectations of the group, as well as an individual's perceptions of the experience, must be stressed (McCanne, 1977:534).

Classification of Goals

Porter, Lawler, and Hackman (1975) classify goals into three categories: official goals, operative goals, and operational goals. The official goals are the publicly stated goals of an organization. These goals are found in the organizational charter, the official documents, the policy statements of its offices, and the like. Operative goals

provide the basis for organizational policy formulation, operating decisions, development and application of information and control systems, and other management functions. Operative goals are considered to be in force whether or not there exists a conscious organizational goal-setting process, and they may be supportive of, indifferent to, or directly opposed to, the official goals of the organization (Manley, 1972:3). Goals are said to be operational when there are "agreed upon criteria for determining the extent to which particular activities or programs of activity contribute to these goals" (March and Simon, 1958:194).

The literature indicated that goals can be categorized into three additional types. Bozeman and McAlpine (1977) conducted an experiment to determine how certain attitudes and strategies of individuals affect the choices from a set of controlled contexts representing a bureaucratic decision environment. The main concern was the decision pattern in which an individual strives to maximize an individual goal to the detriment of organizational (bureaucratic) or mission goals. The individual goal is related to the power and prestige of the individual; whereas, the bureaucratic goal is related to both the specified objectives of the organization and the individual's perceptions of the organizational goals. Finally, the mission goal is related to the perception of the individual as to the social mission of his/ her profession. The findings of the experiment indicated that there was a significant association between professing

a team strategy of pursuing points for mission goals, and in fact, behaving in a manner in which individual goals are maximized.

The very fine line separating the definition of the various classes and types of goals presents additional problems in the area of communication from the management level to the worker level. The interpretation of goals in many cases is inconsistent not only at the different levels of management, but also among the different worker levels. This inconsistency can and does lead to numerous problems within an organization that is supposedly seeking an attainment of a specific set of goals or objectives. Therefore, a greater understanding of this goal-congruent behavior would be a definite aid to "managers."

Goal Congruence

A primary concern of goal congruence is the need for a measurement scheme for the performance of the executives and subordinates which will induce goal-congruent behavior under uncertainty (Itami, 1975:74-75). The ultimate criterion used in selecting a performance measure has been whether the measure induces the action of the subordinates while, at the same time, leading to better overall performance. However, this measure is invalid with the introduction of uncertainty (i.e., environmental factors). Therefore, the congruence of attitudes toward risk may be one of the crucial factors in the discussion of goal congruence, especially

in a decentralized decision making situation under uncertainty. As a result, the problem of goal congruence is complex and involves numerous factors such as organizational structure, uncertainty in environment, incentive schemes, and personal goals of members of the organization.

Another view of goal congruence is that goal congruence plays a key role in organizational and small group processes (Kochan, Cummings, and Huber, 1976:528). As an example, the leadership process will not occur if the parties do not share a common goal. If common goals exist, then compliance can be achieved without the power process. Otherwise, conflict occurs. The theories of conflict have centered on the differences in the goals as the major antecedent to conflict within the organizations (March and Simon, 1958).

The literature on organization behavior is continually growing. A deeper understanding of the role of goals in organization behavior is inevitable for those researchers using decision making processes as their central focus (Kochan, et al., 1976:528-529).

Consensus

Collective decisions are the most common type of decisions that individuals are faced with in social systems. However, this type of decision analysis has two basic faults as pointed out by Coleman (1966). The problems of collective decisions are based on one specific assumption that each individual is a purposive agent with some goals or purposes in

mind. The first problem relates to an individual faced with certain alternatives. The individual will choose the outcome that has the highest utility. The second problem of collective decision concerns a group of individuals (two or more) faced with a number of alternatives. In some instances, an alternative may be preferred by all; therefore, it is chosen. However, in most cases an alternative will not be preferred by all individuals concerned; consequently, the theory breaks down. The basic problem is the absence of consensus for a choice. As a result, there is a failure to predict the outcome.

El-Hakim (1978) conducted a study on decision making by consensus. The most striking feature of the consensus decisions was that each decision critically depended on the achievement of an informal unanimity by the group before any positive decision could be reached. The emphasis on unanimity implied that a minority (a single person) could veto any collective action. The decisions were made when there was no expressed disagreement (consensus). If disagreement persisted, no decision was made. The major disadvantage to the consensus decision process that this group used was the fact that one individual's decisions could help a majority form a certain action. However, this particular group exchanged control among the villagers, in that, if an event did not interest them, then they would not veto the event in exchange for support on an event that was of greater interest to them (E1-Hakim, 1978,55-64).

Souder (1975) conducted an "impact procedure" (similar to the Delphi technique) in which four organizations were tested for shared values and organizational consensus. The results indicated that two of the four organizations elicited high consensus. The two organizations which did not achieve global consensus lacked legitimized formal leadership and clear statements of the larger needs of the total organization. Another indicator of consensus that resulted from the study was the degree to which the participants were willing to engage in open conflict. In this case, the more open the conflict, the higher the degree of consensus attained (Souder, 1975:680).

Predictive Consensus Techniques. There are various methods that can be used to predict consensus (Helmer and Rescher, 1960:46-47). The following list is representative of the procedures available for predicting consensus:

1) The simplest method is to select one favored expert and accept his/her sole judgement. 2) Various expert valuations could be pooled into an average or a mean weighted technique to reflect past predictive success. 3) Several experts could be used to act as a single group in which a decision is made after the discrepancies have been eliminated.

4) Again, a group of experts could be used, but in this case, the experts include their best second guess probabilities. The result is that the influence of the most influential group member is diminished. 5) Another consensus measure is the Delphi technique. This technique is a method for

the systematic solicitation and collation of informed judgements on a particular topic (Turoff, 1970:149).

Although these techniques are representative of the ones available to measure consensus, it is important to note that no one method is universally the best technique. However, the Delphi technique is being studied more and more to determine the validity of measurement for this method.

The Delphi Technique

The Delphi procedure is one method of producing forecasts of future events. Delphi was developed by Helmer and Gordon at the Rand Corporation in the early 1960's (Martino, 1968:139). Delphi forecasting is one of the most popular forms of deriving reasoned expectation about the nature and consequences of emerging developments. "The forecast can be represented as a group judgement situation in which a number of individuals from various disciplinary backgrounds, with input relevant to the forecasting topic, judge the probable occurrence of events and provide supporting rationale for their judgements" (Salancik, 1973:243). For any decision, there is a crisis of concepts, ideas, alternatives, diagnoses, foresight, and planning. Delphi is an attempt to deal with all of these (Coates, 1975:193). "This mode of controlled interaction among the respondents represents a deliberate attempt to avoid the disadvantages associated with more conventional use of experts, such as round-table discussions or other milder forms of confrontation with opposing views"

(Dalkey and Helmer, 1963:459).

Delphi is characterized by three features: anonymity. controlled feedback, and statistical response. Anonymity means that the members do not know who else is serving on the committee. The individual is also unaware of any prior knowledge of questions, the origination of these questions, forecasts, or any issues that are being considered. Controlled feedback means that the exchange of ideas and comments are routed through some type of control (director). who screens out the extraneous material and consolidates the remainder before presentation to the committee. These precautions keep the committee members from reviewing irrelevant material. Statistical response means that the committee does not necessarily have to reach a consensus or achieve some majority position, and that all minority views are considered in the final result (Martino, 1972:37). In essence, the Delphi technique enables a large group of individuals to communicate meaningfully and rapidly with each other in generating group forecasts and in making policy decisions (Turoff, 1971:55-57).

Objective or Purpose of Delphi. The Delphi procedure is one method of obtaining an explicit forecast (Martino, 1968:138). In this type of study, the major purpose of the investigation is to describe potential for future events. To do this, the Delphi technique attempts to obtain a consensus of opinions from a group of respondents. This consensus might be in terms of the timing of some future event

in which an effort is made to describe the potential event in such a manner that all respondents interpret the information in the same way (Salancik, Wenger, and Helfer, 1971; 65). Some other objectives of this technique are: 1) to determine or develop a range of possible alternatives, 2) to explore or expose underlying assumption or information leading to differing judgements, 3) to correlate informed judgements on a topic spanning a wide range of disciplines, and 4) to educate the respondent group as to the diverse and interrelated aspects of the topic (Turoff, 1970:149). The objectives or combination of objectives from this list can cause the design of the summary and feedback procedures to vary to some extent.

Network of Delphi. Since the Delphi technique is relatively new, there is very little that can be agreed upon by the numbers of practitioners who have experimented with it. This disagreement is exemplified by the following questions:

1) Is the respondent group completely anonymous among its own members, to the design team, or to the user body?

2) Should Delphi be used in conjunction with a committee ongoing study effort? 3) Must the design teams be knowledgeable in the subject material or do they rely on the respondents to fill out the subject material? 4) Should the iterations (feedback) be cycled to the same respondent groups interacting serially or in parallel with one another? 5) How many iterations are needed? and Why? 6) How do you evaluate a consensus and are the respondents really using the same

definitions of terms and concepts? (Turoff, 1970:150).

These are only a few of the key questions that must be considered before the formulation of the Delphi technique.

Although a number of different questions need to be answered before the application of Delphi, there exists a relative amount of procedural harmony among the various practitioners. Basically, the first step in implementing Delphi is the selection of the panel (group of experts) in the subject area in which the study is to be made. The question arises here as to "where does the organization select the experts?" (inside or outside of the organization). This depends on the diversity of the experts available within the organization. After the complex task of selecting the panel, the second step is the initial stage questionnaire. This questionnaire requests each panel member to list, for example, the attributes or cues that he/she considers for selecting a research and development project. This portion is usually deliberately phrased in as vague and unstructured a way as possible to preclude inhibiting the panelists or restricting their thinking. Finally, a number of additional questionnaires (usually no more than three) are sent to the panelists one at a time; each questionnaire contains statistical information about the previous answers to questions plus additional questions (Johnson, 1976:45-55; Martino, 1968:138-144). When the questionnaires are returned, two types of information are extracted from them prior to the design of the next questionnaire: structured responses and

written comments. Usually due to a time constraint, a very simple method is used for the questions (i.e., multiple-choice questions). In many cases, computers are used to aid in the analysis process (Schneider, 1972:487).

The main issues in a Delphi study are the direct impacts on the responses of the panel members. These issues are: 1) the possibility of panel fatigue as the number of topic statements becomes very large, 2) the consistency in panel responses, 3) the change of responses as a characteristic of the size of the Delphi studies, and 4) the early plurality of panel responses on many questions. Plurality refers to a number of respondents who have an immediate consensus on the first set of questions (arbitrarily a 70% figure is used in the literature). The larger the Delphi (number of panel members), the more complex the procedures become (Huckfeldt and Judd, 1974:76).

Uses of Delphi. Schneider (1972) focused on five possible uses for the Delphi method. These were as follows:

1) This method has potential as an educational device. However, in order to use this technique as an educational tool, one must ask if it is cost-effective. 2) It could possibly be used in the definition of both action and research programs. 3) The technique may be of value to a continuous planning concept because it offers a method of obtaining the trends in the values or goals held by different constituents.

4) This method would be useful in obtaining individual participation in policy and goal formulation efforts. 5) Lastly,

the technique could be used to serve political objectives. However, the initiator should use caution in the political arena because the technique could rapidly deteriorate in such situations.

Judd (1972) pointed out that Delphi could be used in conjunction with cost-effectiveness and cost-benefit analysis. However, one obvious use is in the area of education where a consensus of values or evaluations is determined. On the other hand, Delphi has received its widest use in the area of technological forecasting (Turoff, 1970:150).

Advantage of the Delphi Technique. Scheele (1975), Martino (1968), and Turoff (1970) agree that the main advantage of the Delphi technique is the elimination of the principle bottleneck in the committee procedure. Committee activity is completely excluded which greatly reduces the bandwagon effect and the unwillingness to abandon publicly expressed opinions. The direct debate approach of the committee activity is replaced by a carefully designed program of sequential questionnaires, intertwined with information and feedback derived from earlier questionnaires of the program. In essence, the use of the Delphi studies "allows for the opportunity to get opinions from a broader group of people than could be assembled in a single place without great difficulty" (Scheele, 1975:215).

In addition, Helmer and Gordon (1964) state, "No claims are made, or can be made, for the reliability of the Delphi predictions. However, in as much as they reflect explicit.

reasoned, self-aware opinions, expressed in light of the opinions of associate experts, such predictions should lessen the chance of surprise and provide a sounder basis for long-range decision making than do implicit, unarticulated, intuitive judgement. Therefore, without substantial evidence that Delphi is unreliable, it can be concluded that it exhibits a predictive characteristic that is just as powerful as any other technique that is available at the present time. Johnson (1976) also indicated that the group median obtained from the Delphi process is usually more accurate than the median obtained from an individual response.

Results Obtained from the Application of Delphi. Sufficient time has passed since the development of Delphi so that the accuracy of the method can be sufficiently evaluated. One study examined six different forecasts of computers and information processing technology in which Delphi techniques were used. Martino (1972) compiled the results. The findings indicated that of the 89 events forecasted to occur between 1968 and 1972, 49 had occurred with the indication that there seemed to be a slight tendency for events to occur earlier than forecasted. Another researcher, Judd (1972), concluded that the use of Delphi in the college arena proved that "a wide range of possible goals and objectives, evaluated by quite different publics, can be the objective of a Delphi exercise." Judd also noted that the various illustrations made it apparent that Delphi techniques

are very diversified.

Johnson (1976) noted that Delphi was a very powerful tool for use in market studies. In this particular study, Johnson determined that Delphi excelled in the following three areas: 1) An excellent quantity of information was extracted from many disciplines. 2) There existed strange divergent opinions indicating a movement towards consensus.

3) The panel members who participated in the study were very committed. A total of 90 percent of the panel members stayed with the study from start to finish.

Brockhaus and Mickelsen (1977) inferred that "70 percent of the respondents felt that the quantification of the consensus of expert opinions in Delphi studies has considerably enhanced the acceptability of the findings by the organization for which the study was conducted. The remaining 30 percent of the respondents felt that quantification did enhance the acceptance of the results, but only to a slight degree."

without too much of a sacrifice of important opinion, while at the same time, the impracticalities of a group discussion are avoided. The expert is aided by the investigator who reworded the questions to attain a consensus. On the other hand, the experts are forced to help themselves toward a consensus by rethinking through the problem by reviewing the divergent estimates. Consequently, the results have indicated a very successful process.

Criticisms of Delphi. Sackman (1975) points out users should be suspect of the Delphi technique. He feels that the practitioners have questionable motives. In addition, Sackman interprets the name "Delphi" as a catchy term which bears connotation of oracular insight. The biggest promotion of Delphi is the regularity and uniformity that exists during the implementation and use of the technique, but Sackman indicates that in fact these procedures and techniques are of a highly diverse collection.

Turoff (1970), from a more realistic standpoint, reviews four potential dangers of the Delphi technique. The four dangers are: 1) Individuals can misinterpret the intent of the use of the Delphi technique. 2) Occasionally, the designers of the exercise are accused of a biased viewpoint. 3) The designers of the technique must make the decision maker(s) aware that once the process begins there is no way to control or guarantee a specific outcome. 4) There is a possible contention that Delphi is being used as a political tool as opposed to an analysis tool. These dangers are good indicators that the implementation of Delphi must be a careful and cautious process which includes exploring numerous underlying factors. In addition, a ten year study conducted by Johnson (1976) for Corning Glass Works revealed other criticisms. More specifically, event questions in the different questionnaires were misinterpreted and in some cases certain questions contained compound events. Also, other problems were noted due to the complexity in filling out the

questionnaires. Finally, Martino (1972) pointed out that Delphi methods are based on data from the past and this data cannot be used to predict something that represents a complete break with the past.

These cited criticisms are the key to the future existence of the Delphi technique. If these criticisms are overlooked, the present results for the most part will be inadequate and this additional aid to decision makers will go awry.

Research and Development Project-Selection

Aside from the Delphi technique which is a method for measuring consensus and goal congruence, the literature on Research and Development(R&D) abounds with formal procedures and sophisticated models for project evaluation and selection. In many of these articles, the assessment of probabilities is required. However, the subjective character of these probabilities entails two serious problems which may have contributed to the low acceptance of these models:

1) The first problem concerns the reliability and validity of the probability assessments (i.e., their degree of association with the actual project outcomes). 2) The second problem refers to the fact that subjective probabilities by their very nature may vary from person to person and thus lack uniqueness (Rubenstein and Schroder, 1977:137).

In order to gain a more thorough understanding of the R&D process, it is useful to investigate the various

components of the selection process. Schwartz and Vertinsky (1977) have focused upon environmental scanning in the process of R&D project-selection, while Souder (1975) focused his attentions upon the organizational problem of achieving a consensus. Schwartz and Vertinsky (1977) have focused on yet another component of the selection process: the formation of individual preferences among R&D investment opportunities. Special attention was paid to the relationship between the characteristics of the executive, position and function, the attributes of his organization, and the tradeoffs he was willing to accept in forming his judgements (decisions). Schwartz and Vertinsky (1977) also formulated a list of 47 indicators or intrinsic attributes which exist prior to any probability assessment and independent of any assessor. After these attributes were rated by executives, the list was shortened to the following: 1) cost of project relative to total R&D budget; 2) payback period; 3) probability of technical and commercial success; 4) market share impact; and 5) expected rate of return.

The cost of the project relative to the total R&D budget of a firm is a measure of resource commitment. The payback period refers to a measure of the time commitment to a project. The probability of technical and commercial success is a measure of risk. The market share is often a subsidiary goal of firms, or from an economic view, it is a reflection of the competitive power of the company and of market security. Lastly, the expected rate of return is a

measure of profitability in certain environments (Schwartz and Vertinsky, 1977:285-286).

The assessment of the probabilities of the attributes for R&D projects may be conceived as being composed of four phases. The first is the perception phase where the intrinsic project attributes are perceived by the assessor(s). The second is the evaluation phase where qualitative judgements begin to emerge, while in the third phase or transformation phase, the qualitative judgements are transformed into numerical values which are the assessor(s) subjective probabilities. Finally, the review phase is where the assessor(s) subjective probabilities are communicated. However, to complicate matters further, interpersonal differences can be found in each of these four phases due to personal, organizational, and situational variables.

The personal variables refer to the ability of the assessor to perceive and evaluate the attributes of a project and transform these into a numerical rating. The organizational variables refer to the impact that the position of the assessor in the company hierarchy and the reward system employed have on the assessment process, while situational variables refer to the involvement of the assessor in the project or the department of top-management interest in the project (Rubenstein and Schroder, 1977:138). As a result, subjective probabilities suffer from inconsistencies in most organizations in which this information is available.

Rubenstein and Schroder (1977) presented a study of

organizational-situational variables that reviewed the impact of the assessors' specific relation towards a project and the impact of the assessors' hierarchical position. The specific relation towards a given project was subdivided into project responsibility and project idea generation. The impact of the organizational-situational variables on the assignment of subjective probabilities for R&D projects can be summarized as follows: 1) Both participation in project-idea generation and prospective project responsibility are likely to result in relatively high probability assessments. 2) There is a tendency for higher ranked assessors to assign lower probabilities than their subordinate due to a tendency to fill the "knowledge gap" with conservatism.

Another problem area concerning assessment of subjective probabilities with a given set of R&D projects results from the dissimilar perceptions of organizational goals among the individuals that make up the organization. Souder (1975) designed an impact study to investigate four groups of individuals with each group consisting of personnel from the same organization. Each group had a combination of a president (in two groups only), division managers, directors, and managers. In essence, each group filled out individual paired comparison instruments for the criteria they used in selecting R&D projects. Then, each group met and discussed the number of criteria used and determined a single set of criteria that should be used. This completed one cycle for the individuals. After a week of normal duty, the second cycle

was completed. Then finally, a third cycle was completed a week later.

In each cycle the same individuals were assigned to the same groups. The results of the impact procedure suggested that this procedure may have general utility in many planning and policy formulation situations in addition to the important problem of R&D investment projects. Many hidden social-interpersonal conflicts and leadership were revealed in the group discussions for each of the four groups. The successfulness of the experiment depended primarily on whether the participants were willing to engage in open conflict, whereas dissatisfaction was related to a clear avoidance of open conflict (Souder, 1975:669-680).

Meadows (1968) conducted an investigation on four RED laboratories primarily in the areas of technical and commercial success with respect to project-selection. The results indicated that three of the four laboratories made no attempt at all to rank products on the basis of their technical success or commercial performance. Meadows concluded that current laboratory selection procedures typically expend more than 50 percent of the firm's development resources on projects that do not produce commercially successful products. Also, there is a tendency for technically and commercially unsuccessful projects, as a group, to incur greater cost overruns than commercially successful projects which results in unsuccessful projects costing more on the average.

Criticisms of Model Formulations for R&D Project-Selection. Baker and Pound (1964) noted through interviews that although a number of models exist, very few have received testing with respect to feasibility and/or desirability. Also very few of these models have seen even limited formal use. The interviewers criticized models or methods primarily in four different areas. Firstly, model construction remains an ambiguous facet because R&D project-selection lacks structure and definition of objectives. So far, R&D projectselection has failed to be described adequately in a thorough and detailed manner. Secondly, data availability and reliability were criticized by personnel of organizations that maintained historical records of decision analysis and by those personnel of organizations without this information. There seemed to be no application for the information in models. Thirdly, acceptance of the models was criticized due to a lack of detailed exposure to the mathematical and statistical techniques being proposed. There also exists no clear demonstration that using a formal method is highly advantageous. Finally, implementation and use were mentioned. Although the model is accepted, the result is a termination of model use due to the sponsor leaving the organization or due to the organization being somewhat unstable.

Many models inherently are possessed with a number of limitations. Baker and Freeland (1975) point out a few of these. There is an existence of the lack of adequate treatment of risk and uncertainty, of multiple criteria, of

project interrelationships, and an inability to recognize and treat nonmonetary aspects such as establishing and maintaining balance in the R&D program. Based on these limitations, it becomes more apparent why decision managers refuse to implement quantitative models for the R&D project-selection and resource allocations.

Examples of Models/Methods. A list of the models/methods follows which are identified by the name or names of the originators:

- 1) Mottley-Newton (1959)-This is a decision theory approach. Project proposals are rated with respect to a number of evaluation criteria. An overall score is computed and used to rank the alternatives. Selection criteria are considered with respect to constraints including research budget, risk, and overall program balance (Baker and Pound, 1964:127).
- 2) Freeman (1960)-This is an operations research approach.
 For each alternative project, an estimate is made of the probability distribution of net value. Selection is accomplished by maximizing expected discounted net value subject to constraints on the total budget, facilities, and personnel.
 A linear programming formulation is used (Baker and Pound, 1964:126).
- 3) Gargiulo, et al. (1961)-This is a decision theory approach. Project proposals are rated with respect to a number of evaluation criteria. An overall score is computed and used to rank the alternatives. Constraints such as research budget, skills available, facilities available, and competitor

efforts in the area are considered (Baker and Pound, 1964: 126).

- 4) Asher (1962)-This is an operations research approach. For each alternative project, estimates are made of the discounted net value of the project and probability of success. Selection is accomplished by maximizing expected discounted net value subject to constraints on the man hours available and on the raw materials available. The optimal manpower allocation is indicated by the result. A linear programming formulation is used (Baker and Pound, 1964:126).
- 5) Hess (1962)-This is an operations research approach. For each alternative project, estimates are made of the discounted gross value as of several points in time. Probabilities of success are also estimated. Selection is accomplished by maximizing expected discounted net value subject to a budget constraint for the first period. The optimal allocation to each project is indicated for each period. A dynamic programming formulation is used.
- 6) Baker-Pound (1964)-This is a decision theory approach.

 Project proposals are rated with respect to a number of weighted selection objectives. An overall score is computed and used to rank the alternatives. The budget constraint is considered.
- 7) Cramer-Smith (1964)-This is an economic analysis and operations research approach, an application of portfolio selection and utility theory to the problem of research project-selection. For each alternative project, estimates are

made of net values and probabilities of occurrence. Utility curves are also obtained. Projects may be ranked on the basis of expected value or expected utility. Lack of project independence is also mentioned (Baker and Pound, 1964; 127).

- 8) Nutt (1965)-This is an operations research approach, a deterministic model which quantifies the value or technical payoff of each research task. The model developed considers the world environment; the Air Force missions future weapons systems configurations; laboratory technical objectives; and the timeliness, complexity, and scope of each research effort. The result consists of recommended funding levels of efficient tasks along with suggested tasks for close scrutiny or possible elimination-a modified linear program.
- 9) Wells (1966)-This is a decision theory approach to store, track, and properly relate judgements concerning systems; to show the impact of these judgements; to permit real-time iterations of planning problems to facilitate the assessment and selection of system candidates for development. Criteria are: threat, types of war, policy objectives, functions, systems contributions, force structure, technical feasibility, schedule and cost, and budget (Cetron, Martino, and Roepcke, 1967:7).
- 10) <u>Dean-Hauser</u> (1967)-This is an economic analysis and operations research approach, an application of project-selection under constrained resource conditions. By using mathematical models, computer programs, and available information

concerning costs, uncertainties, and military values, it is possible to obtain optimum solutions. The case study has developed a mathematical model for handling the large number of alternatives through the use of a series of simpler computerized methods. There the results of one stage are used in the succeeding stage. A dynamic programming formulation is used.

- 11) Belt (1966)-This is a decision theory approach based on quantified subjective judgements on the predicted value of a successful laboratory project outcome, the likelihood of success of the project in terms of its technological achievability, the specific plan of attack and the suitability of the proposed performers of the work, and the predicted cost. This technique stops short of producing a single numerical rating of project value, but gives the decision maker the opportunity to select from a group of alternative projects (Cetron, Martino, and Roepcke, 1967:7).
- 12) Cetron-Martino-Roepcke (1967)-This is an operations research approach. Factors taken into account are importance of military missions, criticality of technological effort to mission, and level of technology required. Funds are allocated among technical projects on the basis of maximum marginal payoff per dollar, with a budget total.
- 13) Watters (1967)-This is a zero-one integer programming approach with a budget constraint in each of several future time periods. Interesting features include the use of an objective function incorporating risk; probabilistic

constraint rows; and the development of model equations for the cases of project dependence and independence (Gear, Lockett, and Pearson, 1971:68).

- 14) Keefer (1978)-This is a multiobjective decision analysis carried out to help management of a major corporation's Research and Engineering Division in planning its allocation among six "missions," or areas of responsibility. The allocation involves tradeoffs between competing objectives. This analysis formally considers the uncertainties and multiple objectives, yet has only modest data requirements due to its use of approximations and its focus on mission rather than on individual projects. This approach uses concepts, techniques, and results from decision analysis, particularly from multivariate utility theory.
- 15) <u>Aaker-Tyebjee</u> (1978)-The concept of interdependence is incorporated into this R&D project-selection and budget allocation model. The model is termed INTERACT to reflect the fact that it was designed to deal explicitly with project interactions and because its use will encourage the interaction of groups of people within the organization.

This list of models is not an exhaustive one but presents somewhat of a broad picture that researchers are attempting to model. However, the majority of the models listed are not considered useable out of the environment in which they were originally designed. The researcher for this study has chosen a newer technique referred to as policy capturing in which the methodology is simpler and is easily

modified to apply to different environments.

Policy Capturing

Policy capturing is essentially quantifying the process used by a decision maker through which informational attributes (cues) are weighted and combined resulting in a decision. Gooch (1972) defines policy capturing as "... identification and quantification of the attributes that are pertinent to a decision and the subsequent mathematical description of the decision policy for the evaluation of these attributes. " Smith (1972) defines policy capturing a little differently by referring to it as "... the building of a model which, given the same information the individual has, will accurately reproduce his judgements based on that information." Both researchers are referring to the "actual combination of the question and the desire to produce a mathematical (or heuristic) model of the judgement making process" (Jones, Mannis, Martin, Summers, and Wagner, 1976: 7).

Policy capturing is not a panacea but should be considered as an aid to decision makers if:

- Externalizing and understanding the decision process would enhance communications.
- 2. It is desirable to remove bias.
- It is desirable to obtain consistency (goal congruence).
- 4. There are a number of decision makers (consensus).

- 5. Several factors influence a decision, and if there were weights for each, these weights would provide a basis for ranking or selecting alternatives, or
- 6. A routine decision making process exists for which automated decision making would be beneficial (Jones, et al., 1976:1, 2).

This research directly involves R&D project-selection in which all of the above list existed. Once policy capturing has been decided on as the aid to use, the following 17 steps are helpful.

- Identify the problem (project-selection for AP R&D Laboratory).
- Determine (if) policy capturing would be a useful tool for addressing the problem (review the above six statements).
- Identify and define the decision(s) to be modeled (6.2 and 6.3 project-selection).
- 4. Identify the judge(s) whose decision(s) will be modeled (Managers-Command Section, Staff, Division, Branch or DEPEMs, and Group or ADPOs).
- 5. Identify the organizational structure as it relates to the judge(s) and to the decision(s) being modeled (levels of management within the laboratory).

- 6. Identify the factors which provide the judge(s) the information needed to make decision(s) (review actual work environment in which decisions are to be made).
- 7. Form a set of variables (cues) from the factors previously identified (Cost-Benefit Ratio, Technical Merit, Resource Availability, Likelihood of Success, Time Period, and Air Force Need).
- 8. Select an appropriate response scale and data collection procedure (graphical scale from -5 to +5 including zero for R&D project-selection support in a decision making exercise). Note:

 See Chapter III and Appendix A for further details.
- Specify the type of case to be presented (hypothetical R&D projects).
- 10. Select a statistical design to yield desired information (linear multiple regression).
- 11. Consider physical aspects of the case presentation (similar to actual environment).
- 12. Pilot test experimental procedure and refine the experiment (pretest instruments).
- Present cue data, collect responses and record pertinent non-formal remarks (See Appendix G).
- 14. Formulate models (See Chapter IV).

- 15. Cross validate and/or validate the model(s) (See Chapter III).
- 16. Investigate irregularities, diversities among models and unresolved conflicts for judgement or organizational policy implications (See Chapter V).
- 17. Utilize model results with appropriate control (use caution in the implementation phase).

(Jones, et al., 1976:36)

As a result of these seventeen steps, the amount of consensus is measured and the determination is made as to whether the organization is operating in a goal congruent environment or not.

Reasons for the Use of Models. The philosophy underlying the studies involved with modeling is that man frequently relies on information that is probabilistic in nature when making decisions concerning the state of his environment. The model represents man's inference about his environment (Beach, 1967:276).

The biggest problem concerning models developed through policy capturing is the difficulty in passing along the path from theory or model to application (Conrath, 1973,873).

Dawes (1971) points out the question of how can a model based on an individual's behavior do a better job of what the individual is trying to do than the individual himself? "The answer, by its very nature, is an abstraction of the process it models; hence, if the decision maker's behavior involves

following valid principles but following them poorly, these valid principles will be abstracted by the model-as long as the deviations from these principles are not systematically related to the variables the decision maker is considering." The paramorphic representation, a term introduced by Hoffman (1960) which means the mathematical representation of the judgement process, would not be affected by extraneous variables such as fatigue, headaches, and boredom. Therefore, if these extraneous variables are not related to the relevant variables, then the model will attach the correct weights to the relevant variables.

A second major reason for the use of models is costbenefit analysis which was presented by Goldberg (1970) and
Dawes (1971). In both studies, the researchers proved that
the use of judgemental models is inherently less costly than
the use of human judges due to the fact that the judges who
were used to derive the models were free to perform other
activities after the models were formulated. Another reason
for the use of models is a method for determining the amount
of consensus within an organization such as this particular
research.

Decision Making Process. Before policy capturing can be completely comprehended, a brief description of the decision making process is presented. Goldberg (1968) depicted the role of the human decision maker as that of a scientist who is discovering or identifying new cues which will improve predictive accuracy and determining new procedures to combine

factors in increasingly more optimal ways. However, the decision maker often encounters numerous problems. Slovic and Hoffman (1969) and Einhorn (1971) indicated that the general problem is understanding the process by which the decision maker combines information to make evaluative decisions. Hoffman (1960) in the clinical judgement research restricted the clinical evaluation of patients in the following manner: (a) the information available was reduced to a common set of variables, (b) the information was expressed in a number of categorical responses, and (c) each variable satisfied the properties of at least the ordinal scale.

Other problems are also in existence. In many cases, the individuals who are to participate in the decision process to determine a model for a decision situation, refuse to take part which results in situations that are not able to be modeled. Also, the models that are formulated are quite different for each individual indicating very different decision making processes. Finally, the evaluation model that subjects feel they use is often quite different and more complex than what they actually use (Huber, Sahney, and Ford, 1969:488). For example, equally attractive choices or alternatives will lead to a random choice, and when the alternatives are of similar total value and different in qualities, the individual will choose with a probability of near 50 percent (Slovic and Hoffman, 1969:7). Taylor and Wilsted (1976) also state that attempts by decision makers to describe their policy are often inaccurate and overstated in

complexity.

Aside from the individual decision making process, groups are considered in many instances of the decision making process. Holloman and Hendrick (1972) in their study offered evidence that the quality of decisions made by groups was positively related to the amount and quality of interaction among the group members. Basically, the more interaction the better the quality of the final decisions. Although consensus was attained by the group, it was responsible indirectly for the interaction due to the differences of opinion.

Although group decisions appear to be better than those derived by individuals, problems do exist. Examples of the problems in the interacting groups are as follows:

- Members of interacting groups often attempt to influence others in proportion to their self-perceived relative competence.
- Dominant personalities often lead to dyfunctional solutions.
- Interacting groups require time and effort to maintain themselves.
- 4. More resources are required to create an interacting group than a nominal group.

(Huber and Delbecq, 1972:163)

Another step in the process of decision making is the choices which involve certain amounts of risk. Myers and Melcher (1969) indicate in their study of decision making

that there are four factors that underlie the choices of various risk pairs. First, the number of alternative choices must be considered whether there are few or many. Second, the planning horizon is examined in relation to its length (short or long). Third, the past success rate of commitments is reviewed. Finally, the expected cost-revenue consequences (high or low) affect the strategy of the decision maker(s).

In summary, the span of absolute judgement and the span of immediate memory impose certain restrictions or limitations on the amount of information that an individual or group of individuals can comprehend and process. Bruner, Goodnow, and Austin (1956) note:

"Where the nature of a task imposes a high degree of strain on memory and inference, the strategy used for coping with the task will tend to be less conducive to cognitive strain. To put it in terms of an analogy, if someone has to move a heavy weight, there is ... likelihood that the mover will have recourse to strainreducing techniques for carrying out his task."

Also, individuals experience a definite recoding process with information during the decision making process. The general consensus among researchers is that this process is an orderly set of relationships (Miller, 1956:95-96). Therefore, the decision making process can be simplified to the following statement:

"The whole trick is to decide what variables to look at and then to know how to add" (Dawes and Corrigan, 1974: 105).

Brunswik Lens Model. The Brunswik lens model is the basic framework for conceptualizing decision making. Brunswik (1956) was the originator of this model of the judgement process (Beach, 1967:276). A number of other researchers have used the Brunswik lens model in their studies (e.g., Beach, 1967; Jones, et al., 1976; Hursch, Hammond, and Hursch, 1964; Naylor and Schenck, 1966; Stenson, 1974). The basic idea is that the real world decisions have to be made concerning the criterion without direct knowledge of that criterion. In general, factors (cues) are determined and used to measure the criterion. The judges perceive, weigh, and combine these cues in a manner which is referred to as the decision process. Slovic, Fischhoff, and Lichtenstein (1977) feel that this process can be described by the use of a linear regression equation. (Refer to Linear Models and Multiple Regression, p. 45, for further discussion.)

The model below (Figure 2-1) is divided into the environment and the judge's action (judgement or policy). The terms of the model can be described as follows:

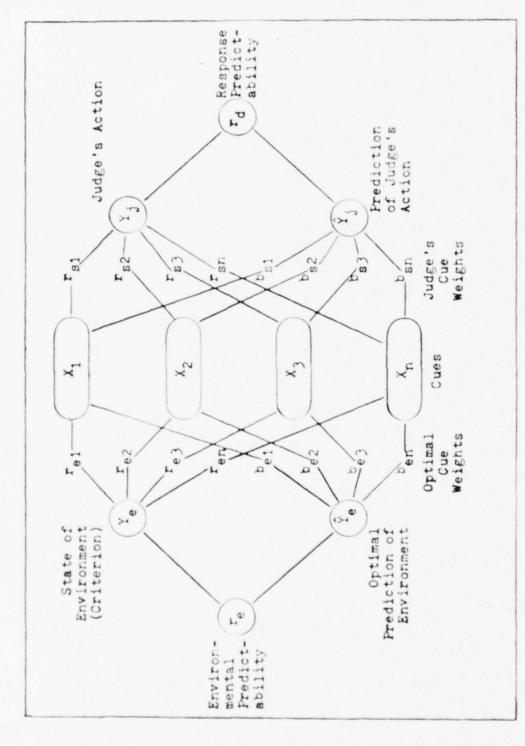
 $X_i = value of the ith cue$

Y = the actual value assigned to the criterion by the judge

 \hat{Y}_{i} = the prediction about the judge's action

 Y_e = criterion in which the judge is interested

Ŷe = the best predicted value of the criterion that can be achieved from the given cues



Brunswik Lens Model (Beach, 1967; and Jones, et al., 1976) Figure 2-1.

rsi rsn = cue weights for the judge (utilization weights)

rei' ..., ren = optimal cue weights for determining actual criterion

bsi, ..., bsp = predicted cue weights for the judge

be1' ... ben = optimal cue weights for prediction of judge's action

re = correlation (environmental predictability)
that measures how well the model (of reality)
corresponds to reality

rd = correlation (response predictability) that
 measures how well the judge can be predicted
 by his model

The following multiple regression equations hold for this model:

$$Y_e = r_{e1}x_1 + r_{e2}x_2 + \dots + r_{en}x_n$$

$$\hat{Y}_e = b_{e1}x_1 + b_{e2}x_2 + \dots + b_{en}x_n$$

$$Y_j = r_{s1}x_1 + r_{s2}x_2 + \dots + r_{sn}x_n$$

$$\hat{Y}_j = b_{s1}x_1 + b_{s2}x_2 + \dots + b_{sn}s_n$$

The task of the Brunswik lens model is essentially to penetrate the realm of uncertainty and make the best intuitive inference about the environment.

Linear Models and Multiple Regression. The first use of linear models dates back to the time of Benjamin Pranklin (1787) in which he developed a system that he could use as an aid in decision making. His mathematical approach was referred to as "moral or prudential algebra." In 1923, Vice-President Wallace proposed the use of a linear model on

the corn judge by regressing his ratings of corn quality.

Again, thirty-seven years later, Hoffman (1960) proposed

that a linear model could represent expert judgements (Dawes
and Corrigan, 1974:95, 100). Since that time, a number of
authors have concluded that linear models are good paramorphic representations or good at capturing the policy of
judges (Beach, 1967; Christal, 1968; Dudycha and Naylor,
1966; Naylor, Dudycha, and Schenck, 1967; Goldberg, 1968;
Hammond, Hursch, and Todd, 1964; Naylor and Schenck, 1966;
Wherry and Naylor, 1966; and Brehmer, 1969). Slovic and
Lichtenstein (1971) and Slovic, Fischhoff, and Lichtenstein
(1977) contain extensive bibliographies.

There exist opposing views concerning linear models.

Many researchers have conducted studies with the use of linear and non-linear models. Hoffman (1960) determined that the non-linear model multiple R was approximately five percent higher than the multiple R of the linear model. However, considering the factors of chance, this increase with the use of non-linear models was insignificant. Brehmer, Kuylenstierna, and Liljergren (1974) presented results which indicated that the learning associated with a linear function is much faster than non-linear functions. Also, these authors noted that the rules extracted from the subjects' judgements were much higher for the linear hypotheses than the non-linear hypotheses. Goldberg (1971) designed an experiment to investigate five models-Linear, Conjunctive, Disjunctive, Logarithmic, and Exponential. His results

indicated that the linear model provided a better representation of the subjects' judgements than any of the other models.

The question often arises, "Why do linear models work?"

Dawes and Corrigan (1974) through their investigations have

determined that linear models work because of the following

reasons:

- 1. Predictor variables have conditionally monotone relationships to the criteria. In other words, the variables can be scaled in such a way that higher values on each predict higher values on the criterion, independently of the values of the remaining variables.
- 2. There is error in the dependent variable.
- 3. There is error in the independent variables.
- 4. Deviations from optimal weightings do not make much difference.

Through the successful predictive power of the linear model, a new term, "bootstrapping," appeared in the literature.

This term referred to the phenomenon that the linear model of the judge often does a better job than the judge himself.

Another area of conflict in policy capturing is whether to derive the model through the use of linear models with the multiple regression technique or equal weights. Dawes and Corrigan (1974), Cattin (1978), Keren and Newman (1978), and Doran and Drasgow (1978) were all researchers exploring the use of multiple regression and equal weights. Keren and

Newman (1978) summarized the present research in the following manner:

- 1. Equal weights procedures can only be justified after application and occasionally equal weights will be slightly better or equal to multiple regression. However, the equal weight technique does not have any explanatory power beyond prediction.
- 2. The formal statistical properties of least squares estimate are neither necessary nor sufficient condition for "good" estimators.

 There is not a specific criterion to use for what is a good estimator. This decision will be dependent upon the particular situation.
- 3. Just because multiple regression (with sum of squares estimation) does not always provide the ideal solution, it is not sufficient reason to advocate the use of equal weights.
- 4. The main advantage of equal weights is its simplicity. However, the price that must be paid for this property must be carefully evaluated.

As a result, multiple regression is still the primary statistical research method used.

Social Judgement Theory. Brunswik (1956) indicated with the lens model that individuals rarely have direct access to the distal state that they must judge. Instead, the

environment provides the cues upon which the judge must base his inferences. Social judgement theorists have stressed the need to consider the nature of the environment outside of the laboratory. The objectives of Social Judgement Theory(SJT) are as follows:

- 1. SJT is intended to be life relevant.
- SJT is intended to be descriptive as opposed to law-seeking.
- 3. Social judgement theorists are interested in creating aids for human judgement particularly for those formulating social policy.
 (Hammond, Stewart, Brehmer, and Steinmann, 1975:276)

Social judgement theorists refer to zone of ambiguity which can be described by five parameters: (a) the ecological validity of each cue, (b) the form of the function between each cue and the distal variable, (c) the organizing principle of the task, (d) the probabilism inherent in the task, and (e) the extent to which the cues are intercorrelated (Hammond, Rohrbaugh, Mumpower, and Adelman, 1977:4). Variations in these parameters of the zone of ambiguity make generalization about the real world difficult. Therefore, social judgement theorists attempt to incorporate the variations so that generalization can be made.

Empirical regularities that were observed in the laboratory are also observed in the real world. SJT research has indicated the following conclusions:

- People do not describe accurately and completely their judgemental policies.
- People are inconsistent in applying judgemental policies.
- 3. Only a small number of cues are utilized.
- 4. Understanding another's policy is very difficult when observing his/her judgements or listening to his/her explanation concerning them.
- Cognitive aids can reduce conflict and increase learning.
- Linear, additive organizational principles are often adequate to describe judgement processes.

(Hammond, et al., 1975:304-305)

In summary, the researcher has presented in this chapter a number of empirical studies involving measuring consensus and goal congruence. One of the most successful methods of measuring consensus was the Delphi technique. Specifically, this study was concerned with R&D project-selection and the literature indicated a number of models used in this type of environment. The researcher's experiment deals with a newer technique for determining consensus called policy capturing. The next chapter shows the methods by which this technique was employed to determine if consensus existed in a large Mid-Western Air Force R&D Laboratory.

III. Research Methodology

Identification of the Key Factors

The identification of the predictive factors (cues) was the majority of the effort in developing the instrument. Six factors were determined that were most commonly used by the management personnel in the R&D project-selection decision making environment. Doctors Michael J. Stahl and Adrain M. Harrell conducted interviews with the management personnel of the laboratory (Command Section through Branch Chiefs) and took a consensus of the factors used by these individuals in the decision process. The resulting six factors were as follows:

- 1) Cost-Benefit Ratio. A comparison of cost required to complete this project with the advantages to be received because of its successful completion is ... *
- 2) Technical Merit. The extent to which this project provides a new or better technical capability to the Air Force is ...
- 3) Resource Availability. The availability of the personnel, equipment, facilities, and other resources needed to complete this project is ...
- 4) Likelihood of Success. The likelihood that this

^{*} NOTE: Specific information about the relationships of this attribute was provided here. The factors were dichotomous (either acceptable or excellent). Refer to the Decision Making Exercise in Appendix A.

- project will achieve technical success, given its planned time and resource constraints, is ... *
- 5) <u>Time Period</u>. The amount of time that is needed to complete this project is ... *
- 6) Air Force Need. The degree to which it has been established that an actual Air Force need for technical capability provided by this project is ... *
 The basic construction of the instrument was concluded with

The Design of the Instrument

the determination of these six factors.

The instrument was intentionally designed to be very simple. There were two sections included in the instrument. The first consisted of demographic questions establishing the individual's management level and particular division. The second section, then, contained 32 decisions referring to R&D project-selection. In addition, the second section was used to determine an individual's policy throughout the decision making exercise.

Decision Making Exercise

The decision making exercise consisted of a 1-factorial, orthogonally-designed, randomly arranged sequence of R&D project-selection decisions. The same design was used for the 6.2 and 6.3 programs. Each project-selection decision

^{*} NOTE: Specific information about the relationships of this attribute was provided here. The factors were dichotomous (either acceptable or excellent). Refer to the Decision Making Exercise in Appendix A.

contained information about whether each predictor variable (6 cues mentioned above) was rated acceptable or excellent where acceptable means "barely meets minimally acceptable value or requirement, " and excellent means "considerably better than minimally acceptable value or requirement." Since there were six predictors (R&D project criteria) and two states for each criteria (acceptable or excellent), there were 26 = 64 possible combinations to consider. However, to minimize the length of the decision making exercise only a 3-factorial design was used which resulted in 32 different projects. The combination of the 32 predictor variable vectors for the projects was determined by a FORTRAN program designed by Dr. Charles W. McNichols. The program was designed so that the combinations generated would be relevant for examining interactions among the factors up to and including five-way interactions. Appendix F lists the sequence of the 32 cue-value combinations.

The R&D project-selection decision consisted of the individual recommending approval or disapproval of funding for the project. Each of the 32 simulated projects were unique in that a mathematically orthogonal vector was representative of a particular project. Therefore, there was no correlation among the predictors in the regression. Consequently, the uniqueness of such an instrument allowed for the assurance of a simple determination of the importance an individual placed on the 6 R&D project criteria. This simple determination was based on the subject's recommendation for the

project. The final decision of the exercise required each individual to distribute 100 points between the 6 cues. In other words, each individual provided his subjective weights for the cues.

After the instrument was designed, a final step had to be completed. This step was to validate the information obtained with the use of the instrument.

Validation

Nunnally (1978) described three types of validity:

1) predictive validity, 2) content validity, and 3) construct validity. Predictive validity is of importance when an instrument is used to determine some form of behavior that is external to the instrument itself. Content validity "depends primarily on the adequacy with which a specified domain of content is sampled" (Nunnally, 1978:91). Finally, construct validity refers to measurement problems in basic research in the behavioral sciences. Since variables are used to explain other variables, researchers must be sure that each variable measures what it was purported to measure (Nunnally, 1978: 87-94).

Reliability is another key term used in conjunction with validation of an instrument. The ease with which the measurement error places a limit on the amount of validity exhibited, results in reliability being a necessary but not sufficient condition. In addition, internal consistency is a measure of importance. It is the estimate of the

reliability based on the average correlation among the items in the test (Nunnally, 1978:212).

Validity is not an "all or none" concept, rather it is usually an unending process. The result is an instrument which is considered valid only to a matter of degree. The following quote emphasizes the complex process of validation:

"There is no way to prove the validity of an instrument purely by appeal to authority, deduction from a psychological theory, or any type of mathematical proof" (Nunnally, 1978:87).

In many cases the validation process is simplified by numerous assumptions.

The basic assumption made by previous investigators is that models formulated with policy capturing techniques are similar to those formulated under natural judgemental conditions. Brown (1972) was the first to attempt to validate the experimental conditions model as a replacement for the real life model. Brown's research was instigated by Hoffman's works (1960). The models developed by Hoffman were in question because the judgemental task was different in several ways from the judgement with which radiologists normally use. By changing the real life judgement into a contrived one and sufficient altering of the conditions, the resulting decisions are likely to be unrepresentative of the decision making process of the original judgement. Therefore, Brown's research with the Los Angeles Suicide Prevention Center reflected a very similar atmosphere between the simulated situation and the real world environment. The results

of the experiment indicated that the assumptions made by researchers in past investigations with respect to judgemental modeling are correct. More specifically, the models developed from the contrived settings agreed closely with the models developed from natural settings.

On the other hand, two research efforts, Ebbesen and Koneeni (1975) and Phelps and Shanteau (1978), have concluded that the models developed from natural settings are different from those contrived from experimental conditions. The first study by Ebbesen and Koneeni (1975) involved a construction of a bail setting model for judges based on certain factors. The results of the experiment indicated that there was a difference between the controlled laboratory research and the natural environment. However, one key point was overlooked in this study. That is, the factors used in the simulated experiment were not the same as those in the natural environment. For example, the severity of the crime was eliminated from the contrived conditions but was noted as one of the five key factors in the natural settings.

In the second study by Phelps and Shanteau (1978), a similar error was made. The purpose of their research was to derive a model for judging livestock (specifically, gilts). The results of the experiment again indicated a difference between the natural and contrived models. The error was that the conditions of the natural environment and simulated environment were not very similar. Therefore, both sets of results attained by these research efforts were

invalid because of the drastic differences noted between the two environments.

Therefore, as stated above, an extensive effort was exerted in determining the factors to use in this decision making exercise. Based on the consensus among the management personnel of the laboratory concerning the six cues, it was assumed that the simulated R&D project-selection exercise was similar to the actual R&D project-selection environment. Due to the design of the policy capturing instrument, the reliability or R² for each individual, as well as group R²s, was also calculated.

In summary, two key points concerning validation are as follows:

- 1. Validation always requires empirical investigation.
- An instrument is not validated, only the use to which it is put.

Collection of the Empirical Data

Due to the difference between 6.2 and 6.3 programs, separate subpopulations of the laboratory received the decision making exercise, however, there was some overlap within the upper echelon of management. The 6.2 program management personnel consisted of the Command Section, Staff, Division Chiefs, Branch Chiefs, and Group Leaders. On the other hand, the 6.3 program management personnel included individuals in the Command Section, Staff, Division, DEPEMs, and ADPOs.

There were 120 and 49 R&D project-selection decision making

exercise packages distributed by name to the management personnel respectively in the 6.2 and 6.3 programs. In the package a return envelope was enclosed for the individual's convenience. For the returned exercise to be considered useable, each R&D project-selection decision had to be completed. The return rate was 58% for the 6.2 project managers and 69% for the 6.3 project managers.

Coding of the Data

Upon return of the decision making exercises, the data were then coded onto a standard IBM card for each individual. The format used is shown in Appendix G. In addition, a separate listing was maintained for those individuals requesting feedback. An example of the Letter used to assign the codes and the compiled information sheet are included in Appendix E.

Restructuring of the Data for Regression Analysis

Two problem areas were encountered due to horizontal format used in coding the data. Pirst, the regression algorithm available to the researcher required that the regression variables to read line by line. This regression algorithm was the <u>Statistical Package for Social Sciences</u>(SFSS) by Nie, Hull, Jenkins, Steinbrenner, and Bent (1978). The second problem area was that the predictor variables were not associated with the specific decisions of the individuals. Therefore, another FORTRAN program, designed by Dr. Charles W. McNichols, had to be used to eliminate these problem

areas. This program computed each of the individual's R²s, Beta Weights, and Relative Weights as well as providing for the option of storing the information on tape. After the information was stored, the overall and group regression models were formulated. (See Appendix C for the FORTRAN program.)

Preliminary Checks on the Data

Two F-tests, one for the simple model and one for the interactive model, were constructed and solved for R². The respective R²s found were the minimum values for which an R² was considered statistically significant. If any individual in the simple model calculations or interactive model calculations had an R² of less than the calculated model R²s, then the individual's model was considered unuseable for data analyses. In essence, this test was used to measure the internal consistency of the instrument.

After the minimum acceptable values of the simple and interactive model ${\bf R}^2{\bf s}$ were calculated, another test was conducted in order to determine whether or not the interactive model was significantly greater than the simple model for that particular individual. Equation B-3 in Appendix B was used to calculate the $\triangle_{R_1^2-R_2^2}$. Appendix B also includes the basic structure of the two models and the other equations used for the above calculations.

Data Analysis Procedures

The Aeronautical Systems Division CDC 6600 CYBRE 70

Computer was used for all the data analysis including the preliminary checks discussed above. The specific types of analysis used for this study were regression, frequencies, F-test, and t-test.

The regression analysis was based on the sum of squares technique. Each group analyzed had the same forced fit regression model, so that the factors were common to the different groups. This in turn simplified the comparison process. The output of the regression analysis was as follows:

$$b = (X'X)^{-1} X'Y$$
 (3-1)

where

- b is a column vector of standardized regression coefficients (beta weights).
- X is the standardized matrix of all the values of the orthogonal cues in the decision making exercise.
- Y is the standardized column vector of the individual decision responses.

(McNichols, 1978:4-27)

After the beta weights were calculated, the relative weights were computed for the overall and group models by the use of the following equation.

$$RW_{i} = \frac{(b_{i})^{2}}{R^{2}}$$
 (for orthogonal predictor variables) (3-2)

where

RW, is the relative weight for a particular factor.

b; is the beta weight for a particular factor.

 ${\ensuremath{\mathsf{R}}}^2$ is the measure of consistency.

(Hoffman, 1960:120-121)

NOTE: The regression weights were all relative weights.

The comparisons and hypotheses tests were conducted with reference to the specific relative weights of the factors in each of the individual and group regression runs (Ward, 1962; and Jones, et al., 1976).

The Chow's F-test was applied to determine if the model formulated for one group was statistically different from those of another group. The general structure of the test equation was as follows:

$$F_{o} = \frac{SS_{E} \cdot - SS_{Ej}/((p-1)(k+1))}{SS_{Ej}/(n-p(k+1))}$$

$$\sim F_{(p-1)(k+1), n-p(k+1)}$$
(3-3)

where

SSE* is obtained from a regression accomplished with all of the data combined.

SS_{Ej} is the error sum of squares from the regression analysis accomplished with the jth subset of the data.

n is the number of decisions.

k is the number of factors.

p is the number of subpopulations.

(McNichols, 1978:4-56)

Figure 3-1 indicates the various regression runs accomplished.

The null hypothesis for the test was that there was no

												-
	1	2	3	4	5	6	7	8	9	10	11	12
1	х	0	0	0	0	0	0	0	0	0	0	0
2	0	X	Х	Х	Х	Х	0	0	0	0	0	0
3	0	0	Х	Х	X	Х	0	0	0	0	0	0
4	0	0	0	Х	X	X	0	0	0	0	0	0
5	0	0	0	0	X	Χ	0	0	0	0	0	0
6	0	0	0	0	0	X	0	0	0	0	0	0
7	0	0	0	0	0	0	Х	0	0	0	0	0
8	0	0	0	0	0	0	0	X	X	Χ	Χ	Х
9	0	0	0	0	0	0	0	0	Х	Χ	Х	Х
10	0	0	0	0	0	0	0	0	0	X	X	Х
11	0	0	0	0	0	0	0	0	0	0	X	Х
12	0	0	0	0	0	0	0	0	0	0	0	Χ
	ressio	on —		Pro						ogra		
	1				Labor		ry				orat	
	2				Sec	tion				d Se	ctio	n
	3		Stat						aff			
	4			ision	ח			-	visi	on		
	5		Bran						PEM			
	6		Grou					AD:				
	7			al Dulat	ivis: ion	ion				Divi	sion	
	8		Div	ision	n FX			Div	visi	on F	X.	
	9		Div	ision	n FG			Div	/isi	on F	'G	
	10			ision				Div	isi	on F	Έ	
	11		Div	ision	n FB			Div	risi	on F	B	
										on P		

Pigure 3-1. Regression Runs. The tabular entries indicate a regression run for the group identified by the row/column interactions. The interaction of the same group indicates a regression for that group only.

significant difference between the models formulated for the different groups. The rejection of the null hypothesis, for purposes of this study, indicated that the groups were statistically different in the decision making process used to select the R&D projects. All calculations were based on the .05 level of significance. In addition, frequency runs were generated to produce various statistical information. Six paired sample t-tests were used to determine if the individual subjective weights differed from the regression weights for any of the six cues. A two sample t-test was used to determine which of the specific factors introduced differences among the groups, and also, to determine if the model formulated for the 6.2 program differed statistically from the model formulated for the 6.3 program.

IV. Results

The analysis of the data is provided in this chapter. Each of the eight hypotheses mentioned in Chapter I (pg. 5) were explicitly examined with respect to the 6.2 and 6.3 programs when applicable.

Internal Consistency

Internal consistency (R²) was used as a reliability measure of this policy capturing technique. McNichols' FORTRAN program (Appendix C) was used to obtain an R² for each individual. This program was used to derive the R²s for the individuals in the 6.2 program, simple and interactive models, as well as the 6.3 program individuals, simple and interactive models. The results are listed in Appendix D. Table I lists the minimum R² values that were calculated for the simple and interactive models.

TABLE I

1	Minimum Values of R ² (Calculated : Simple and Interactive Model:	for the s)
Program	Simple Model R ² S	Interactive Model R _I ²
6.2 and 6.	3* .374	.853

^{*} The values of R_S^2 and R_I^2 were identical for each program because the same decision making exercise was used for both programs. Equations B-1 and B-2 were used to calculate the respective R^2 s (Appendix B).

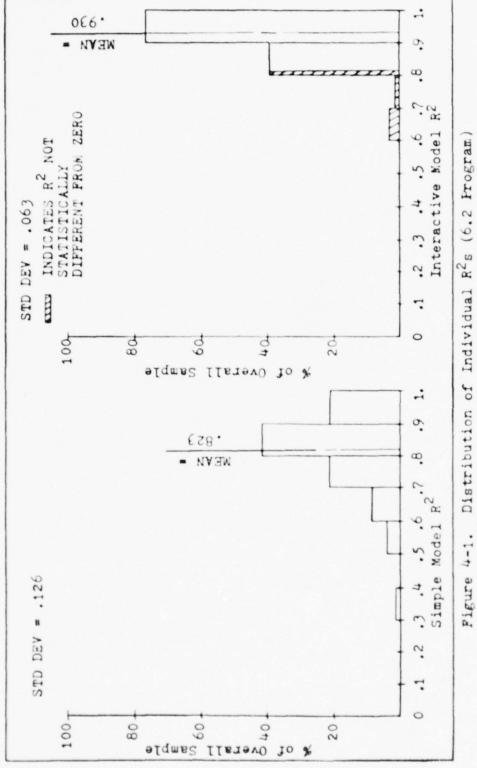
All of the individuals in the 6.2 and 6.3 programs had significant R² values for the simple model. However, approximately 7.2% of the individuals in the 6.2 program and 3.2% of the individuals in the 6.3 program had interactive models that could not be considered statistically different from zero at the .05 significance level. Table II indicates the average R²s of the individuals in the 6.2 and 6.3 programs for the simple and interactive models.

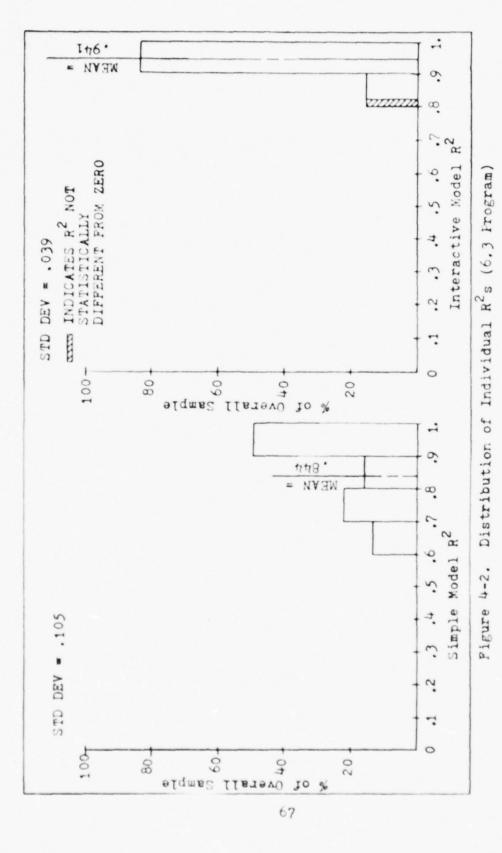
TABLE II

	Average Individual R ² Values	
Program	Simple Model R ² S	Interactive Model R _I ²
6.2	.826	.930
6.3	.844	. 941

In addition, approximately 63% of the simple model R²s for the 6.2 program and 65% of the simple model R²s for the 6.3 program were greater than .80. On the other hand, 96% of the 6.2 program and 100% of the 6.3 program R²s for the interactive model were greater than .80. These very high R²s indicate that the information provided by the cues was used consistently by the individuals in the policy capturing exercise. In summary, review Pigures 4-1 and 4-2.







Hypothesis #1

H1: Managers combine the R&D project-selection criteria in essentially a linear fashion while rendering a judgement.

Equation B-3 in Appendix B was used to determine if the simple or the interactive model was significant for each individual. Approximately 8.7% of the individuals in the 6.2 program and 6.5% of the individuals in the 6.3 program had an interactive model that accounted for significantly more variance than the simple model. Therefore, the simple model was used for the remaining data analysis. (Refer to Appendix D for the compiled listing of the results for this calculation.)

Hypothesis #2

H2: The average individual manager's R^2 (\overline{R}^2) is higher than the R^2 s of the different levels of management

 $(\overline{R}^2 > R_{CS}^2 > R_S^2 > R_D^2 > R_B^2 > R_G^2 > R_{Tot}^2).$

CS = Command Section

S = Staff

D = Division

B = Branch

G = Group

Tot = Entire Laboratory

This hypothesis was applicable to the 6.2 program individuals. Table III indicates the compiled results. The results although different than those hypothesized were not surprising due to the number of the staff section personnel who indicated on the instrument that they were assigned to the section because of an established job rotation program. Therefore, the low \mathbb{R}^2 was indicative of the circumstances.

TABLE III

			R ² Values	3		
\bar{R}^2	CS	S	D	В	G	Tot
826	.794	.534	.558	.567	.468	.510

In summary, the R² values were as high as compared to other research efforts with similar policy capturing exercises.

Hypothesis #3

H3: Managers incorporate available information in their R&D project-selection decisions by utilizing the selected R&D factors in the R&D project-selection decision process.

The six factors listed in Chapter II (pgs. 51-52) were tested to see if each was used by managers of the 6.2 and 6.3 programs in making their decisions. The results for the 6.2 and 6.3 programs are listed in Table IV.

The high values of t in Table IV were very positive indicators that all six factors were used by the managers in both the 6.2 and 6.3 project-selection decisions. Therefore, all six factors were used in the data analysis.

Hypothesis #4

H4: Each manager places the same relative weight upon the criteria used for R&D project-selection decisions. (Judgement policies are homogeneous among all managers.)

The Chow's F-test was used to determine if the judgement

TABLE IV

T-Test	of	Factor	Utiliza	tion	by Managers
	of	the 6.2	and 6.	3 Pro	jects

	6.2 Project Mana	gers	
Factor	Mean Regression Relative Weight	Variance	t
Cost-Benefit Ratio	.089	.010	73.929
Technical Merit	.286	.046	51.646
Resource Availability	.065	.008	67.491
Likelihood of Success	.056	.003	155.057
Time Period	.028	,001	232.585
Air Force Need	.475	.054	73.068

Ho: The regression relative weights for each of the six factors are not statistically different than zero.

Reject H_o if t = $t_{\alpha/2}$ at the .05 level of significance.

t_{n-1,a/2} = t_{68,.025} = 1.96

	6.3 Project Mana	gers	
Factor	Mean Regression Relative Weight	Variance	t
Cost-Benefit Ratio	.123	.011	62.258
Technical Merit	.245	.040	34.103
Resource Availability	.065	.005	72.381

T-Test of Factor Utilization by Managers of the 6.2 and 6.3 Projects

	6.3 Project Mana	gers	
Factor	Mean Regression Relative Weight	Variance	t
Likelihood of Success	.061	.006	56.606
Time Period	.049	.003	90.940
Air Force Need	.457	.039	65.243

Ho! The regression relative weights for each of the six factors are not statistically different than zero.

Reject H_o if t = $t_{\alpha/2}$ at the .05 level of significance.

$$t_{n-1,\alpha/2} = t_{30,.025} = 1.96$$

policies were homogeneous among all managers. The test was based on the sum of squares error associated with each individual model and the sum of squares error which resulted from the entire laboratory regression model. The results indicated that at least one manager's model in the 6.2 and 6.3 projects differed from the remainder of the managers in the respective programs. The largest difference was noted with respect to the manager's relative weight of Technical Merit and Air Force Need. Therefore, the models formulated by the managers were not homogeneous in either the 6.2 or

6.3 projects.

Hypothesis #5

H5: Each management level places the same relative weight upon the criteria used for R&D project-selection decisions. (Homogeneity exists among the levels of management.)

The resulting regression models for the management levels are listed in Table V for the 6.2 projects and Table VI for the 6.3 projects. The Chow's F-test was used to determine if homogeneity existed among the management levels of the respective projects.

The models formulated for the 6.2 project management levels were essentially the same. On the other hand, the models formulated for the 6.3 project management levels were determined to be statistically different.

A mean difference t-test was used to determine where the differences among the management levels for the 6.3 projects occurred. Approximately 86% of the Regression Weight for the model formulated was accounted for by three factors (Cost-Benefit Ratio, Technical Merit, and Air Porce Need). Therefore, these factors were reviewed in more detail. The results are listed in Table VII.

The results in Table VII indicated that the Staff and ADFO management levels were the same while the other management level comparisons were different with respect to Cost-Benefit Ratio. Technical Merit caused the most differences among all management levels. Air Force Need, on the other hand, resulted in 50% of the management level comparison

Entire Laboratory .069* .305 .045 .043 .017 .522 Command .097 .319 .001 .059 .030 .494 .081 .047 .042 .042 .439 .104 .289 .081 .047 .042 .439 .104 .052 .326 .041 .020 .011 .551 .551 .104 .043 .293 .043 .058 .015 .551 .551 .041 .081 .081 .081 .041 .037 .015 .517	Regression Group	Cost- Benefit Ratio	Technical Merit	Resource Avail- ability	Likeli- hood of Success	Time	Air Force Need
on .097 .319 .001 .059 .030 .104 .289 .081 .042 ion .052 .326 .041 .020 .011 h .043 .043 .058 .015 .081 .310 .041 .037 .015	Entire Laboratory	•690.	.305	540.	. 043	.017	. 522
ion .052 .042 .041 .047 .042 ion .052 .326 .041 .020 .011 n .043 .293 .043 .058 .015 n .041 .310 .041 .037 .015	Command Section		.319	.001	650.	.030	767.
ion .052 .326 .041 .020 .011 h .043 .293 .043 .058 .015 .081 .310 .041 .037 .015	Staff	***	.289	.081	240.	.042	.439
n .043 .059 .043 .015 .015 .015 .015 .015 .015 .015	Division		.326	. 041	.020	.011	.551
.081 .310 .041 .037	Branch		.293	.043	.058	.015	.547
	Group	. 081	.310	.041	.037	.015	.517

* Regression Relative Weights

Regression E Group						
	Cost- Benefit Ratio	Technical	Resource Avail- ability	Likeli- hood of Success	Time Feriod	Air Porce Need
Entire Laboratory '	114.	.237	. 247	. 042	. 041	.519
Command Section	090	.380	700.	.010	500.	.541
Staff.	660	.039	.142	.088	.063	695.
Division .	920	.340	.042	,024	.014	. 505
DEPEK .	146	.132	540.	690.	.119	684.
ADPO .	133	.276	070.	.038	.037	.477
•	Regressi	Regression Relative Weights	Veights			

TABLE VII

Comparisons of the Management Level Models With Respect to the Factors (6.3 Projects)

		Factors	
Management Levels Being Compared	Cost-Benefit Ratio	Technical Merit	Air Force Need
Com Sec/Staff	DIFF	DIFF	SAME
Com Sec/Division	DIFF	SAME	DIFF
Com Sec/DEPEM	DIFF	DIFF	DIFF
Com Sec/ADPO	DIFF	DIFF	DIFF
Staff/Division	DIFF	DIFF	SAME
Staff/DEPEM	DIFF	DIFF	DIFF
Staff/ADPO	SAME	DIFF	SAME
Division/DEPEM	DIFF	DIFF	SAME
Division/ADPO	DIFF	DIFF	SAME
DEPEM/ADPO	DIFF	DIFF	DIFF

SAME indicates that the models were not statistically different with respect to that particular factor.

DIFF indicates that the models were statistically different with respect to that particular factor at the .05 level of significance.

Com Sec = Command Section

being considered statistically different. (See Appendix I for the t-test results.)

Hypothesis #6

H6: Each division places the same relative weight upon the criteria used for R&D project-selection decisions. (Homogeneity exists among the divisions.)

The resulting regression models for the different divisions are listed in Table VIII for the 6.2 projects and Table IX for the 6.3 projects. Again, the Chow's P-test was used to determine if homogeneity existed among the divisions of the respective projects.

For both the 6.2 and 6.3 projects, the F-test indicated that the models formulated for the divisions were different. Again, a mean difference t-test was used to determine the specific division differences. Approximately 84% of the 6.2 project models was accounted for with two factors (Technical Merit and Air Force Need). The results for these factors are listed in Table X. On the other hand, approximately 88% of the 6.3 project models was accounted for with three factors (Cost-Benefit Ratio, Technical Merit, and Air Force Need). Table XI lists the results. The other factors not considered in this discussion accounted for less than 12-16% of the overall model.

The results of Table X indicated that the divisions were completely different with respect to Technical Merit and Air Force Need. No combination of divisions was the same for either factor. The results of Table XI indicated

TABLE VIII

Regression Group	Cost- Benefit Ratio	Technical Merit	Resource Avail- ability	Likeli- hood of Success	Time Feriod	Air Force Need
Entire Division Fopulation	• 790.	.306	.042	. 042	.015	.532
PX Division	.055	1441	240.	.030	.018	604.
PG Division	.084	.325	.053	020.	.017	.451
PE Division	.072	.117	.022	.016	.008	.766
PB Division	.038	.236	.038	.061	.010	.618
	* Regressi	Regression Relative Weights	Weights			

TABLE IX

		Division	Division Models (6.3 Projects)	Projects)		
Regression Group	Cost- Benefit Ratio	Technical Merit	Resource Avail- ability	Likeli- hood of Success	Time Period	Air Porce
Entire Division Population	.120•	.261	. 042	.022	.042	\$64.
PX Division	.151	.488	.073	.032	.017	.239
FG Division	060.	.332	.033	.023	240.	767.
PE Division	.231	.113	.058	860.	.039	.461
PB Division	.070	.239	.029	.021	940.	765.
PI Division	.102	.212	.020	.102	.062	.503

* Regression Relative Weights

TABLE X

Comparisons of the Division Models With Respect to the Factors (6.2 Projects)

	Fac	tors
Divisions Being Compared	Technical Merit	Air Force Need
FX/PG	DIFF	DIFF
FX/FE	DIFF	DIFF
FX/FB	DIFF	DIFF
FG/FE	DIFF	DIFF
FG/FB	DIFF	DIFF
FE/FB	DIFF	DIFF

DIFF indicates that the models were statistically different with respect to that particular factor at the .05 level of significance.

TABLE XI

Comparisons of the Division Level Models With Respect to the Factors (6.3 Projects)

		Factors	
Divisions Being Compared	Cost-Benefit Ratio	Technical Merit	Air Force Need
FX/FG	DIFP	DIFF	DIFF
FX/FE	DIFF	DIFF	DIFF
FX/FB	DIFF	DIFF	DIFF
FG/FE	DIFF	DIFP	SAME
FG/FB	SAME	DIFF	DIFF
FE/FB	DIFF	DIFP	DIFF

SAME indicates that the models were not statistically different with respect to that particular factor.

DIFF indicates that the models were statistically different with respect to that particular factor at the .05 level of significance.

NOTE: Division FI was eliminated from the calculations because only one individual completed the instrument.

that Divisions PG and PB were statistically the same with respect to Cost-Benefit Ratio. For Air Force Need, Divisions FG and FE were the same. All division combinations for Technical Merit were considered statistically different at the .05 significance level. Division PI was eliminated from these calculations because only one individual completed the instrument. (See Appendix I for the t-test results for both projects.)

Hypothesis #7

H7: Managers accurately specify the relative weights they place upon the criteria used to render the R&D project-selection decisions.

The individual subjective weights and regression weights were compared by using a paired sample t-test. Table XII indicates the results of the 6.2 project and Table XIII the results of the 6.3 project.

The 6.2 project managers' subjective weights were statistically different from the regression weights for each of the factors. The regression models formulated implied that the managers actually use a different model than they perceive.

As noted with the 6.2 project managers, the 6.3 project managers' subjective weights were statistically different from the regression weights. The 6.3 project managers also use models for the selection of their projects that are different than they perceive. (See Appendix H for the calculation of the difference between the subjective and regression weights.)

TABLE XII

Comparison of Individual Subjective and Regression Relative Weights (6.2 Project)

Factor	t	
Cost-Benefit Ratio	6.896	
Technical Merit	-2.858	
Resource Availability	7.075	
Likelihood of Success	11.285	
Time Period	5.447	
Air Force Need	-8.384	

 $\rm H_{o}^{-}$ μ_{S}^{-} μ_{R}^{-} = 0 $\,$ where μ_{S}^{-} = Subjective Weight and $\,$ $\,$ $\,$ $\,$ $\,$ $\,$ Regression Relative Weight

Reject H_0 if $t > t_{\alpha/2}$ at the .05 level of significance.

$$t_{n-1,\alpha/2} = t_{63,.025} = 1.96$$

Hypothesis #8

H8: Managers of the 6.2 and 6.3 projects place the same relative weight upon the criteria used for R&D project-selection decisions. (Homogeneity exists among the 6.2 and 6.3 managers.)

A difference between means t-test was used to determine the existence of homogeneity between the managers of 6.2 and 6.3 projects. Table XIV shows the tabulated results of this test.

The results in Table XIV indicate that Time Period was

TABLE XIII

	Comparison	of	Indiv	ridual	Sub.	ject	ive	
and	Regression	Rela	tive	Weight	8 (5.3	Project)

Factor	t	
Cost-Benefit Ratio	3.283	
Technical Merit	-2.802	
Resource Availability	4.825	
Likelihood of Success	5.419	
Time Period	4.383	
Air Force Need	-6.196	

H_o: μ_S - μ_R = 0 where μ_S = Subjective Weight and μ_R = Regression Relative Weight Reject H_o if t > t_{\alpha/2} at the .05 level of significance. t_{n-1,\alpha/2} = t_{28..025} = 2.048

the only factor in which the 6.2 and 6.3 project models statistically differed. However, this conclusion could be misleading because this factor only accounts for a weight of 2.8% in the 6.2 project model and 4.9% in the 6.3 project model. Since this factor also has such a small variance in each case, the probability of concluding a significant difference was very high. Therefore, the difference in Time Period between the 6.2 and 6.3 projects would not be considered substantial. As a result the 6.2 and 6.3 project

AVAILABILLEY			
Likelihood of Success	.056	.003	155.057
Pime Period	.028	.001	232.585
Air Force Need	.475	.054	73.068

Ho: The regression relative weights for each of the six factors are not statistically different than zero.

Reject H_0 if $t = t_{\alpha/2}$ at the .05 level of significance.

t_{n-1,a/2} = t_{68,.025} = 1.96

	6.3 Project Mana	gers	
Factor	Mean Regression Relative Weight	Variance	t
Cost-Benefit Ratio	.123	.011	62.258
Technical Merit	.245	.040	34.103
Resource Availability	.065	.005	72.381

70

TABLE XIV

	Comparisons	Between the Managers'	6.2 and 6.3 Models	Project	
Factor	6.2 X	6.2 Variance	6.3 X	6.3 Variance	t
Cost- Benefit Ratio	.089	.010	.123	.011	-1.549
Technica Merit	.286	.046	.245	.040	0.902
Resource Avail- ability	.065	.008	.065	.005	0.000
Likeli- hood of Success	.056	.003	.061	.006	0.244
Time leriod	.028	.001	.049	.003	2.419
Air Force	.475	.054	.457	.039	0.375

H_o: $\mu_{6,2} = \mu_{6,3} = 0$ where $\mu_{6,2}$ = mean regression relative

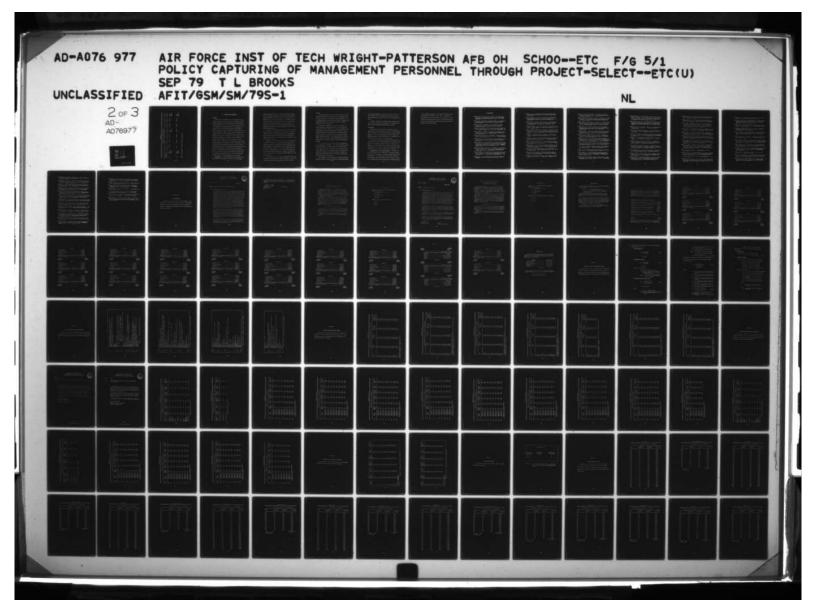


TABLE XV

			Results of Hypotheses Tests	Hypotheses	Tests			
Project H1	н	Н2	н3	7H	Н5	н6	Н?	н8
6.2	Pail to Reject	Re ject	Reject	Reject	Fail to Reject	Reject	Reject	Fail to Reject
6.3	Pail to Reject	N/A	Reject	Reject	Reject	Reject	Reject	Fail to Reject

NOTE: See Chapter I (pg 5) for the hypotheses.

V. Summary and Conclusions

Summary

The scope of this study was to investigate the possibility of using the policy capturing technique to model individual members of a large Mid-Western Air Force R&D Laboratory and determine if consensus existed among the levels of management and the divisions within the laboratory. so doing, eight specific hypotheses were investigated: first, to apply the policy capturing technique and determine if the models were linear; second, to see if internal consistency (R2) has any set pattern among the different management levels; third, to determine if each manager uses all available information in rendering a decision; fourth, to determine if all managers place the same weight upon the factors; fifth, to determine if each management level places the same weight upon the factors; sixth, to determine if each division places the same weight upon the factors; seventh, to measure the accuracy of an individual manager's subjective weight (distribution of 100 points over the six cues) as opposed to the regression weight (calculated relative weight for the six cues as a result of the decisions); and eighth, to determine if the managers of the 6.2 project formulate the same models as those managers of the 6.3 project.

Methodology. Of utmost importance was the identification process of the factors to be used in the instrument.

Through interviews by Drs. M.J. Stahl and Adrian M. Harrell with the laboratory managers, six factors were determined as the most important for the R&D project-selection decision making process. These factors were: 1) Cost-Benefit Ratio; 2) Technical Merit; 3) Resource Availability; 4) Likelihood of Success; 5) Time Period; and, 6) Air Force Need. A 3-factorial, orthogonally designed instrument was used with these factors representing the informational cues in the decision making exercise.

A total of 32 different R&D projects were rated with regard to approval or disapproval of the project for funding. Through the rating process of the project, the weights that each individual associated with the six factors were captured. Weight refers to the importance an individual places on that particular cue.

Results. The high internal consistency (R²) values were a positive indication of the successful use of the policy capturing technique in formulating the models for the individual managers. Approximately 63% of the simple model R²s for the 6.2 project and 65% of the simple model R²s for the 6.3 project were greater than .80. None of the individual simple models were eliminated from the study for either the 6.2 or 6.3 projects. The interactive model added very little to the analysis.

The R² values for the 6.2 project management levels did not have the set pattern as suspected; however, the R² values for the groups were as high as those of similar research efforts.

It was determined that all six factors that made up the decision making exercise were used by the individuals of the 6.2 and 6.3 projects. The t-values were indicative of the high significance associated with each factor. However, each individual manager did not weight the factors the same in either the 6.2 or 6.3 projects.

In the group comparisons, it was found that the 6.2 project management levels weighted all of the factors statistically the same, whereas the 6.3 project management levels weighted the factors statistically different. The key interest factors were Cost-Benefit Ratio, Technical Merit, and Air Force Need. Differences were noted among the management levels in relation to Cost-Benefit Ratio, Technical Merit, and Air Force Need. The other factors were not considered due to the small percent of the model accounted for by them.

The 6.2 project division level models were determined to be statistically different. The largest differences were noted with respect to Technical Merit and Air Force Need. The 6.3 project division models were also statistically different with respect to Cost-Benefit Ratio, Technical Merit, and Air Force Need as the major contributors. Again, the factors eliminated from the above discussion accounted for very little percent of the model.

The comparison of the individual subjective weights and regression weights resulted in significant differences among

the individual managers of both the 6.2 and 6.3 projects. This indicated that the managers as a whole were unable to correctly specify the models they used in R&D project-selection.

Finally, the average individual manager models of both the 6.2 and 6.3 projects were compared. The results indicated that the models were statistically the same.

Conclusions

The results of this study were supportive of policy capturing as a technique capable of modeling individual managers' responses in an R&D project-selection decision making exercise. All of the informational cues were used by the managers and were distinguishable across the management levels and divisions of the 6.2 and 6.3 projects.

The two most important conclusions were that there was not a consensus in the decision making process among the managers of the management levels of the 6.3 project, or the managers in the divisions of the 6.2 and 6.3 projects. Also, the managers of both projects did not use a decision making process exactly the same as that which they perceived.

Recommendations for Further Research. To attain more of a consensus within the laboratory, if laboratory management deems that advisable, a follow on research effort would be suggested. This effort would introduce the technique known as Delphi discussed extensively in Chapter II. Briefly, a desired decision making model should be made available

to the individual managers. An instrument similar to this one should be circulated to them. Then, the individual models should be formulated and the data analyzed. If this process is completed at least twice, a change should result in that the more recently formulated models should then resemble the publicized models.

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APPENDIX A

The Instrument

The cover letters, instructions, and demographic questions for 6.2 and 6.3 projects are included in this appendix followed by the R&D project-selection decision making exercise. The actual decision making section was used for the 6.2 and 6.3 projects.

DEPARTMENT OF THE AIR FORCE AIR FORCE FLIGHT DYNAMICS LABORATORY WRIGHT-PATTERSON AIR FORCE BASE, ONIO 45433



Office of the Commander

30 Mar 79

SUBJECT: R&D Project-Selection Decision Making Exercise

TO: AFFDL Management Personnel

- 1. R&D project decision making is a complex function. Many methods have been tried to provide a systematic approach to programming and budgeting. Recently, Capt Stahl from AFIT described a new decision modeling process called policy capturing which is based upon information obtained from the decision makers themselves. I have asked Capt Stahl and one of his students, Capt Brooks, to devise such a model for AFFDL. You can provide the information they need by completing the attached "instrument." But first, a brief explanation. Making decisions to accept or to turn down a proposed R&D program involves a combination of factors and judgements based upon expectations which cannot be verified at the time. The uncertainty surrounding these decisions is not unique to R&D. For example, supervisors must make decisions about promotions and hiring, and loan officials in banks must recommend acceptance or denial of loan applications. Policy capturing was devised and applied with success in determining the relative importance of the key factors used for promotions and making loans by certain organizations. The possibility for using policy capturing as a tool to better understand R&D program decision making is being explored with this exercise.
- 2. The measurements will be based on an AFIT-developed decision making exercise (instrument) that takes approximately 15 minutes to complete. Using data already obtained from laboratory managers, the exercise was designed specifically for management personnel whose position requires R&D program selection decision making. The exercise is composed of two parts. The first part of the exercise requires you to identify your level of management so that decision models may be formulated for these levels. The second part involves 32 management decisions. Each decision should be answered with your best opinion.
- 3. Your participation is strictly voluntary. If you put your name on the exercise, you will be provided the decision model formulated from your responses. A specific coding system will be used to identify the decision models and the thesis student and his advisor will be the only ones who know the code.

4. When you have completed the exercise, place it in the addressed envelope provided and drop it into base mail. A high response rate is needed to build a representative decision model. Thank you for your response.

KEITH I. COLLIER Deputy Director l Atch Questionnaire

POR CANADEMENT PERSONNEL IN THE AIR FORCE FLIGHT DIMANICS LABORATORY

THIS IS NOT A EXPLICITABLE. It is a project-selection decision making exercise to investigate how managers make certain 6.2 project-selection decisions. The data collected will support a research effort requested by the AFFOL and a master's thesis at the Air Force Institute of Technology but you will not be identified in the final report. Your cooperation is, therefore, sincerely requested. Your input to this research will be kept strictly confidential.

The exercise is divided into two sections. Jection I involves two questions referring to your organizational level and Jection II involves project-selection decisions with respect to several attributes. Inereare no "correct" or "incorrect" answers so please respond as candidly as possible. The information provided by you and other respondents will be combined to statistically test hypotheses about how information is used by management personnel in the AFFDL to make certain project-selection decisions. The instrument appears to be lengthy, however, we are only asking you to make 32 decisions.

ALL EXAMPLE PROJECTS ARE 6.2 PROJECTS

If you would like to receive information about your overall response as compared with those of your contemporaries, please print your name and address in the space provided at the end of the exercise. A summary comparison will be mailed to you in confidence after completion of the study (September 1979).

Flease return your completed exercise to AFIT/ENG (Capt. Brooks) via base distribution. A return envelope is enclosed for your convenience. Thank you.

I. ORGANIZATIONAL LEVEL

Flease indicate your organizational level by checking the appropriate space provided:
Command Section(CC, CD, CA)
Staff
Division Office
Branch
Group
Please check your two letter divisional symbol:
FX
FG
FE
F3

DEPARTMENT OF THE AIR FORCE AIR FORCE FLIGHT DYNAMICS LABORATORY WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433



Office of the Commander

16 MAY 1979

SUBJECT: 6.3 Project Selection Policy

TO: AFFDL Management Personnel

- 1. Recently, some of the management personnel within AFFDL participated in a research effort sponsored by Capt Stahl and one of his thesis students, Capt Brooks, from AFIT. This study has involved the use of a new decision making process called "policy capturing." With the completion of phase I of the study we determined that AFFDL managers probably use a simple decision making model for the project-selection of 6.2 programs. The results so far have indicated that there is no difference in the models among the management levels (Command Section, Staff, Division, Branch, and Group); however, there was a significant difference in the models among the specific divisions (FX, FG, FE, and FB). The second and final phase of this research involves formulating models for 6.3 projects. You can provide the information needed by completing the attached exercise or instrument.
- 2. The decision making exercise is very similar to the form used for 6.2 projects. The exercise is composed of two parts. The first part of the exercise requires you to identify your level of management so that decision models may be formulated for these levels. The second part involves 32 management decisions. Each decision should be answered with your best opinion.
- 3. Your participation is strictly voluntary. If you put your name on the exercise, you will be provided the decision model formulated from your responses. Your model identification will remain completely anonymous to other individuals in the AFFDL.
- 4. When you have completed the exercise, place it in the addressed envelope provided and drop it into base mail. I am especially interested in Phase II due to the significant results provided thus far by Phase I. Thank you for your response.

KEITH I. COLLIER Deputy Director

l Atch Decision Making Exercise

A PROJECT-SELECTION DECISION MAKING EXERCISE POR MANAGEMENT PERSONNEL IN THE AIR FORCE FLIGHT DYNAMICS LABORATORY

THIS IS NOT A QUESTIONNAIRE. It is a project-selection decision making exercise to investigate how managers make certain 6.3 project-selection decisions. The data collected will support a research effort requested by the AFFDL and a master's thesis at the Air Force Institute of Technology, but you will not be identified in the final report. Your cooperation is, therefore, sincerely requested. Your input to this research will be kept strictly confidential.

The exercise is divided into two sections. Section I involves two questions referring to your organizational level and Section II involves project-selection decisions with respect to several attributes. There are no "correct" or "incorrect" answers so please respond as candidly as possible. The information provided by you and other respondents will be combined to statistically test hypotheses about how information is used by management personnel in the AFFDL to make certain project-selection decisions. The instrument appears to be lengthy, however, we are only asking you to make 32 decisions.

ALL EXAMPLE PROJECTS ARE 6.3 PROJECTS

If you would like to receive information about your overall response as compared with those of your contemporaries, please print your name and address in the space provided at the end of the exercise. A summary comparison will be mailed to you in confidence after completion of the study (September 1979).

Please return your completed exercise to AFIT/ENS (Capt. Brooks) via base distribution. A return envelope is enclosed for your convenience. Thank you.

I. ORGANIZATIONAL LEVEL

Flease	indica	te your organizational level by checking the
appropr	riate e	pace provided,
		Command Section(CC, CD, CA)
		Staff
		Division Office
		DEFEM
		ADFO
Please	check	your two letter divisional symbol, if applicable:
		FX
		FG
		FE
		FB

PRIVACY STATEMENT

In accordance with paragraph 30, APR 12-35, the following information is provided as required by the Privacy Act of 1974:

- a. Authority
 - (1) 4 U.S.C. 301, Departmental Regulations: and/or
 - (2) 10 U.S.C. 80-12, Secretary of the Air Force, Powers and Duties, Delegation by.
- b. Principal purposes. The survey is being conducted to collect information to be used in research simed at illuminating and providing inputs to the solution of problems of interest to the Air Porce and/or DOD.
- c. Routing Uses. The survey data will be converted to information for use in research of management related problems. Results of the research based on the data provided, will be included in written Master's thesis and may also be included in published articles, reports, or texts. Distribution of the results of the research, based on the survey data, whether in written form or orally presented, will be unlimited.
 - d. Participation in this survey is entirely voluntary.
- e. No adverse action of any kind may be taken against an individual who elects to participate in any or all of this survey.

II. FROJECT-SELECTION DECISION MAKING EXERCISE INSTRUCTIONS

This section consists of a project-selection decision making exercise. During the exercise, you should assume that you are responsible for recommending or disapproving projects. The only real differences in these projects are the extent to which six key attributes are involved with each of the projects. Assume the projects do not differ on other attributes.

These six attributes are described as ADEQUATE or EXTENSION. For this exercise ADEQUATE means "BARBLY REETS RIVINALLY ACCEPTABLE VALUE OR REQUIREMENT." EXCELLENT means "CONDIDERABLY BETTER THAN RIVINALLY ACCEPTABLE VALUE OR REQUIREMENT." A sample project is shown below.

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	technical s	uccess, giv	en its planne	d time v	acceptable value or require-
Time Feriod.					ment will
complete this	s project is				presented nere.)
lished that capability p	an actual Ai	r Force nee	for the tec	hnical	
	your recomm			val or disapprov	al of
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Strongly Recommend					Strongly
Disapproval					Approval
Van about 4 sim	-1				

You should circle the number that best indicates your recommendation for this particular project. Yake each decision one at a time and independently of the others. Do not change a decision once you have made it. York at a brisk pace, but don't hurry your decisions. Complete EVERY case. as each case is DIFFERENT.

FROJECT #1

PROJECT #3 COST-BENEFIT RATIO											
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A FINAL DECISION

Please indicate the relative importance you believe you placed upon the six attributes during the exercise by distributing 100 points among these criteria. The most important attribute, as you perceive it, will receive the most points, and so on.

ATTRIBUTES		ASSIGNED POINTS
COST-BENEFIT RATIO		
TECHNICAL MERIT		
RESOURCE AVAILABILITY .		
LIKELIHOOD OF SUCCESS .		
TIME PERIOD		
AIP PORCE NEED		
	Total Points.	100
Again, thank you for yo	ur participation. Remem	mber, if you desire
a summary comparison mailed	to you, just print your	name and address here:

APPENDIX B

Procedures of the Experimental Design

This appendix includes the equations used for measuring internal consistency and determining whether to use the simple or the interactive model for the data analysis (also includes the structure of the simple and interactive model).

- A. These equations were used for the F-test to determine the significance of R²:
 - 1. Simple Model, R2

$$P_0 = \frac{(n-k-1)R^2}{k(1-R^2)}$$
 (B-1)

$$\sim F_{k,n-k-1}$$

2. Interactive Model. R2

$$F_0 = \frac{(n-k-1)R^2}{k(1-R^2)}$$
 (B-2)

$$\sim F_{k,n-k-1}$$

where in both equations

n = number of decisions (32)

k = number of predictor variables (6
 for the simple model; 21 for the
 interactive model)
 (Jones, et al., 1976:133-134)

NOTE: In each of the above equations, R^2 is the unknown.

3. Interactive versus Simple Model

$$P_{o} = \frac{(R_{I}^{2} - R_{S}^{2})(n - k_{I} - 1)}{(k_{I} - k_{S})(1 - R_{I}^{2})}$$
(B-3)

where

n = number of decisions (32)

k_I = number of predictor variables in the interactive model (21) k_S = number of predictor variables in the simple model (6)

 R_{I}^{2} = the R^{2} of the individual's interactive model

 $R_{I}^{2}-R_{S}^{2}$ = the maximum difference between R_{I}^{2} and R_{S}^{2} for which the simple model remains significant

NOTE: R_I^2 is different for each individual.

B. This equation was used for the t-test to determine if a difference existed between the two formulated models (6.2 versus 6.3):

$$T = \frac{(\overline{Y}_1 - Y_2) - (\mu_1 - \mu_2)}{s \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$
(B-4)

where

Y
1 = the sample mean relative weight for a particular factor in the 6.2 programs

Y₂ = the sample mean relative weight for a particular factor in the 6.3 programs

 the population mean relative weight for a particular factor in the 6.2 programs

μ₂ = the population mean relative weight
for a particular factor in the 6.3
programs

n₁ = the number in the sample population of the 6.2 programs

n₂ = the number in the sample population of the 6.3 programs

$$S = \frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}$$
 (B-5)

S_i = the sample variance for the ith sample (Mendenhall and Scheaffer, 1973:285-287)
123

NOTE: $\mu_1 - \mu_2 = 0$ for the test used

- C. The general structure of the Simple and Interactive Models was:
 - 5. Simple Model

$$Y_{i} = \beta_{0} + \beta_{1}X_{i1} + \beta_{2}X_{i2} + \beta_{3}X_{i3} + \beta_{4}X_{i4} + \beta_{5}X_{i5} + \beta_{6}X_{i6}$$
 (B-6)

6. Interactive Model

$$Y_{i} = \beta_{0} + \beta_{1}X_{i1} + \beta_{2}X_{i2} + \beta_{3}X_{i3} + \beta_{4}X_{i4} + \beta_{5}X_{i5}$$

$$+ \beta_{6}X_{i6} + \beta_{7}X_{i1}X_{i2} + \beta_{8}X_{i1}X_{i3} + \beta_{9}X_{i1}X_{i4}$$

$$+ \beta_{10}X_{i1}X_{i5} + \beta_{11}X_{i1}X_{i6} + \beta_{12}X_{i2}X_{i3}$$

$$+ \beta_{13}X_{i2}X_{i4} + \beta_{14}X_{i2}X_{i5} + \beta_{15}X_{i2}X_{i6}$$

$$+ \beta_{16}X_{i3}X_{i4} + \beta_{17}X_{i3}X_{i5} + \beta_{18}X_{i3}X_{i6}$$

$$+ \beta_{19}X_{i4}X_{i5} + \beta_{20}X_{i4}X_{i6} + \beta_{21}X_{i5}X_{i6}$$

$$+ \beta_{19}X_{i4}X_{i5} + \beta_{20}X_{i4}X_{i6} + \beta_{21}X_{i5}X_{i6}$$

$$(B-7)$$

where for both models

X_{il} = Cost-Benefit Ratio predictor variable

X₁₂ = Technical Merit predictor variable

X₁₃ = Resource Availability predictor variable

X_{i4} = Likelihood of Success predictor variable

X; 5 = Time Period predictor variable

X;6 = Air Force Need predictor variable

 $x_{i1}x_{i2}$

Two-Way Interactive predictor variables

X15X16

β_i = beta weight for the ith predictor variable

APPENDIX C

FORTRAN Regression Analysis Program

A complete copy of the regression analysis program used to generate the \mathbb{R}^2 s, Beta Weights, and Relative Weights from the individual decision responses is included in this appendix.

Pigure C-1. FORTRAN Regression Analysis Frogram

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1 "OUTFUT FORMAT STATEMENT IS! ",8A10
READ FACTOR CODING, ONE CARD FOR EACH DECISIONS, THE FIRST NF
COLUMNS OF EACH CARD CONTAIN ONE-ZERO CODING FOR EACH FACTOR
FOR THAT DECISION, THERE MUST BE ND CARDS IN ALL.
                                                                                                                                                                                                                                                                                               RECODE X() TO +1/-1 FORMAT TO YIELD ZERO MEANS
DO 300 1=1,ND
DO 300 J=1,NP
IF(XX(I,J).Eq.0.) X(I,J)=-1.0
IF(XX(I,J).Eq.1.0) X(I,J)=1.0
IF(XX(I,J).Eq.1.0) X(I,J)=1.0
IF(XX(I,J).Eq.-1.0.OR.X(I,J).Eq.1.0) GO TO 300
IF(X(I,J).Eq.-1.0.OR.X(I,J).Eq.1.0) GO TO 300
IF(XXII.J).Eq.-1.0.OR.X(I,J).Eq.1.0) GO TO 300
                                                                                                                                                 READ 20, (XX(I,J),J=1,NM)

FORMAT(21F1.0)

IP(EOP(5LINFUT).Eq.0) GO TO 200

PRINT *,"INSUFFICIENT FACTOR-CODING CARDS, NEEDED ",ND
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DO 500 I=1,NF

DO 400 J=1,NF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              PRINT 40, (B(JJ), JJ=1, NP)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             B(J)=B(J)+X(K,I \bullet X(K,J)
                                                                                                                           DO 200 I=1,ND
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    DO 400 K=1,ND
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   PRINT 30
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Figure C-1 (cont.). PORTRAN Regression Analysis Program

```
SIGY=SQRT((SIGY-(YBAR**2)/ND)/(ND-1.0))
YBAR=YBAR/ND
COMPUTE COEFFICIENTS, STANDARDIZE THEM, ACCUMULATE R**2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            PRINT AND WRITE RESULTS TO TAPE - THEN GET NEXT CASE
                           CALCULATE CONSTANTS TO USE IN COEFF. GENERATION XPXINV=1.0/ND SIGX=SQRT(ND-1.0))
SIGX=SQRT(ND-1.0))
PROCESS ONE CASE
CALCULATE MEAN AND VARIANCE OF Y'S, THE DECISIONS READ(1,FMT) (DEMO(J),J=1,NC),(Y(J),J=1,ND),CASE IF(EOF(1).NE.0) GO TO 2000
                                                                                                                                                                                                                                                                                                                                                                                                                                                COMPUTE RELATIVE WEIGHTS
                                                                                                                                                                                                                                                                                                                                                                                               B(J)=XFXINV*B(J)*SIGRAT
RSQ=RSQ+B(J)**2
                                                                                                                                                                                                                                                                                                                                 B(J)=0.

DO 700 I=1,ND

B(J)=B(J)+X(I,J)•Y(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                              DO 900 J=1,NF
REL(J)=B(J)**2/RSQ
PORMAT(1H0,21F6.2)
                                                                                                                                                                       DO 600 I=1,ND
YBAR=YBAR+Y(I)
SIGY=SIGY+Y(I) **2
                                                                                                                                                                                                                                                                                                   SIGRAT=SIGX/SIGY
DO 800 J=1,NP
                                                                                                                                                                                                                                                                                                                                                                                   CONTINUE
              CONTINUE
                                                                                                                                                                                                                       CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CONTINUE
                                                                                                                                                       SIGY=0.
                                                                                                                                         YBAR=0.
                                                                                                                                                                                                                                                                                     RSQ=0.
                                                                            550
2000
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              006
                                                                                                                                                                                                                       9009
                                                                                                                                                                                                                                                                                                                                                                                 700
                                                                                                                                                                                                                                                                                                                                                                                                                                 800
                                                                                                                                                                                                                                                                        O
```

Figure C-1 (cont.). FORTRAN Regression Analysis Program

```
WRITE OPTIONAL EXPANDED FILE IP REQUESTED

IP(IOUT.EQ.O) GO TO 550

DO 1000 I=1,ND

WRITE(2,FMT2) (DENO(J),J=1,NC),(XX(I,J),J=1,NM),Y(I),SIGY,RSQ,

(B(J),J=1,NP),(REL(J),J=1,NF),CASE

CONTINUE
                                                              FORMAT(1H1, "CASE YBAR SIGY RSQ",

"BETA WEIGHTS FOLLOWED BY RELATIVE WEIGHTS"/)

PRINT 60, CASE, YBAR, SIGY, RSQ,

(B(J), J=1, NP), (REL(J), J=1, NF)

FORMAT(1H, A10, 3F7, 3/4x, 6F7, 3/4x, 15F7, 3/4x, 6F7, 3/4x, 15Fy, 3/)
IF(NL.LT.51) GO TO 950
PRINT 55
                                                                                                                                                                                                                                                                                                                                   GO TO 550
END OF PROCESSING
                                                                                                                                                                                                                                                                                                                                                                                CONTINUE
                                                                                                                                                                            NI-NI+1
                                                                                                                                                                                                                                                                                                                                                                                                        STOP
                                                                                                                                                                                                                                                                                                                 1000
                                                                                                                                                                                                                                                                                                                                                          2000
                                                                                                             950
```

Figure C-1 (cont.), PORTRAN Regression Analysis Program

APPENDIX D

Simple Versus Interactive Model

This appendix includes a tabulation of the results of equation B-3 in determining whether the simple or the interactive model is more representative of the population for both the 6.2 and 6.3 projects.

Case	Simple RS	Interactive R1	$R_{\rm I}^2 - R_{\rm S}^2$ (Actual)	$\Delta_{R_{\underline{I}}^2 - R_{\underline{S}}^2}$ (Calculated)
001	459.	.887	.233	.483
002•	.895	066.	560.	.043
600	.835	768.	,062	077.
700	.862	.922	090.	.334
500	.759	668.	.140	.432
900	.895	.953	.058	.201
200	468.	196.	.070	.154
900	.892	956.	1790.	.188
600	.930	.980	.050	.085
010	.627	.876	.249	.530
011	.877	076.	.063	.257
012	.882	456.	.072	.198
013	.891	.952	190.	.205
014.	.793	696.	.176	.133
015	686.	566.	900.	.021
016	626.	686	.010	240

* Indicates Significant Interactive Model

TABLE XVI (cont.)

Case Simple Interactive $R_{1}^{2} - R_{5}^{2}$ (Actual) (Calculated) 017* 875 .957 .082 .061 018* .982 .992 .010 .034 019* .515 .693 .178 .1313 020 .806 .913 .107 .372 021 .739 .946 .207 .213 022 .748 .870 .082 .094 024 .877 .966 .089 .145 025 .928 .985 .057 .064 026 .928 .865 .177 .577 027 .028 .896 .090 .308 030 .838 .928 .090 .308 031 .703 .883 .180 .500		Simple Versus	Simple Versus Interactive Model (6.2 Projects)	. (6.2 Projects)	
. 875	Case Case	Simple RS	Interactive RI	$R_{\rm I}^2 - R_{\rm S}^2$ (Actual)	$\triangle_{R_{I}^{2}-R_{S}^{2}}^{2}$ (Calculated)
. 982 992 010 . 515 . 693 178 . 806 913 107 . 739 946 207 . 896 978 082 . 970 977 089 . 928 985 057 . 986 865 177 . 988 988 . 928 090 . 977 988 . 988 011	017*	.875	.957	.082	.061
. 515 . 693 178 . 806 913 107 . 739 946 207 . 748 870 122 . 896 978 089 . 900 977 077 . 928 985 057 . 688 865 177 . 938 938 . 703 883 180	018	.982	. 992	.010	460.
.806 .913 .107 .739 .946 .207 .748 .870 .122 .896 .978 .082 .900 .977 .077 .928 .985 .057 .865 .057 .873 .986 .011 .838 .928 .090	019.	.515	.693	.178	1.313
.739 .946 .207 .748 .870 .122 .896 .978 .082 .900 .977 .077 .928 .985 .057 .873 .953 .080 .977 .988 .011 .838 .928 .090 .703 .883 .180	020	.806	.913	.107	.372
. 748 870 122	021	.739	946.	.207	.231
.896 .978 .082 .877 .966 .089 .928 .985 .077 .688 .865 .057 .873 .953 .080 .977 .988 .011 .838 .928 .090	022	842.	.870	.122	.556
. 966	023	968.	.978	.082	760.
.900 .977 .077 .928 .985 .057 .688 .865 .177 .977 .988 .080 .977 .988 .011 .838 .928 .090	024	.877	996.	680.	.145
.928 .985 .057 .688 .865 .177 .873 .953 .080 .977 .988 .011 .838 .928 .090 .703 .883 .180	025	006.	.977	.077	860.
.688 .865 .177 .873 .953 .080 .977 .988 .011 .838 .928 .090 .703 .883 .180	026	.928	.985	.057	790.
.977 .988 .011 .977 .988 .011 .838 .928 .090	027	.688	.865	.177	.577
.977 .988 .011 .838 .928 .090 .703 .883 .180	028	.873	.953	.080	.201
.838 .928 .090 .703 .883 .180	029	776.	.988	.011	.051
.703 .883 .180	030	.838	.928	060.	.308
	031	.703	.883	.180	.500

* Indicates Significant Interactive Model ** Indicates Interactive Model Is Not Statistically Different From Zero *** Refer to Appendix 5, equation 8-3

	Simple Versus	Simple Versus Interactive Model (6.2 Projects)	(6.2 Projects)	
C Bse	Simple RS	Interactive R _I	$R_{\rm I}^2 - R_{\rm S}^2$ (Actual)	$\Delta_{R_{I}^{2}-R_{S}^{2}}^{2-R_{S}^{2}}$ (Calculated)
032	.885	826.	. 093	760.
033.	.602	.841	.239	.795
034	.784	876.	.164	.222
035	669.	.855	.156	.620
036	768.	676.	.052	.218
037	.887	. 932	540.	.291
038	.713	.878	.165	.522
039.	.836	.971	.135	.124
040	.983	.988	500.	.051
041	.871	696.	860.	.133
045*	.867	486.	.117	890.
043	.782	.930	.148	.299
7170	.857	466.	.077	.282
540	.752	.889	.137	.475
940	.733	.862	.129	.590

* Indicates Significant Interactive Model ** Indicates Interactive Model Is Not Statistically Different From Zero *** Refer to Appendix B, equation B-3

TABLE XVI (cont.)

	Simple Versus	Simple Versus Interactive Model (6.2 Projects)	(6.2 Projects)	
S 88	Simple RS	Interactive R1	$R_{\rm I}^2 - R_{\rm S}^2$ (Actual)	$\Delta_{R_1^2-R_5^2}$ (Calculated)
240	898	466.	.036	.282
840	.987	.992	500.	.034
•640	546.	.953	.208	.200
050	.792	. 931	.139	.295
051	.925	.970	540.	.128
052**	.530	.755	.225	1.047
053	869.	.913	.215	.372
750	162.	.928	.134	.308
055	686.	686.	000.	240.
950	.898	.962	190.	.163
057	.818	.934	.116	.282
058**	.371	.681	.307	1.363
•650	.817	.978	.161	760.
090	.737	.910	.173	.385
061	.950	026.	.020	.128

Indicates Significant Interactive Model
 Indicates Interactive Model Is Not Statistically Different From Zero
 Refer to Appendix B, equation B-3

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TABLE XVI (cont.)

	Simple Vers	Simple Versus Interactive Model (6.2 Projects)	1 (6.2 Projects)	
C as se	Simple R2 RS	Interactive RI	$R_{\rm I}^2 - R_{\rm S}^2$ (Actual)	$\Delta_{R_{I}^{2}-R_{S}^{2}}^{2}$ (Calculated)
062	.735	676.	.214	.218
••€90	. 552	.821	.269	.765
1790	.867	.929	.062	.304
590	.838	.942	.104	.248
990	606.	.950	670.	.214
290	. 843	.920	.077	.342
890	.929	956.	.027	.188
690	1.000	1.000	000.	000.

** Indicates Interactive Model Is Not Statistically Different From Zero *** Refer to Appendix B, equation B-3

		THE RESIDENCE AND PARTY AND PERSONS ASSESSED.	THE RESERVE AND ADDRESS OF THE PERSON NAMED IN COLUMN 2 IS NOT THE OWNER.	
C 28 60	Simple RS	Interactive R _I	$R_{\rm I}^2 - R_{\rm S}^2$ (Actual)	$\triangle_{R_{I}^{2}-R_{S}^{2}}^{2}$ (Calculated)
001	.926	996.	040.	.145
202	979.	968.	.250	544.
5003	.781	. 933	.152	.286
700	906.	. 965	.059	.150
500	.897	026.	.073	.128
900	.938	.978	040.	760.
200	.767	.914	.147	.368
908	.808	.857	640.	.611
600	.924	956.	.032	.188
010.	.934	.989	.055	640.
011	.916	.982	990.	.077
012	996.	.975	600.	.107
013	.717	206.	.190	.398
014	.920	486.	₹90.	890.
015	956.	.980	420.	980.
016	.826	000	103	304

* Indicates Significant Interactive Model *** Refer to Appendix B, equation B-3

TABLE XVII (cont.)

Case Simple Interactive $R_{1}^{2} - R_{2}^{2}$ (Actual) (Calculated) 17 .756 .916 .160 .359 1844 .215 .657 195 .962 .969 .277 .133 195 .962 .965 .165 22 .967 .973 .057 .115 22 .766 .914 .148 .368 22 .768 .997 .907 .119 .398 22 .860 .949 .099 .218 22 .860 .941 .015 .252 22 .926 .941 .015 .252 23 .926 .942 .000 .034 23 .927 .067 .119 .252 24 .927 .067 .132 25 .926 .941 .015 .252 26 .941 .015 .252 27 .000 .034 28 .992 .992 .004 .015 .252 28 .992 .992 .000 .034 29 .992 .992 .000 .034 29 .992 .992 .000 .034 29 .992 .992 .000 .034 29 .992 .992 .000 .034 29 .992 .992 .000 .034 29 .992 .992 .000 .034 29 .992 .000 .034 20 .992 .000 .034 20 .992 .000 .034 20 .992 .000 .034 20 .992 .000 .034 20 .992 .000 .034		Simple Versus	Simple Versus Interactive Model (6.3 Projects)	(6.3 Projects)	
. 916 . 969 . 844 . 962 . 973 . 973 . 974 . 914 . 981 . 949 . 949 . 940 . 962 . 962 . 963 . 964 . 965 . 966 . 966	C 28 S G	Simple RS	Interactive R _I	$R_{\rm I}^2 - R_{\rm S}^2$ (Actual)	$\Delta_{R_{I}^{2}-R_{S}^{2}}^{2-R_{S}^{2}}$ (Calculated)
. 692 969 277	017	.756	.916	.160	.359
. 629 . 844215 . 907962055 . 916973057 . 766914148 . 763891128 . 860907119 . 860949067 . 980949015 . 992043 . 652883231 . 907043 . 928941015 . 949962044	018*	.692	696.	.277	.133
.907 .962 .055 .916 .973 .057 .766 .914 .148 .763 .891 .128 .860 .907 .119 .860 .927 .067 .850 .949 .069 .926 .941 .015 .926 .942 .009 .926 .962 .043 .652 .883 .231	019**	.629	. 844	.215	.667
.916 .973 .057 .766 .914 .148 .763 .891 .128 .788 .907 .119 .860 .927 .067 .850 .949 .099 .926 .941 .015 .932 .000 .919 .962 .043 .652 .883 .231	020	206.	.962	.055	.162
.766 .914 .128 .763 .891 .128 .788 .907 .119 .860 .927 .067 .850 .949 .099 .926 .941 .015 .992 .962 .000 .919 .962 .043 .652 .883 .231 .922 .947	021	.916	.973	.057	.115
.763 .891 .128 .788 .907 .119 .860 .927 .067 .850 .949 .099 .926 .941 .015 .992 .000 .919 .962 .043 .652 .883 .231	022	992.	.914	.148	.368
.788 .907 .119 .860 .927 .067 .850 .949 .099 .926 .941 .015 .992 .992 .000 .919 .962 .043 .652 .883 .231	023	.763	.891	.128	994.
.860 .927 .067 .850 .949 .099 .926 .941 .015 .992 .992 .000 .919 .962 .043 .652 .883 .231 .922 .969	024	.788	.907	.119	.398
.850 .949 .099 .926 .941 .015 .992 .992 .000 .919 .962 .043 .652 .883 .231 .922 .969 .047	025	.860	.927	.067	.312
.926 .941 .015 .992 .992 .000 .919 .962 .043 .652 .883 .231 .922 .969 .047	026	.850	676.	660.	.218
.992 .992 .000 .919 .962 .043 .652 .883 .231 .922 .969 .047	027	.926	.941	.015	.252
.919 .962 .043 .652 .883 .231 .922 .969 .047	028	.992	.992	000.	£0°
.652 .883 .231	029	.919	.962	.043	.162
. 922 . 969 . 047	030	.652	.883	.231	.500
	031	.922	696.	240.	.132

* Indicates Significant Interactive Model ** Indicates Interactive Model Is Not Statistically Different From Zero *** Refer to Appendix 3, equation B-3

APPENDIX E

Code Assignment Letters and Feedback

This appendix includes a copy of the letters used to assign the specific code to the model associated with those individuals who requested feedback and the results of the 6.2 and 6.3 individual and group models.

DEPARTMENT OF THE AIR FORCE AIR FORCE INSTITUTE OF TECHNOLOGY (ATC) WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433



ATTH OF ENS

10

R&D Project-Selection Decision Making Exercise (6.2 Programs)

- 1. The response rate for this decision making exercise was excellent. The preliminary results indicated that all of the individuals who completed the instrument were consistent in their decision making process. In other words, the model formulated for each individual was statistically significant.
- 2. I have assigned a specific code to each individual who requested feedback concerning his model. Your personal code is ____. This code should be retained to identify your specific model when the final analysis is completed.
- 3. Again, thank you for your efforts. I plan to send you the final results of the decision making exercise in the near future (NLT August 1979).

TERRY L. BROOKS, Capt, USAF Graduate Student, GSM-79S School of Engineering

DEPARTMENT OF THE AIR FORCE AIR FORCE INSTITUTE OF TECHNOLOGY (ATC) WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433



ATTH OF

ENS

.....

R&D Project-Selection Decision Making Exercise (6.3 Programs)

1. Thank you for completing the 6.3 program instrument. The response rate was better than the rate for the 6.2 program. The preliminary results indicated that each individual was consistent in the decision making process. All individual models formulated were statistically significant.

- 2. I have assigned a specific code to each individual who requested feedback concerning his model. Your personal code is _____. This code should be retained to identify your specific model when the final analysis is completed.
- 3. Again, thank you for your cooperation. The final results will be sent out by the middle of August 1979.

Jemy & Brooks, Capt, USAF Graduate Student, GSM-79S School of Engineering

TABLE XVIII

	Page 196	יימיומר המוני דכיני מיות דודינים וויימים מיות המיותר		7.01	100000000000000000000000000000000000000	
Regression Group	Cost- Benefit Ratio	Technical Merit	Resource Avail- ability	Likeli- hood of Success	Time Period	Air Force Need
Entire Laboratory	•690.	.305	540.	. 043	.017	. 522
Command	260.	.319	.001	650.	.030	767.
Staff	.104	.289	.081	240.	. 042	.439
Division	.052	.326	. 041	.020	.011	.551
Branch	.043	.293	640.	.058	.015	. 547
Group	.081	.310	. 041	.037	.015	.517
Entire Division Population	790.	,306	.042	.042	.015	.532
PX Division	.055	. 441	240.	.030	.018	604.
	P. D. Carrier	44-1-2	1-1-1-6			

· Regression Relative Weights

TABLE XVIII (cont.)

	Manage	Management Level and Division Models (6.2 Projects)	nd Division	Models (6.2	Projects)	
Regression Group	Cost- Benefit Ratio	Technical Merit	Resource Avail- ability	Likeli- hood of Success	Time Period	Air Porce Need
PG Division	• 1/80.	. 325	.053	.070	.017	.451
FE Division	.072	.117	. 022	.016	.008	992.
PB Division	.038	.236	.038	.061	.010	.618
	· Regressi	Regression Relative Weights	Veights			

		Indivi	Individual Models (6.2 Projects)	s (6.2 Pro	jects)		
Case	Type	Cost- Benefit Ratio	Technical Merit	Resource Avail- ability	Likeli- hood of Success	Time Period	Air Force Need
001	Regression Subjective	.226	.115	.029	.074	760.	.462
200	Regression Subjective	.163	.163	.007	.016	.010	.572
600	Regression Subjective	.002	.556	875!	000.	.017	.377
700	Regression Subjective	.126	.220	2447	680.	.107	.010
500	Regression Subjective	.15	.439	.027	.001	.020	.504
900	Regression Subjective	.034	. 522	.000	.102	.034	.307
200	Regression Subjective	.046	. 545	.010	.022	.03	.334
800	Regression Subjective	.20	.382	.020	.001	.013	.30

Regression Relative Weights
 Subjective Weights

TABLE XIX (cont.)

		Indivi	Individual Models (6.2 Projects)	s (6.2 Pro	jects)		
Case	Type Model	Cost- Benefit Ratio	Technical Merit	Resource Avail- ability	Likeli- hood of Success	Time Period	Air Force Need
600	Regression Subjective	.013	.388	.10	.020	.027	. 525
010	Regression Subjective	.027	.197	.044	.123	.014	.595
011	Regression Subjective	.000	.496	.048	.039	.10	.320
012	Regression Subjective	.001	.010	.018	.073	.000	.50
013	Regression Subjective	.020	.139	.10	.014	.10	.30
014	Regression Subjective	.249	.383	.090	.048	.020	.30
015	Regression Subjective	.030	.40	.030	.078	.007	.20
910	Regression Subjective	.007	.003	.002	.000	.002	.970
	+ of od not accompany		Wo tohto				

Regression Relative Weights
 Subjective Weights

TABLE XIX (cont.)

			Individual Models (6.2 Projects)	s (6.2 Pro	jects)		
Case	Case Type Case Model F	Cost- Benefit Ratio	Technical Merit	Resource Avail- ability	Likeli- hood of Success	Time	Air Porce Need
017	Regression Subjective	.037	.066	.102	.066	.037	.693
018	Regression Subjective	.008	.921	.10	.005	.015	.044
019	Regression Subjective	.20	669.	.025	.003	.000	.273
050	Regression Subjective	.169	.127	.091	.091	.012	605.
021	Regression Subjective	.428	.154	.112	.026	.076	.203
022	Regression Subjective	.046	.200	.15	.013	.000	.30
023	Regression Subjective	.024	.20	.012	.069	.10	.491
420	Regression Subjective	.20	.25	.008	.057	.019	.413

* Regression Relative Weights

TABLE XIX (cont.)

		Indivi	Individual Models (6.2 Projects)	8 (6.2 Pro	jects)		
C # 8 e	Type Model	Cost- Benefit Ratio	Technical Merit	Resource Avail- ability	Likeli- hood of Success	Time	Air Porce Need
025	Regression Subjective	.117	.152	.040	.031	.031	.627
920	Regression Subjective	.378	.102	.030	.267	500.	.218
526	Regression Subjective	.149	.20	\$05.	.001	.10	.553
028	Regression Subjective	.113	.366	.085	.085	.085	.266
620	Regression Subjective	.018	.30	.229	.10	.10	.255
030	Regression Subjective	.002	.088	.002	.179	.016	.714
031	Regression Subjective	.003	.210	.007	.026	.012	.743
032	Regression Subjective	.025	.349	.042	.001	.007	.30
	• Regression	Relative	Weights				

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TABLE XIX (cont.)

		Indivi	Individual Models (6.2 Projects)	s (6.2 Pro	jects)		
Case	Type Model	Cost- Benefit Ratio	Technical	Resource Avail- ability	Likeli- hood of Success	Time Period	Air Porce
033	Regression Subjective	.059	.059	.015	.000	2007	.862
250	Regression Subjective	.000	.222	.037	.110	.015	.30
035	Regression Subjective	.108	.155	.039	990.	.108	.522
980	Regression Subjective	.028	.519	.151	.021	.010	.272
037	Regression Subjective	.136	.251	.215	.001	.020	.378
038	Regression Subjective	.088	.088	.198	.002	.000	.624
039	Regression Subjective	.133	.039	.013	.050	.007	.758
070	Regression Subjective	.001	.019	.000	.006	.000	. 50
•:	Regression Subjective	Relative	Weights				

TABLE XIX (cont.)

		Indivi	Individual Models (6.2 Projects)	s (6.2 Pro	jects)		
Case Tyr	Type Model	Cost- Benefit Ratio	Technical Merit	Resource Avail- ability	Likeli- hood of Success	Time Period	Air Force Need
041	Regression Subjective	.041	.30	.021	.102	.021	.30
042	Regression Subjective	.213	.122	900.	.056	\$ 501	. 603
8	Regression Subjective	.114	.168	.140	.038	. 0008	. 532
7770	Regression Subjective	.219	.577	.024	.005	.009	.165
545	Regression Subjective	.013	.252	.013	.060	.004	.30
946	Regression Subjective	.075	.000	.033	.134	.002	.555
240	Regression Subjective	.129	.066	.042	.024	.10	.674
840	Regression Subjective	.275	.155	660.	460.	900.	.430

Regression Relative Weights
 Subjective Weights

TABLE XIX (cont.)

		Indivi	Individual Models (6.2 Frojects)	s (6.2 Pro	jects)		
Case	Type Model	Cost- Benefit Ratio	Technical Merit	Resource Avail- ability	Likeli- hood of Success	Time Period	Air Force Need
640	Regression Subjective	215.	.138	.0444	.013	.105	.50
050	Regression Subjective	.011	.160	.011	.086	. 003	.728
051	Regression Subjective	.10	.118	.041	.118	.10	.25
052	Regression Subjective	.10	.518	.036	.195	.013	.153
053	Regression Subjective	.368	.082	6000.	.001	. 100	.30
750	Regression Subjective	260.	.319	.001	650.	.030	767.
055	Regression Subjective	. 20	.176	. 20	.275	.011	.396
950	Regression Subjective	.257	.25	.20	.064	.016	.121
•	-	2001	44.4.4.4				

Regression Relative Weights
 Subjective Weights

TABLE XIX (cont.)

		Indivi	Individual Models (6.2 Projects)	s (6.2 Pro	jects)		
Casse	Type Model	Cost- Benefit Ratio	Technical Merit	Resource Avail- ability	Likeli- hood of Success	Time Period	Air Force
057	Regression Subjective	081	.450	.130	.096	.113	.130
058	Regression Subjective	.000	.15	.340	.038	.038	.135
650	Regression Subjective	.035	.603	.001	.002	.001	.358
090	Regression Subjective	. 200	.097	.10	.032	.032	.25
061	Regression Subjective	.037	.337	.057	.037	.016	.515
062	Regression Subjective	.006	.353	900.	.014	0000.	. 50
690	Regression Subjective	.009	.003	.360	.084	.030	.513
1790	Regression Subjective	.30	.058	.000	.10	.039	.25

Regression Relative Weights
 Subjective Weights

TABLE XIX (cont.)

		Indivi	Individual Models (6.2 Projects)	s (6.2 Pro	jects)		
Case	Type Model	Cost- Benefit Ratio	Technical Merit	Resource Avail- ability	Likeli- hood of Success	Time	Air Force Need
590	Regression Subjective	.091	.380	.091	.091	.150	.198
990	Regression Subjective	.037	.307	700.	.20	.000	.578
290	Regression Subjective	.085	.851	.038	.021	.002	.002
890	Regression Subjective	.072	045.	.011	.114	.011	.252
690	Regression Subjective	.200	.200	.050	.050	.050	.30

* Regression Relative Weights ** Subjective Weights

Regression Group	Cost- Benefit Ratio	Technical	Resource Avail- ability	Likeli- hood of Success	Time	Air Force Need
Entire	.114.	.237	2470.	. 042	.041	.519
Command	090.	.380	700.	.010	500.	.541
Staff	660.	.039	.142	.088	.063	695.
Division	920.	.340	. 042	,024	.014	. 505
DEPEM	.146	.132	5 700.	690.	.119	684.
ADFO	.133	.276	070.	.038	.037	.477
Entire Division Population	.120	.261	. 042	.022	.042	564.
PX Division .	.151	.488	.073	.032	.017	.239

* Regression Relative Weights

TABLE XX (cont.)

	Manage	Management Level and Division Models (6.3 Projects)	nd Division	Models (6.3	Projects)	
Regression Group	Cost- Benefit Ratio	Technical	Resource Avail- ability	Likeli- hood of Success	Time Period	Air Force Need
PG Division	•060.	.332	.033	.023	240.	474.
PE Division	.231	.113	.058	860.	.039	.461
PB Division	070.	.239	.029	.021	940.	765.
FI Division	.102	.212	.020	.102	.062	.503
		3	11-1-1			

· Regression Relative Weights

TABLE XXI

		Indivi	Individual Models (6.3 Projects)	s (6.3 Pro	jects)		
Case	Type Model	Cost- Benefit Ratio	Technical Merit	Resource Avail- ability	Likeli- hood of Success	Time	Air Porce Need
001	Regression Subjective	.073	.121	700.	. 0008	000.	.793
005	Regression Subjective	.202	.073	.129	.008	.073	.516
600	Regression Subjective	.039	.660	.002	.010	.022	.267
700	Regression Subjective	.351	.351	.033	.052	.063	.150
500	Regression Subjective	.015	.376	.102	.015	.087	.30
900	Regression Subjective	.108	.061	.168	.091	.243	.330
200	Regression Subjective	.117	.011	.338	.011	.057	.30
800	Regression Subjective	.035	.078	.20	.106	.078	.626

* Regression Relative Weights ** Subjective Weights

TABLE XXI (cont.)

		Indivi	Individual Models (6.3 Projects)	8 (6.3 Pro	jects)		
() () () ()	Type Model	Cost- Benefit Ratio	Technical	Resource Avail- ability	Likel1- hood of Success	Time Period	Air Force Need
600	Regression	.004	.257	.10	.039	.012	. 30
010	Regression Subjective	.158	.042	.051	.141	.061	.548
011	Regression Subjective	.293	.008	.090	.20	.033	.399
012	Regression Subjective	.220	.103	.001	500.	.005	599.
013	Regression Subjective	.065	.445	.198	.001	.001	.291
014	Regression Subjective	.007	.275	.012	.012	.025	.30
015	Regression Subjective	.073	.149	2000	.017	.023	.29
910	Regression Subjective	.037	.395	.087	.10	.020	.462
		4 4 4 6 0 0	44010				

* Regression Relative Weights

TABLE XXI (cont.)

		Indivi	Individual Models (6.3 Projects)	8 (6.3 Pro	jects)		
C 88 89	Type Model	Cost- Benefit Ratio	Technical Merit	Resource Avail- ability	Likeli- hood of Success	Time Period	Air Force Need
017	Regression Subjective	.053	.672	.099	.099	.022	.053
018	Regression Subjective	.102	.212	.020	.102	.062	.503
019	Regression Subjective	.034	.302	.086	.034	.109	.435
020	Regression Subjective	.041	.069	.102	.373	.041	.373
021	Regression Subjective	.264	.380	.001	.001	.10	.340
022	Regression Subjective	.20	.112	.005	.10	.20	.642
023	Regression Subjective	.041	.507	.001	.008	.001	.243
420	Regression Subjective	.215	.360	.074	.074	.036	.241
•	• Regression • Subjective	Relative	Weights				

TABLE XXI (cont.)

		Indivi	Individual Models (6.3 Projects)	s (6.3 Pro	jects)		
Case	Type Model	Cost- Benefit Ratio	Technical Merit	Resource Avail- ability	Likeli- hood of Success	Time Period	Air Force Need
025	Regression	.030•	560.	.015	.030	.022	808
920	gression	.307	.10	.110	.20	.059	.307
027	Regression Subjective	.315	.315	.027	.132	.027	.184
028	Regression Subjective	.230	.179	.065	.065	.039	.422
029	Regression Subjective	.036	440.	.1064	.044	\$0°	.50
030	Regression Subjective	.143	.218	.000	090.	040.	.539
031	Regression Subjective	.142	.30	.10	.003	.007	.351
•							

* Regression Relative Weights ** Subjective Weights

APPENDIX P

Sequence of Cue-Value Combinations

This appendix includes the different cue-value combinations for the 32 R&D project-selection decisions.

t-		Resource	Likeli-	E	5 4
	recnnical Merit	Avail- ability	hood of Success	Period	Air rorce Need
Acc		Acc	Ex.	Acc	Acc
Acc		Ex	Acc	Acc	Ex
Ex		Acc	Acc	Ex	Ex
Acc		Acc	Ex	Ex	Acc
EX		Εx	Ex	Ex	Ε×
Ex		Ex	Acc	Acc	Acc
Ex		Ex	Ex	Ex	Ycc
EX		Ex	Acc	Ex	Acc
Ex		Acc	Acc	Acc	Acc
Acc		Ex	Ex	Acc	Acc
Acc		Ex	Ex	Acc	Ex
Ex		Ex	Acc	Acc	Ex
Ex		Acc	Ex	Yec	Acc
Ex		Acc	Ex	Ex	Acc
Ex		Ex	Ex	Acc	Acc
Acc		Ex	Ex	Ex	Ex
Ex		Ex	Acc	Ex	Ex
YCC		Acc	Ex	Ex	Ex

Pigure P-1. Sequence of Cue-Value Combinations

19 Acc* Acc Ex* Acc Ex Ex Acc Acc Ex Acc Acc Ex Acc Acc	Project	Cost- Benefit Ratio	Technical Merit	Resource Avail- ability	Likeli- hood of Success	Time	Air Force Need
Ex Acc Ex Acc Ex Acc Acc Acc Bx Acc Ex Acc Acc Bx Bx Ex Acc Acc Bx Bx Acc Acc Bx Bx Acc Acc Acc Bx Acc Acc Acc Acc Acc Acc Acc Acc Acc Acc Acc Acc Acc Acc Acc Acc Acc Bx Acc Acc Acc Acc Bx Acc Acc Acc Acc Bx Acc Acc Acc Acc	6	• >>Y	Yee	Ex**	Acc	Ex	Ex
Acc Acc Acc Acc Bx Bx Bx Bx Acc Bx Acc Bx <	0	Ex	Acc	Ex	Acc	Ex	Acc
Ex Ex Ex Ex Acc Ex Acc Ex Acc Acc Acc Ex Ex Acc Acc Ex Acc Ex Acc Acc Ex Acc Acc Acc Acc Acc Acc Acc Acc Acc Acc Acc Acc Acc Acc Acc Acc Acc Bx Acc Acc Acc Acc Acc Acc Acc	1	Acc	Acc	Acc	Acc	Ex	Acc
Ex Acc Acc Ex Ex Acc Acc Acc Bx Ex Acc Acc Ex Ex Acc Acc Ex Acc Acc Acc Acc Acc Acc Acc Acc Acc Acc Acc Acc Acc Bx Acc Acc Acc Acc Bx Acc Acc Acc Acc Bx Acc Acc Acc Acc	2	Ex	Ex	Ex	Ex	Acc	Ex
Ex Acc Acc Acc Ex Ex Ex Acc Acc Ex Ex Acc Acc Acc Acc Acc Acc Acc Acc Acc Acc Acc Acc Acc Acc Acc Acc Acc Ex Acc Acc Acc Acc Acc Acc Ex Acc Acc Acc Acc Acc Acc Ex Acc Acc Acc Acc Acc Acc	3	Ex	Ex	Acc	Ex	Ex	Ex
Acc Acc Ex Ex Acc Acc Acc Ex Acc Acc	7	Ex	Acc	Acc	Acc	Ex	Ex
Ex Acc Acc Ex Acc Acc Ex Acc Acc Acc Acc Acc Acc Acc Acc Acc Acc Ex Acc Acc Acc Acc Acc Ex Acc Acc Acc Acc Acc Ex Ex Acc Acc Ex	5	Acc	Acc	Ex	Ex	Ex	Acc
Acc Ex Acc Bx	9	Ex	Acc	Acc	Ex	Acc	Ex
Ex Ex Acc Bx	7	Acc	Ex	Acc	Ex	Yec	Ex
Acc Acc Ex Acc Bx	8	Ex	Ex	Acc	Acc	Acc	Ex
Acc Bx	6	Acc	Aoc	Ex	Acc	Y cc	Yec
Acc Acc Acc Acc Ex	0	Acc	Acc	Acc	Acc	Acc	Ex
x Ex Acc Acc Ex	1	Ex	Acc	Acc	Acc	Acc	Acc
	2	Бх	Ex	Acc	Acc	Ex	Acc

Pigure P-1 (cont.). Sequence of Cue-Value Combinations

APPENDIX G

Data Coding Process

This appendix shows the coding process used to prepare the raw data for analysis.

· CARD COLUMNS ·

1 2 Demograph	5 Through 69 lics Decisions	72 Through 74 Case Numbers
D D	D	C
E E	E	A
M M	C	S
0 0		E
1 2		

Figure G-1. Example of Data Coding Process. The DEMO and CASE variables were alpha/numerically coded whereas the DEC variables were numerically coded.

APPENDIX H

Factor Pairwise T-Tests

This appendix is made up of the tables used to calculate the t values for the pairwise t-test on the factors.

The difference between the subjective weight and the regression weight for each individual per factor was the basis of the test.

TABLE XXII

Cost-Benefit Ratio (6.2 Projects)

Case	Subjective Weights	Regression Weights	Difference
001	.20	.226	026
002	.20	.163	.037
005	.15	.009	.141
006	.20	.034	.166
007	.19	.046	.144
008	.20	.051	.149
009	.10	.013	.087
010	.15	.027	.123
011	.15	.000	.150
012	.15	.001	.149
013	.10	.020	.080
014	.25	. 249	.001
015	.10	.030	.070
016	.00	.007	007
017	.15	.037	.113
018	.05	.008	.042
019	.20	.000	.200
020	.20	.169	.031
021	.25	.428	178
022	.15	.046	.104
023	.15	.024	.126
024	.20	.057	.143
025	.15	.117	.033
026	.25	. 378	128
027	.15	.149	.001
028	.10	.113	013
029	.10	,018	.082
030	.10	.002	.098
031	.10	.003	.097
032	.05	.025	.025
033	.20	.059	.141
034	.10	.000	.100
035	.15	.108	.042
036	.08	.028	.052
037	.15	.136	.014
038	.10	.088	.012
039	.25	.133	.117
040	.05	.001	.049
041	.10	.041	.059
042	. 22	.213	.007
043	.20	.114	.086
044	.21	.219	009
045	.10	.013	.087

TABLE XXII (cont.)

Cost-Benefit Ratio (6.2 Projects)

Case	Subjective Weights	Regression Weights	Difference
046	.12	.075	.045
047	.20	.129	.071
049	.10	.215	115
051	.10	.007	.093
052	.10	. 084	.016
053	. 30	. 368	068
055	.15	.099	.051
056	.20	.257	057
057	.10	.081	.019
058	.15	.000	.150
059	.20	.035	.165
060	.20	.000	.200
061	.18	.037	.143
062	.15	.006	.144
063	.10	.009	.091
064	.30	.173	.127
065	.15	.091	.059
066	.20	.037	.163
067	.20	.085	.115
068	.10	.072	.028
069	.20	.200	.000
	2662	_	- 4 222

MEAN = .0662 STD DEV = .0768 n = 64

= 4.237

TABLE XXIII

Technical Merit (6.2 Projects)

Case	Subjective Weights	Regression Weights	Difference
001	.10	.115	015
002	.15	.163	013
005	.30	.439	139
006	.40	.522	122
007	.40	.542	142
008	. 30	. 382	082
009	. 30	.388	088
010	.19	.197	007
011	.21	.496	286
012	.20	.010	.190
013	.20	.139	.061
014	.20	.383	183
015	.40	.705	305
016	.00	.013	013
017	.15	.066	.084
018	.40	.921	521
019	.40	.699	299
020	.10	.127	027
021 022	.25	.154	.096
023	.25	.200	.050
024	.20	.404	204
	.25	.446	196
025	.23	.152	.078
026	.10	.102	002
027	.20	.076	.124
028	.35	. 366	016
029	.30	.407	107
030 031	.15	.088	.062
032	.25	.210	109
033		.349	049
034	.01	.059	022
035	.20		.045
036		.155	219
037	.30	.251	001
038	.15	.088	.062
039	-13	.039	.091
040	.13 .15 .30 .22	.019	.131
041	. 30	.445	145
042	.22	.122	.098
043	.30	.168	.132
044	.40	.577	177
045	.20	.252	052

Technical Merit (6.2 Proje

Case	Subjective Weights	Regression Weights
046	.05	.000
047	.12	.066
049	.05	.138
051	.20	.118
052	.40	.518
053	.20	.082
055	.20	.176
056	.25	.442
057	. 35	.450
058	.15	.449
059	.30	.603
060	.25	.097
061	.20	. 337
062	.35	.353
063	.15	.003
064	.25	.058
065	.20	.380
066	.25	.307
067	.25	.851
068	.40	.540
069	.20	.200

MEAN = -.0562 STD DEV = .1573 n = 64

TABLE XXIV

Resource Availability (6.2 Pro

		14011103 (0.2
Case	Subjective Weights	Regression Weights
001	.15	.029
002	.05	.077
005	.10	.027
006	.05	.000
007	.07	.010
008	.10	.020
009	.10	.027
010	.17	.044
11	.15	.048
012	.05	.018
013	.10	.044
014	.05	.090
015	.10	.030
016	.00	.002
017	.10	.102
018	.10	.008
019	.05	.025
021	.10	.091
022	.10	.079
23	.15	.012
024	.15	.008
25	.19	.040
26	.10	.030
027	.20	.194
28	.15	.085
029	.20	.229
30	.10	.002
31	.10	.007
32	.19	.042
033	.02	.015
134	.20	.037
35	.05	.039
36	.20	.039
37	.20	.215
38	.25	.198
39	.07	.013
040	. 05	.000
141	.05	.021
042	.07	.006
143	.00	.140
)44	.10	.024
145	.10	.013

TABLE XXIV (cont.)

Resource Availability (6.2 Frojects)

Case	Subjective Weights	Regression Weights	Difference
046	.06	.033	.027
047	.18	.042	.138
049	.20	. 044	.156
051	.15	. 041	.109
052	.20	.036	.164
053	.05	.009	.041
055	.10	. 044	.056
056	.20	.100	.100
057	.20	.130	.070
058	.20	. 340	140
059	.08	.001	.079
060	.10	.049	.051
061	.15	.057	.093
062	.00	.006	006
063	.30	. 360	060
064	.05	.000	.050
065	.10	.091	.009
066	.00	.004	004
067	.20	.038	.162
068	.06	.011	.049
069	.10	.050	.050

- 3.528

MEAN = .0551 STD DEV = .0623 n = 64

TABLE XXV

Likelihood of Suc	cess (6.2	Projects)
-------------------	-----------	-----------

Case	Subjective Weights	Regression Weights	Difference
001	.25	.074	.176
002	.10	.016	. 084
005	.05	.001	.049
006	.10	.102	002
007	.10	.022	.078
008	.05	.001	.049
009	.10	.020	.080
010	.13	.123	.007
011	.18	.039	.141
012	.05	.073	023
013	.20	.014	.186
014	.15	.048	.102
015	.15	.078	.072
016	.00	.007	.143
017	.15	.066	.084
018	.15	.005	.145
019	.15	.003	.147
020	.10	.091	.009
021	.10	.026	.074
022	.10	.013	.087
023	.15	.069	.081
024	.15	.057	.093
025	.12	.031	.089
026	.25	.267	017
027	.10	.001	.099
		.085	
028	.15		.065
029	.10	.045	.055
030	.15	.179	029
031	.15	.026	.124
032	.14	.001	.139
033	.02	.000	.020
034	.15	.110	.040
035	.05	.069	019
036	.12	.021	.099
037	.05	.001	.049
038	.15	.002	.148
039	.12	.050	.070
040	.10	.006	.094
041	.20	.102	.098
042	.15	.056	.094
043	.10	.038	.062
6 4	.05	.005	.045
045	.15	.060	.090

TABLE XXV (cont.)

Likelihood of Success (6.2 Projects)

= 4.751

Case	Subjective Weights	Regression Weights	Difference
046	.25	.134	.116
047	.15	.024	.126
049	.10	.013	.087
051	.20	.118	.082
052	.15	.195	045
053	.05	.001	.049
055	.25	.275	025
056	.10	.064	.036
057	.15	.096	.054
058	.20	.038	.162
059	.13	.002	.128
060	.10	.032	.068
061	.12	.037	.083
062	.00	.014	014
063	.15	.084	.066
064	.10	.000	.100
065	.15	.091	.059
066	.20	.073	.127
067	.15	.021	.129
068	.15	.114	.036
069	.10	.050	.050

MEAN = .0742 STD DEV = .0526 n = 64

TABLE XXVI

Time	Peri	od	(6.2	Pro	ects)

Case	Subjective Weights	Regression Weights	Difference
001	.05	.094	044
002	.25	.010	.240
005	.05	.020	.030
006	.10	.034	.066
007	.03	.046	016
008	.05	.013	.037
009	.10	.027	170
010	.11	.014	.096
011	.10	.097	.003
012	.05	.000	.050
013	.10	.078	.022
014	.05	.020	.030
015	.05	.007	.043
016	.00	.002	002
017	.10	.037	.063
018	.05	.015	.035
019	.05	.000	.050
020	.10	.012	.088
021	.10	.076	
022	.05	.000	.024
023	.10	.000	
024	.10	.019	.100
025			
	.08	.031	.049
026	.05	.005	.045
027	.10	.027	.073
028	.05	.085	035
029	.10	.045	.055
030	.05	.016	.034
031	.05	.012	.038
032	. 08	.007	.010
033	.05	.007	.043
034	.05	.015	.035
035	.05	.108	058
036	.05	.010	.040
037	.05	.020	.030
038	.05	.000	.050
039	.03	.007	.023
040	.15	.000	.150
041	.05	.021	.029
042	. 04	.001	.039
043	.00	.008	008
044	.05	.009	. 041
045	.15	.004	.146

TABLE XXVI (cont.)

Time Period (6.2 Projects)

= 2.442

Саве	Subjective Weights	Regression Weights	Difference
046	.01	.002	.008
047	.10	.066	.034
049	.05	.105	055
051	.10	.007	.093
052	.10	.013	.087
053	.10	.001	.099
055	.05	.011	.039
056	.05	.016	.034
057	.10	.113	013
058	.10	.038	.062
059	. 04	.001	.039
060	.10	.032	.068
061	.10	.016	.084
062	.00	.00	.000
063	.00	.030	030
064	.05	.039	.011
065	.10	.150	050
066	.05	.000	.050
067	.10	.002	.098
068	. 04	.011	.029
069	.10	.050	.050

MEAN = .0382 STD DEV = .0561 n = 64

TABLE XXVII

Air Force Need (6.2 Projects)

Case	Subjective Weights	Regression Weights	Difference
001	.25	.462	212
002	.25	.572	322
005	. 35	. 504	154
006	.15	.307	157
007	.21	. 334	124
008	. 30	.534	234
009	. 30	.525	225
010	.25	. 595	345
011	.21	. 320	110
012	.50	.897	397
013	.30	.705	405
014	.30	.211	.089
015	.20	.150	.050
016	1.00	.970	.030
017	.35	.693	343
018	.25	.044	.206
019	.15	.273	123
020	.40	.509	109
021	.20	.203	003
022	.30	.660	360
023	.25	.491	241
024	.20	.413	213
025	.27	.627	357
026	.25	.218	.032
027	.25	.553	303
028	.20	.266	066
029	.20	.255	055
030	.45	.714	291
031	.35	.743	393
032	.30	.576	276
033	.70	.862	162
034	.30	.616	316
035	.50	.522	022
036	.25	.272	022
037	.30	.378	078
038	.30	.624	324
039	.40	.758	358
040	.50	.974	474
041	.30	.371	071
042	.30	:603	303
043	.40	.532	132
044	.19	.165	357

TABLE XXVII (cont.)

Air Force Need (6.2 Projects)

Case	Subjective Weights	Regression Weights	Difference
046	.51	.755	245
047	.25	.674	424
049	.50	.484	.016
051	.25	.709	459
052	.05	.153	103
053	.30	.539	239
055	.25	. 396	146
056	.20	.121	.079
057	.10	.130	030
058	.20	.135	.065
059	.25	. 358	108
060	.25	.791	541
061	.25	.515	265
062	.50	.622	122
063	.30	.513	213
064	.25	.729	479
065	.30	.198	.102
066	.30	.578	278
067	.10	.002	.098
068	.25	.252	002
069	.30	.450	150

= -11.449

MEAN = -.1789 STD DEV = .1707 n = 64

TABLE XXVIII

Cost-Benefit Ratio (6.3 Projects)

Case	Subjective Weights	Regression Weights	Difference
002	. 30	.202	.098
003	.10	.039	.061
004	.25	. 351	101
005	.10	.015	.085
006	.10	.108	008
007	.20	.117	.083
008	.15	.035	.115
009	.20	.004	.196
010	.20	.158	.042
011	.25	.293	043
012	.26	.220	.040
013	.15	.065	.085
014	.10	.007	.093
015	.19	.073	.117
016	.10	.037	.063
017	.20	.053	.147
018	.20	.102	.098
019	.05	.034	.016
020	.15	.041	.109
021	.25	.264	014
022	.20	.061	.139
023	.05	.041	.009
024	.20	.215	015
026	.25	.307	057
027	.20	.315	115
028	.23	.230	.000
029	.15	.036	.114
030	.10	.143	043
031	.15	.142	.008

MEAN = .0456 STD DEV = .0748 n = 29

- 1.322

TABLE XXIX

Technical Merit (6.3 Projects)

Case	Subjective Weights	Regression Weights	Difference
002	.15	.073	.077
003	.25	.660	041
004	.25	. 351	101
005	.20	. 376	176
006	.10	.061	.039
007	.10	.011	.089
008	.05	.078	028
009	.20	.257	057
010	.10	.042	.058
011	.03	.008	.022
012	.15	.103	.047
013	.25	.445	195
014	.20	.275	075
015	. 24	.149	.091
016	.20	. 395	195
017	.40	.672	272
018	.15	.212	062
019	.22	. 302	082
020	.15	.069	.081
021	.20	.380	180
022	.15	.112	.038
023	.50	.707	- 207
024	.20	.360	160
026	.10	. 040	.060
027	.25	.315	065
028	.18	.179	.001
029	.05	.044	.006
030	.20	.218	018
031	.30	.491	191
MEAN -	0643		-1.865

STD DEV = .1236 n = 29

TABLE XXX

Resource Availability (6.3 Projects)

Case	Subjective Weights	Regression Weights	Difference
002	.05	.129	079
003	.18	.002	.178
004	.10	.033	.067
005	.15	.102	.048
006	.20	.168	.032
007	.20	. 338	138
008	.20	.078	.122
009	.10	.024	.076
010	.10	.051	.049
011	.15	.090	.060
012	.09	.001	.089
013	.20	.198	.002
014	.10	.012	.088
015	.09	.007	.083
016	.15	.087	.063
017	.15	.099	.051
018	.10	.020	.080
019	.15	.086	.064
020	.10	.102	002
021	.10	.001	.099
022	.10	.005	.095
023	.05	.001	.049
024	.10	.074	.026
026	.10	.110	010
027	.10	.027	.073
028	.12	.065	.055
029	.10	.064	.036
030	.05	.000	.050
031	.10	.007	.093
MEAN =	.0517		= 1.499

MEAN = .0517 STD DEV = .0577 n = 29

TABLE XXXI

Likelihood of Success (6.3 Projects)

Case	Subjective Weights	Regression Weights	Difference
002	.05	.008	.042
003	.17	.010	.160
004	.15	.052	.092
005	.10	.015	.085
006	.10	.091	.009
007	.15	.011	.139
008	.15	.106	. 044
009	.10	.039	.061
010	.20	.141	.059
011	.20	.177	.023
012	. 04	.005	.035
013	.05	.001	.049
014	.15	.012	.138
015	.14	.017	.123
016	.10	.000	.100
017	.15	.099	.051
018	.25	.102	.148
019	.17	.034	.136
020	.17	. 373	173
021	.05	.001	.049
022	.10	.000	.100
023	.10	.008	.092
024	.15	.074	.076
026	.20	.177	.023
027	.15	.132	.018
028	.12	.065	.055
029	.15	.044	.106
030	.40	.060	. 340
031	.15	.003	.147
MEAN =	.0804		2.333

MEAN = .0804 STD DEV = .0799 n = 29

.20	. 383	183
	.705	305
.00	.013	013
.15		.084
.40	.921	521
.40	.699	299
.10	.127	027
.25	.154	.096
.25	.200	.050
.20	.404	204
.25	.446	196
.23		.078
	.102	002
.20	.076	.124
.35	. 366	016
	.407	107
	.088	.062
	.210	.040
. 24	. 349	109
.01	.059	049
.20	.222	022
	.155	.045
	.519	219
.25	.251	001
	.088	.062
.13	.039	.091
.15	.019	.131
. 30		145
.22	.122	.098
. 30	.168	.132
		177
.20	.252	052
	.25 .25 .20 .25 .23 .10 .20 .35 .30 .15 .25 .24	.40

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TABLE XXXII

mima	Dani	ad	16	3	Dra	tanta	1

Case	Subjective Weights	Regression Weights	Difference
002	.15	.073	.077
003	.10	.022	.078
004	.10	.063	.037
005	.15	.087	.063
006	.20	.243	043
007	.05	.057	007
008	.05	.078	028
009	.10	.012	.088
010	.10	.061	.039
011	.07	.033	.037
012	.02	.005	.015
013	.10	.001	.099
014	.15	.025	.125
015	.05	.023	.027
016	. 05	.020	.030
017	.05	.022	.028
018	.00	.062	062
019	.16	.109	.051
020	.05	.041	.009
021	.10	.006	.094
022	.20	.179	.021
023	.05	.001	.049
024	.10	.036	.064
026	.05	.059	009
027	.10	.027	.073
000	04	020	023

AD-A076 977

AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOO--ETC F/G 5/1
POLICY CAPTURING OF MANAGEMENT PERSONNEL THROUGH PROJECT-SELECT--ETC(U)
SEP 79 T L BROOKS
AFIT/6SM/SM/79S-1 NL

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END DATE

12-79

TABLE XXXIII

Air Force Need (6.3 Projects)

Саве	Subject iv e Weights	Regression Weights	Difference
002	.30	.516	-,216
003	.20	.267	067
004	.15	.150	.000
005	.30	.406	106
006	.30	.330	030
007	:30	.467	167
008	.40	.626	226
009	.30	.664	364
010	.30	. 548	248
011	.30	. 399	099
012	.44	.665	225
013	.25	.291	041
014	. 30	.668	368
015	.29	.731	441
016	.40	.462	062
017	.05	.053	003
018	.30	.503	203
019	.25	.435	185
020	. 35	. 373	023
021	. 30	.349	049
022	.25	.642	392
023	.25	.243	.007
024	.15	.241	091
026	. 30	.307	007
027	.20	.184	.016
028	.29	.422	132
029	.50	.747	247
030	.20	.539	339
031	.25	.351	101
MEAN =	1520		4.409

MEAN = -.1520 STD DEV = .1321 n = 29

APPENDIX I

T-Test of the Comparisons for the Management Levels and Divisions

This appendix includes the test for both the 6.2 and 6.3 projects with respect to the management levels and divisions. Each test had the following hypothesis:

where

 μ_{A} and μ_{B} represent the mean relative weights of the management levels or divisions being compared.

Reject H_o if $t > t_{\alpha/2}$ at the .05 level of significance.

t_{n-1}, $\alpha/2$ = t_∞, .025 = 1.96

TABLE XXXIV

			Pactor	Pactor t Values		
Divisions Being Compared	Cost- Benefit Ratio	Technical Merit	Resource Avail- ability	Likeli- hood of Success	Time	Air Force Need
PX/PG	-1.70	7.93	.28	-11.28	1.35	-4.05
PX/FE	-3.39	23.25	4.72	3.62	94.9	-22.25
PX/PB	89.5	8.96	\$:	-6.86	3.91	-9.77
PG/FE	-1.32	13.13	3.96	12.95	4.97	-15.27
PG/PB	6.59	5.09	25	84.9	2.59	-5.73
FE/PB	8.71	₹.8-	-3.43	-9.50	-1.94	2.00

T-Test of the Comparisons for the Management Levels (6.3 Project)

			Pactor	Pactor t Values		
Kanagement Levels Being Compared	Cost- Benefit Ratio	Technical Merit	Resource Avail- ability	Likeli- hood of Success	Time Feriod	Air Porce Need
cs/sr	-6.95	10.28	-15.71	-11.26	-27.96	1.56
cs/biv	-7.59	1.6	-16.56	-9.48	-7.63	2.11
CS/BR	-12.68	6.32	-13.96	-17.08	-15.51	3.12
CS/GR	-12.35	3.49	-17.06	-16.20	-13.63	5.09
st/biv	2.20	-19.87	10.10	9.50	19.74	.78
ST/BR	-2.71	-14.81	99.8	5.17	-8.38	2.93
ST/GR	50	-29.08	10.00	7.92	8.63	.88
DIV/BR	-6.11	9.77	-2.00	-11.00	-13.17	1.92
DIV/GR	-3.83	3.98	24	-6.01	-6.98	07
BR/GR	2.93	-8.75	1.85	6.67	10.66	-2.66

BR = Branch GR = Group

CS = Command Section ST = Staff DIV = Division

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TABLE XXXVI

	T-Test of the Comparisons for the Divisions (6.3 Project)	Comparisons	for the Div	isions (6.3	Project)	
			Pactor	Pactor t Values		
Divisions Being Compared	Cost- Benefit Ratio	Technical Merit	Resource Avail- ability	Likeli- hood of Success	Time Period	Air Porce Need
PX/PG	2.63	8.44	3.62	3.81	64.9-	-11.40
PX/PE	-5.01	19.57	4.36	-6.64	.08	-11.00
PX/PB	3.66	13.37	4.21	2.83	4.21	-13.54
PG/PE	-16.91	9.93	.12	-11.10	7.32	73
PG/PB	1.90	3.77	86.	85	65	ま.す
FE/PB	21.15	-8.09	.98	10.37	7.4	-3.75

Vita

Terry L. Brooks was born in Rock Hill, South Carolina on 7 August 1951, the son of Leon M. Brooks and the late Anne R. Brooks. He graduated from Rock Hill High School in 1969 and attended Clemson University, Clemson, South Carolina. He graduated from there in 1973 with a Bachelor's Degree in Ceramic Engineering and a commission in the United States Air Porce.

After completing Undergraduate Pilot Training at Webb
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