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PRODUCTIVITY AND JOB SATISFACTION IN  
RESEARCH AND DEVELOPMENT: ASSOCIATED  
INDIVIDUAL AND SUPERVISORY VARIABLES

THESIS

AFIT/GSM/SM/77S-2

Larry J. Corbin  
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14 AFIT/GSM/SM/77S-2

6 PRODUCTIVITY AND JOB SATISFACTION IN RESEARCH AND DEVELOPMENT: ASSOCIATED INDIVIDUAL AND SUPERVISORY VARIABLES.

9 Master's THESIS,

Presented to the Faculty of the School of Engineering of the Air Force Institute of Technology Air University in Partial Fulfillment of the Requirements for the Degree of Master of Science

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10 by Larry J. Corbin Capt USAF

Graduate Systems Management

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12 135p.

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## ACKNOWLEDGEMENTS

Historically, there seems to be a certain amount of mental pain, frustration, and uncertainty involved in every thesis effort. I wish to express my gratitude to the following individuals whose efforts during this research lessened the impact of these factors:

Captain Michael J. Stahl. As my thesis advisor, his encouragement, direction, and interest throughout this research effort proved invaluable.

Mr. Max Davis, AFFDL. As my laboratory point of contact, his assistance in obtaining data was most helpful.

My parents, Arthur and Betty. Their moral support throughout this effort was extremely beneficial to me.

Finally, my wife, Sue. Her assistance and encouragement during the "low points" of this research effort are extremely meaningful to me and leave me indebted to her.

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ABSTRACT

This research explored the relationships of supervisory and individual variables to the productivity and job satisfaction of scientists and engineers in a selected Air Force research and development laboratory.

Productivity was defined as quantity of output and was measured across six different types of output. Job satisfaction was measured by the Hoppock measure.

Supervisory and individual variables were measured by nine demographic variables and the following measurement scales: (1) the Supervisory Behavior Description Questionnaire (SBDQ), (2) the Leader Reward Behavior Instrument (LRBI), and (3) The Rotter Internal-External (I-E) Scale of Control of Reinforcement. These variables were then tested for their relationships with the criteria.

The method was a questionnaire administered to the individual scientist/engineer. Usable information was obtained on 326 civilian and military scientists/engineers resulting in a sample of 272 nonsupervisory scientists/engineers and 54 group leaders.

Factor analysis indicated, with the exception of the Rotter I-E scale, that the measurement scales were valid. The analysis of the Rotter I-E scale indicated that the scale has questionable validity, is multi-dimensional, and may be sensitive to population differences.

→ For both the nonsupervisory scientists/engineers and the group leaders, the following relationships were found. No relationship was found between productivity and job satisfaction. Although higher education, grade, and experience were associated with higher productivity, no single predictor variable was shown to be significantly associated with all six of the productivity variables, including leader behavior and the Rotter score. However, consideration and positive leader reward behavior were positively related to job satisfaction. Education was found to be associated to job satisfaction: positively for the nonsupervisory scientists/engineers and negatively for the group leaders.

The total Rotter score was negatively associated with job satisfaction for the nonsupervisory scientists/engineers.

PRODUCTIVITY AND JOB SATISFACTION IN  
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CHAPTER 1. INTRODUCTION

1.1 Overview

The questions of organizational (situational) determinants and/or individual determinants of output and job satisfaction as they relate to reward perceptions in a Research and Development (R&D) Organization have been only recently investigated. The major portion of reward-contingency research has been directed at the impact of monetary rewards on motivation and performance (Sims and Szilagyi, 1975). Additionally, such topics as supervisory style, morale, employee satisfaction, communications systems, etc., have been studied for a number of years although these topics have not been thoroughly related to reward-contingency research. However, the current government position on R&D is to get more R&D for the dollars expended. Vincent (1972) identified this change in R&D policy and recommended that "in order to get more R&D for the dollars expended, it becomes imperative that management be able to identify factors which influence productivity".

The purpose of this research then is to investigate the relationships among individual perceptions of reward - both as a generalized expectancy and as a perception of leader reward behavior, and leader behavior (supervisory style) as they relate to productivity and job satisfaction.

## 1.2 Statement of the Problem

What is the relationship between the productivity and job satisfaction of AF R&D scientists/engineers and their generalized expectancy of reward? Is the productivity and job satisfaction of scientists/engineers related to their perception of leader reward behavior? Does a relationship exist between the individual's generalized expectancy of reward and the individual's perception of leader reward behavior? What effect does the supervisory style have on productivity, job satisfaction, and the individual's perception of leader reward behavior?

The basic problem can be related to the Lewinian field theory whereby the work behavior of the individual was postulated to be a function of the individual and his environment, i. e. , Behavior = f (individual X environment) (McCarrey and Edwards, 1973). Thus, productivity and job satisfaction can be thought of as being determined by both the individual and the environment. The supervisor is the individual's main contact with the environment: the supervisor controls the positive or negative rewards which are given to the individual. Similarly, the individual's expectancy of reward, both as a generalized and leader-oriented concept impacts upon productivity and job satisfaction. The goal then is to determine how certain management practices affect the individual's perceptions and ultimately productivity and job satisfaction.

### 1.3 Limitations

This study investigated AF R&D scientists/engineers only. It was further limited to one AF laboratory and involved working level scientists/engineers and group leaders. This policy included both military and civilian personnel, but excluded all levels of management, staff and administrative personnel, technicians, and trainees except for the group leaders.

### 1.4 Definitions

The following definitions serve to clarify the terms which will be used throughout this report:

1. Internal: an individual who perceives positive and/or negative events as being a consequence of his own actions and thereby under personal control.

2. External: an individual who perceives positive and/or negative events as being unrelated to his own behavior in certain situations and therefore beyond personal control.

3. Initiating Structure (S): Reflects the extent to which an individual is likely to define and structure his role and those of his subordinates toward goal attainment. A high score on this dimension characterizes individuals who play a more active role in directing group activities through planning communicating information, trying out new ideas, etc.

4. Consideration (C): Reflects the extent to which an individual is likely to have job relationships characterized by mutual trust, respect for subordinates' ideas and consideration of their feelings. A high score is indicative of a climate of good rapport and two-way communication. A low score indicates the supervisor is likely to be more impersonal in his relations with group members.

5. Productive: an individual, who, based on the productivity measures used in this research effort, produced one or more items of output.

6. Nonproductive: an individual who, based on the productivity measures used in this research effort, did not produce any output in a particular category.

#### 1.5 Hypotheses

The following hypotheses were tested:

1. A positive relationship exists between productivity and job satisfaction.
2. A positive relationship exists between productivity and an internal.
3. A positive relationship exists between job satisfaction and an internal.

4. A positive relationship exists between both productivity and job satisfaction and positive leader reward behavior. A negative relationship exists between both productivity and job satisfaction and punitive leader reward behavior.

5. A positive relationship exists between both productivity and job satisfaction and the supervisory style of "Consideration".

6. A negative relationship exists between both productivity and job satisfaction and the supervisory style of "Initiating Structure".

#### 1.6 Objectives

The following objectives will serve as guidance during this research effort:

1. Using the developed survey, collect data on a sample of scientists/engineers from an AF R&D laboratory.

2. Test the relationships among the following factors: productivity, job satisfaction, generalized expectancies for internal versus external control of reinforcement, leader reward behavior, supervisory style, and certain statistical control data such as education, age, experience, etc.

3. By using the collected data, attempt to recommend certain laboratory policies which would improve/maintain the current management practices.

## CHAPTER 2. LITERATURE REVIEW

### 2.1 Introduction

There are many basic problems when one tries to study an area such as productivity. First, there are many methods which may be used to measure productivity. These various methods have certain advantages dependent upon the circumstances. One must decide what method best fits the situation dependent upon the desired result of the measurement and the individuals being surveyed.

The second problem deals with both the organizational and individual differences which impact upon productivity. There are a variety of factors such as supervisory style, innovation, morale, satisfaction, etc., which might affect the productivity of individuals and ultimately, the organization. By necessity, these factors must be limited to allow for a manageable research effort. In particular, the following factors will be investigated in this research effort: supervisory style (leader behavior), internal versus external control of reinforcement, and leader reward behavior. Prior to reviewing the literature regarding these factors, the concepts of productivity and job satisfaction must be described as they relate to measures of these concepts.

### 2.2 Productivity

Many forms of identifying productivity are available. McCarrey and Edwards (1973) list nine performance measures which are

dimensions of scientist performance: 1) productivity rank - order scores (peers), 2) creativity rank - order scores (peers), 3) departmental percentile score, 4) professional recognition score, 5) communications rank - order scores (peers), 6) quality of published work (peer ratings), 7) originality of published work (peer ratings), 8) citation rate (number per paper), and 9) publications rate (number per year). for purposes of this research, however, only output that can be quantitatively identified will be used to represent a worker's productivity. Although a qualitative assessment of R&D productivity is often more practical than a quantitative measure, quantity is easier to determine and measure, and much less subjective (Hughes Study, 1974).

Due to the practicality of a quantitative measure and the ease with data may be gathered, a quantitative productivity measure was used in this study. The specific details of the productivity measure are described in the following chapter.

### 2.3 Job Satisfaction

The basic factors of job satisfaction may be broken into two types: those characteristics of the individual and those characteristics of the job. As factors associated with job satisfaction, these factors incorporate the personal characteristics of each individual and the organizational characteristics of each job.

In particular, the individual characteristics of age, education, intelligence, sex, occupational level and individual differences have been investigated as they relate to job satisfaction (Fournet, 1966). Various research efforts have concluded that each of these characteristics can have considerable impact on an individual's job satisfaction. For example, some research indicates that satisfaction or morale increases as the job level progresses (Fournet, 1966). This research indicates that a Maslow-type satisfaction of different needs may be present which progression from lower job levels to higher job levels satisfies.

In contrast to individual characteristics, many studies have indicated that the work situation has tremendous impact on job satisfaction. Some factors which have been related to job satisfaction include organization and management, immediate supervision, social environment, communication, security, monotony, and pay. Job satisfaction could depend, in part, upon the effect of these factors by the extent to which they lower or increase the worker's self-evaluation (Vroom, 1962).

In an attempt to capture the individual's job satisfaction, Hoppock in 1935 formulated a four question measure for job satisfaction. The intent of the four questions was to capture various aspects of an individual's satisfaction with his job in a global rather than specific measure of job satisfaction.

The validity and reliability of this measure has been fairly well established. Using a data base of over 28,000 responses, McNichols, Stahl, and Manley (1976) found that Hoppock's measure appears to be a meaningful global measure of an employee's perception of his job satisfaction over a wide range of organizations. In particular, it was found that "... the measure performs consistently when applied to a variety of sample populations including many different job categories, organizational levels and demographic groupings".

Thus, the Hoppock measure of job satisfaction was used in this study. The specific details of the measure are described in Chapter 3.

#### 2.4 Leader Behavior

Among some of the large scale psychological research programs on leader behavior, one which had considerable impact was conducted at Ohio State University during the period 1945-1956. This research revealed two basic dimensions of leader behavior in the formal organization, "Consideration" and "Initiating Structure". These basic dimensions were derived from the initial investigation of eleven dimensions of leader behavior descriptions (Stogdill and Coons, 1957). As a result of the research effort, it was found that leader behavior could be described in the dimensions of "Consideration" and "Initiating Structure".

The leader behavior research resulted in three separate devices to measure the behavior: the Leader Behavior Description Questionnaire, the Supervisory Behavior Description Questionnaire, and the Leadership Opinion Questionnaire. All questionnaires rely upon the "Consideration" and "Initiating Structure" concepts, but approach the measurement of leader behavior from different avenues.

The Leader Behavior Description Questionnaire (LBDQ) is a measurement of the subordinate's perception of leader behavior originally containing 150 questions. The Supervisory Behavior Description Questionnaire (SBDQ) was developed by Fleishman containing 48 questions for use in industry.

A recent study by Szilagyi and Keller (1976) has shown the SBDQ to be a "better measure" than the LBDQ by using concurrent validity analysis. Although no significant differences were found in correlation with the leader consideration dimension, there were significantly different results reported in the leader initiating structure dimension with the SBDQ being more valid.

In contrast to the LBDQ and SBDQ, the Leadership Opinion Questionnaire (LOQ) approaches the measurement from a different perspective. The LOQ is a Likert-type attitude scale which assesses leadership attitudes. Each supervisor is asked not to indicate how he performs in the work situation but how he believes he should perform (Stogdill and Coons, 1957).

The design of all questionnaires is to provide independent measures of "Consideration" and "initiating Structure". The scales for these two dimensions have been shown to be reliable and independent in a wide variety of situations (Stogdill and Coons, 1957). Thus, due to the rating of the SBDQ as a "better measure", it will be used in this study. Additionally, however, there is yet little evidence of the predictive validity of these two dimensions nor the kinds of situational variables which might effect such validity (Korman, 1966).

In an attempt to capture the situational variables which affect the predictive validity of these dimensions, Kerr found that the variables which moderate the validity of the leader behavior prediction are the following: subordinate need for information, job level, subordinate expectations of leader behavior, perceived organizational independence, leader's similarity of attitudes and behavior to managerial style of higher management, leader upward influence, and the characteristics of the task (Kerr, 1974). Thus, the relationship between leader behavior, employee attitudes, and job performance is substantially affected by the organization in which the leadership takes place.

Since the supervisory style has considerable impact on productivity and job satisfaction, this concept was investigated using the SBDQ. The specific details of this measure are discussed in the following chapter.

## 2.5 Internal Versus External Control of Reinforcement

Various research efforts have been conducted which have concerned themselves with man's ability to control his personal environment. In particular, the role of reinforcement, reward, or gratification is recognized as a crucial one in the acquisition and performance of skills and knowledge (Rotter, 1966). One of the research efforts in this regard is the Internal-External Control of Reinforcement described by Julian B. Rotter.

Rotter's theory is based on a general principle that: "Internal control refers to the perception of positive and/or negative events as being a consequence of one's own actions and thereby under personal control; external control refers to the perception of positive and/or negative events as being unrelated to one's own behavior in certain situations and therefore beyond personal control" (Lefcourt, 1966). Thus, the basic theoretical background for Rotter's Internal-External concept is that a reinforcement acts to strengthen an expectancy that a particular behavior or event will be followed by that reinforcement in the future. If the reinforcement is perceived to be contingent upon the individual's own behavior, reward or punishment in the future will be seen as causally related to past behavior. Likewise, if the individual senses no relationship between behavior and reward or punishment, the reward or punishment will be perceived to be beyond the individual's control. Thus, Rotter (1966) hypothesized that "depending upon the

individual's history of reinforcement, individuals would differ in the degree to which they attributed reinforcements to be their own actions".

The items in the Internal-External (I-E) scale deal exclusively with the individual's belief about the nature of the world, that is, the items are concerned with the subject's expectations about how reinforcement is controlled.

In general, most studies have reported an unusually consistent set of findings. The validity and reliability of the I-E scale has been extensively tested and on the whole, substantiated the concept's usefulness in several areas. Data tends to support Rotter's contention that the internal-external control theory is a generalized expectancy operating across many situations (Joe, 1971).

Due to the possible impact of the feelings of power/powerlessness which are entailed in the I-E concept, this concept was investigated in the study. The specific details of the I-E scale are described in Chapter 3.

## 2.6 Leader Reward Behavior

In 1971, W.E. Scott, A.J. Reitz, and R.D. Johnson developed an instrument which is designed to measure the degree to which the subordinate perceives that the rewards, or outcomes (positive or negative), he receives through his supervisor reflect his performance, or accomplishments, on the job. The instrument is based on two dimensions:

"positive reward behavior", representing the relationship between good performance and leader-administered rewards such as recognition and pay increases, and "punitive reward behavior", representing the relationship between low job performance and leader corrective behavior (Johnson, 1973).

In a study conducted in a major midwestern university's medical center using the instrument, it was found that across all occupational skills, there was a relationship between job satisfaction and positive leader reward behavior. However, in relation to job satisfaction and punitive reward behavior, varying relationships existed across occupational skills (Sims and Szilagyi, 1975).

The effects of leader reward behavior were found by Stevens (1976) to have an association with productivity in an AF research and development laboratory. For this reason, the Leader Reward Behavior instrument was used in this study and its specific details are described in Chapter 3.

## 2.7 Theory Relationships

One commonly held view of supervision for R&D engineers is that the supervisor should do little except keep out of the way of his subordinates. This viewpoint indicates that the soundest way to encourage high achievement is to secure good people, give them good equipment, and then leave them alone. However, current results show that this viewpoint may not be entirely accurate.

In a research effort conducted by Pelz, it was found that productivity was highest when independence from the supervisor is combined with frequent contact with him, that is, when the individual has frequent interaction with the supervisor, but also has considerable voice in the final decisions (Pelz, 1956). Additional support for such a theory is from Lawler and Hall who conclude that the more the engineer feels he has control over what goes on, the more he feels his job allows him to be creative and satisfying (Lawler and Hall, 1967).

In light of these conclusions, what would one expect from a survey of R&D engineers using the SBDQ? In general (placing aside individual differences between engineers), one would expect that R&D engineers in a laboratory would perceive their supervisor as being rather low or moderate in "Initiating Structure" and high in "Consideration". Thus, the supervisor would provide an environment characterized by mutual trust, respect for his subordinates' ideas, and consideration of their feelings, while taking a less active role in structuring the roles of his subordinates toward goal attainment. One would expect an unsuccessful supervisor to exhibit or be perceived by his subordinates as exhibiting behavior contrary to that described above. This point is consistent with Stogdill and Coons (1957), with Hill and Hunt (1973), and with Bradwhat (1970), whose data showed respondent preference for structure to diminish at higher organizational job levels. Additionally, Bradshaw (1970) found preference for consideration to be relatively constant across different organizational levels.

However, could the individual's perception of his supervisor be based on some other factor such as the individual's expectancy of internal versus external control of reinforcement or the leader's perceived reward behavior? This author believes that the individual's self-conception would impact greatly on his perception of his supervisor. Additional studies tend to support this expectation. The individual who perceives that he has control over what happens to him may conform or may go along with suggestions when he chooses to and when he is given a conscious alternative. However, as indicated in one study, if such suggestions or attempts at manipulation are not to his benefit or if he perceives them as subtle attempts to influence him without his awareness, he reacts resistively (Rotter, 1966). Thus, if a supervisor were attempting to slightly structure the work situation, the internal may perceive the supervisor in a negative sense of "Initiating Structure". Additionally, Evans (1973) found that people with a high internal orientation (on the I-E scale) have stronger consideration relationships than do people whose orientation is external.

In this same vein, one could hypothesize that most engineers should express internal tendencies. If this hypothesis is correct, the series of studies provided by Rotter (1966) express strong support for the hypotheses that an internal is likely to:

(a) be more alert to those aspects of the environment which provided useful information for his future behavior;

(b) take steps to improve his environmental condition;

(c) place greater value on skill or achievement reinforcements and be generally more concerned with his ability, particularly his failures; and

(d) be resistive to subtle attempts to influence him.

If these hypotheses are valid, the implications for successful leader behavior in an R&D laboratory are evident, assuming most individuals are internals.

Additionally, as suggested by the work of Sims and Szilagyi (1975), the internal who has the desire to control his future will probably react favorably to a supervisor who he perceives to be high in positive reward behavior. As stated by Lawler and Porter (1967), "... the greater the value of a set of rewards and the higher the probability that receiving each of these rewards depends upon effort, the greater the effort that will be put forth in a given situation". The subordinate's perception of his chance of receiving rewards should impact both on job satisfaction and productivity. Thus, the combined effect of leader behavior, internal-external theory, and leader reward behavior for R&D engineers are far-reaching.

If most engineers are internals, they would show more overt striving for achievement than externals who feel that they have little control over their rewards and punishment. This hypothesis has been substantiated and internals tend to manifest greater interest and effort

in achievement-related activities than do externals (Lefcourt, 1966). In some respects, Rotter's internal-external concept and the leader reward behavior concept could be compared to a theory advanced by Vroom of ego involvement. In this theory, the degree of job involvement (an apparent correlation between involvement and leader behavior can be drawn) for a particular person was measured by his choice of "ego" rather than extrinsic factors in describing sources of satisfaction and dissatisfaction on the job. A person was described as ego-involved in a task or job to whatever extent his self-esteem (or internal characteristics) is affected by his perceived level of performance (Vroom, 1962). Vroom found that persons high in ego-involvement were rated higher in job performance than those with low ego-involvement. Thus, one could hypothesize that an internal who perceives his rewards as based on his own actions would tend to be more ego-involved in a work setting. Vroom (1962) discovered that individuals ego-involved in their jobs were more affected by the extent to which their jobs gave them an opportunity for self-expression and that the greater the opportunity for self-expression, the greater the job satisfaction and productivity.

Additionally, studies have shown that job satisfaction and productivity is congruent with the immediate supervisor's personal support and interest for the worker (Fourmet, 1966). This result would tend to support the hypotheses that in an R&D laboratory, the successful supervisor would be rated high on the "Consideration" dimension.

Thus, it is clear from the previous studies that productivity and job satisfaction might be affected by such factors as supervisory behavior, leader reward behavior, and the individual's perception of his control of reinforcement. The methods which were used to identify the relationships among these factors are described in Chapter 3.

## CHAPTER 3. METHODOLOGY

### 3.1 Introduction

The purpose of this chapter is to 1) discuss the survey technique which will be used, 2) describe the sample, 3) describe the distribution method, 4) describe the questionnaire's structure, 5) describe the measurement scales, 6) list the variable abbreviations, and 7) discuss the analytic methods which will be used to analyze the data.

### 3.2 Survey Technique

The use of a questionnaire as a data collection technique is fairly commonplace in the study of productivity and job satisfaction. Additionally, the need for a large volume of data in a relatively short period of time was the primary factor involved in selecting the questionnaire over other data collection techniques. There were 540 scientists/engineers selected to participate in this survey and they were allowed four weeks to complete and return the questionnaire.

Due to the nature of some questions, the question of anonymity was satisfied by the survey technique. Personal data on each respondent was obtained by some demographic questions which did not allow for identification of specific respondents. Additionally, the response rate and validity of responses tend to be higher when anonymity is insured for the respondents.

Some of the inherent disadvantages of the survey technique are response rate and the respondent's psychological feelings about involvement. Each of these disadvantages was partially compensated for by the location of the survey participants. Additional action was taken to further compensate for these disadvantages.

To insure a response rate which would permit a meaningful analysis of the data, the complexity of the questionnaire was reduced as much as possible, although this factor could still limit the number of responses. Additionally, the Commander of the laboratory surveyed was personally interested in this study and signed a cover letter which was attached to the questionnaire requesting each respondent's assistance in supporting this research effort. Appendix A contains these letters.

The second disadvantage of the survey technique was partially modified by the involvement of top management in this research effort. Besides providing a charge number for the time involved in completing the survey, the Commander's letter promised a short summary of the survey results to all interested participants. The questionnaire also contained a letter from the researcher stating that each participant was welcome to contact the researcher on any questions that might arise. Additionally, space was provided in the questionnaire for comments concerning the scope, intent, and length of the questionnaire.

To insure that the questionnaire was returned in time for appropriate analysis, a deadline was imposed on the respondent. A date was identified which allowed the participants four weeks to return the completed questionnaires. It was felt that this time period was long enough to include most periods of worker absenteeism, including vacations.

### 3.3 Sample

Support for this research was provided by the Air Force Flight Dynamics Laboratory (AFFDL) at Wright-Patterson Air Force Base, Ohio. As previously indicated, laboratory management actively supported this research. In addition, a sufficient number of scientists/engineers existed within this laboratory to provide a good data base.

The AFFDL administrative offices provided the necessary personnel information to identify specific individuals to receive the survey questionnaire.

Since the intent of the research was to survey primarily first-line supervisors and nonsupervisory scientists/engineers, 540 scientists/engineers were identified out of approximately 1000 people working in the laboratory. These individuals were identified by using laboratory personnel rosters and included all individuals which meet the above survey criteria.

### 3.4 Distribution

On 8 April 1977, 540 questionnaires were distributed to the five divisions within AFFDL. By 22 April 1977, the response rate was 53 percent and gradually leveling off. By the cut-off date, 1 May 1977, 61.1 percent of the questionnaires had been returned.

Four of the returned questionnaires were deleted from the survey analysis due to the respondents failure to complete any of the measures. These deletions resulted in 326 questionnaires (60.4 percent of the survey sample) being included in the final data analysis.

The 326 questionnaires consisted of 273 questionnaires with no missing data and 53 questionnaires with some missing data. The missing data was generally restricted to one of the parts, basically the Rotter I-E scale, for any one respondent and provided useful data in the analysis of the other completed parts. The impact of excluding the 53 questionnaires was considered more critical than the impact of the missing data on the analysis.

Due to the missing values, some analysis is based on a sample size of 326 while some analysis is based on a sample size as low as 214. Additionally, the group leaders accounted for 54 of the returned questionnaires. The sample size which is pertinent for a particular analysis is included in the discussion of the results.

### 3.5 Questionnaire Structure

The questionnaire used in this study consisted of five previously validated and reliable instruments. The first draft of the questionnaire consisted of the following sections: output/productivity and demographic questions, Rotter's I-E scale, Hoppock's Job Satisfaction measure, and the Supervisory Behavior Description questionnaire.

Further analysis and discussion of this draft resulted in the modification of some of the statistical and demographic questions and the addition of two sections dealing with leader reward behavior and a management development program currently being implemented in the laboratory at the request of the laboratory management.

The final questionnaire consisted of five main parts plus two cover letters (see Appendix A). Parts A, B, and C were similar to the draft questionnaire and consisted of the following question categories: output/productivity and demographic information, Rotter's I-E scale, and Hoppock's Job Satisfaction measure.

Part D was modified to include both the Supervisory Behavior Description questionnaire and the added Leader Reward Behavior instrument. This part required the respondent to identify his perceptions of his supervisor's management behavior and his supervisor's reward behavior.

Part E was added at the request of laboratory management as a means to determine the respondent's awareness of the team development program currently being conducted in the laboratory.

Due to the proven validity and reliability of the instruments used in the questionnaire, no pretest of the questions readability and comprehensibility was felt to be necessary.

The details of these measurement scales are discussed in Section 3.6.

### 3.6 Measurement Scales

Several measurement scales were used throughout this questionnaire, basically corresponding to the different instruments which were contained within. The purpose of this section is to describe the various scales used in the questionnaire. The measurement scales which are described in turn are:

- 1) Output/productivity;
- 2) Rotter's I-E scale;
- 3) Hoppock's Job Satisfaction measure;
- 4) the Supervisory Behavior Description Questionnaire; and
- 5) the Leader Reward Behavior Instrument.

#### 3.6.1 Output/Productivity

The output measurement was a quantitative measure only and was similar to the measure used at AFFDL by Stevens (1976). As indicated in Table I, the productivity of each respondent is determined by the identification of the quantity of each output category over the past two years. All outputs are treated separately in any analysis.

TABLE I  
Output/Productivity Categories

Variable Number	Output Included
1	Published Papers in Technical or Professional Journals
2	Unpublished Manuscripts
3	Technical Reports
4	Technical Memorandums
5	New or improved processes, products, and techniques, and patents or patent application.
6	Hardware/software specifications, test reports, test plans, statements of work, requests for proposal
7	Oral presentations to technical or professional audiences

The output/productivity section of the questionnaire can be referred to in Appendix A, Part A, Section I.

### 3. 6. 2 Rotter's I-E Scale

Rotter's I-E scale is a forced-choice, 29 item battery consisting of 6 fillers and 23 questions which are summed for a total score. The scale is designed to find out the way in which certain important events in our society affect different people. As a measure of personal belief, there are no right or wrong answers to the Rotter questions, however, a low score indicates that the person feels he has control over his rewards while a high score indicates that the person feels he has little control over his rewards.

The I-E scale, contained in Part B of the questionnaire, was determined by Rotter (1966) to be one dimensional. Additional studies, however, by Cherlin and Bouque (1974) and Gurin (1969) have indicated that the scale is multidimensional. The analysis of this question will be discussed in the section on analytic methods.

### 3. 6. 3 Hoppock's Job Satisfaction Measure

Hoppock's job satisfaction measure is a four-question survey which deals with the respondent's perceptions of his job. Using a seven point Likert-type scale, the answers to each question are scored from 1 to 7. The individual answers are summed to arrive at a total score whose value then ranges between 4 and 28, with the lower scores indicating less job satisfaction.

The Hoppock measure is Part C of the questionnaire. It has been shown to be a global measure of job satisfaction which is relatively easy to administer and is highly valid and reliable (McNichols, Stahl, and Manley, 1976).

### 3. 6. 4 Supervisory Behavior Description Questionnaire (SBDQ)

The SBDQ, contained in Part D of the questionnaire, was developed by Edwin A. Fleishman and was based on the "Consideration" and "Initiating Structure" format resulting from the Ohio State studies in the 1950s. The SBDQ is a 48 item questionnaire where each item is scored from 0 to 4, dependent upon the response. The "Consideration" portion (SBDQC) of the questionnaire consists of 28 questions for a range of

possible scores of 0 to 112, while the "Initiating Structure" portion (SBDQI) consists of 20 questions for a range of possible scores of 0 to 80.

Evidence that each portion of the SBDQ is valid and reliable was presented by Fleishman (1957) where most of the items assigned to each portion had high loadings with that dimension and insignificant loading with the other dimension.

### 3.6.5 Leader Reward Behavior Instrument

The Leader Reward Behavior Instrument, contained in Part D of the questionnaire, is a 22 item instrument dealing with a subordinate's perception of his supervisor's use of a reward system. Developed by Scott, Reitz, and Johnson in 1971, the Leader Reward Behavior Instrument, which utilizes a seven-point Likert scale, consists of two portions: the Leader Reward Behavior Positive (LRBP) and the Leader Reward Behavior Punitive (LRBN). The LRBP consists of 16 questions for a total range of possible scores of 16 to 112, while the LRBN consists of 6 questions with a range of possible scores of 6 to 42.

The technique of factor analysis is used to test the dimensionality of this instrument and is described in Section 3.8.

### 3.7 Variable Abbreviations

Table II lists the different sections identified in the questionnaire and their associated variables and variable abbreviations used for analysis purposes.

TABLE II  
Variable Abbreviations

Variable Category and Abbreviation	Variable Title
Demographic Control Variables	
AGE	Age
GRADE	Civilian grade or military rank
YRRSEC	Actual years in section
YRSIS	Actual years under immediate supervisor
EDCTN	Level of education
NCWR	Percent of current work in research
NCWD	Percent of current work in development
CONM	Percent of current work in contract monitoring
YEXP	Years of scientific/engineering experience
Productivity	
PVAR 1	Published papers in professional/technical journals
PVAR 2	Unpublished manuscripts
PVAR 3	Technical Reports
PVAR 4	Technical Memorandums
PVAR 5	New or improved processes, products, and techniques, and patents or patent application
PVAR 6	Hardware/software specifications, test reports, test plans, statements of work, requests for proposals
PVAR 7	Oral presentations to technical or professional audiences
Group Leader	
GPL	Identification of group leaders
I-E Scale	
R1 to R29	Rotter's 29 questions
ROT	Rotter's total summed score

TABLE II  
(continued)

Variable Category and Abbreviation	Variable Title
Job Satisfaction	
H1 to H4 HOP	Respondent's score for each Hoppock question Job satisfaction summed score
Supervisory Behavior	
S1 to S48 SBDQC SBDQI	Respondent's score for each SBDQ question Consideration total score Initiating Structure total score
Leader Reward Behavior	
L1 to L22 LRBP LRBN	Respondent's score for each leader reward behavior question Positive reward behavior total score Punitive reward behavior total score
Team Development	
AWARE PART	Awareness of team development program Participation in team development program
MILCIV	Identification of Military Respondents

### 3.8 Analytic Methods

The objectives which were introduced in Chapter I dictate the use of certain analytic techniques.

Many of the variable relationships require relatively simple statistical techniques while others require more complex and detailed analytical techniques. The following analytical techniques were identified for application to the survey data. In addition, the techniques

were available in local computer facilities through the Statistical Package for the Social Sciences (SPSS).

Due to the fact that the group leaders are included in survey data, analysis of the data required the application of the analytical techniques to both the nonsupervisory group and the group leaders as two separate and distinct groups.

Additionally, a commonly held practice requires at least one data point for each estimated parameter. For this reason, certain analytical techniques could not be applied to all the data. Techniques where the amount of data points did not satisfy this requirement are identified in subsequent sections.

#### 3.8.1 Frequencies and Statistics

Means, standard deviations, frequency of responses, and the number of valid data responses was identified for each variable, where appropriate, using the statistical routines available in SPSS. This analysis allows a quick check for the data's distribution and the appropriateness of the responses.

#### 3.8.2 Factor Analysis

Each of the instruments in this questionnaire have been factor analyzed in other studies. In particular, Rotter's I-E scale and the Leader Reward Behavior instrument have been investigated for their dimensionality. For this reason, factor analysis was applied to the

survey data to test for the dimensionality of each of these measures for this sample.

The SBDQ could not be factor analyzed because the amount of data was not large enough to meet the aforementioned restriction.

There are three decisions to be made when utilizing factor analysis. The method of factor analysis, the method of axis rotation, and the decision rule to apply to the initial factors must be identified.

The SPSS manual identifies five factor analysis methods. Principal factoring without iteration was selected as the factor analysis technique for this research because of its frequency of use in this type of research and the recommendation of the writers of the SPSS manual to those individuals who are unfamiliar with factor analysis methods (Nie, et al, 1975).

The VARIMAX orthogonal method of rotation was also selected because of its frequency of use and the same recommendations by the authors of the SPSS manual.

Harman (1976) identifies two decision rules to apply to select factors which have any practical significance. These decision rules are: 1) the scree rule, and 2) the rule which proscribes retaining a number of factors equal to the number of principal components whose eigenvalues are greater than one. For purposes of this study, only the second decision rule was used to select significant factors because of its frequency of use.

### 3.8.3 Correlation Analysis

The next step in the analysis process was a general check of the linear relationships between the variables in Table II. For those variables approximated by a normal distribution, the Pearson Product-Moment correlations were calculated using the appropriate SPSS routine.

It was expected that the productivity variables would not approximate normal distributions (Stevens, 1976), therefore, nonparametric techniques within SPSS were used to calculate variable correlations. For purposes of this research, if nonparametric correlations are required, the Spearman correlation coefficients were calculated and used for determining variables relationships.

### 3.8.4 Regression Analysis of Predictor Variable

Once the degree of linear correlation between variables had been determined, an investigation was made on the amount of variance displayed by the criterion variables. Due to the expected nature of the productivity distributions, regression analysis was used to analyze only the job satisfaction variable.

Although a number of regression techniques are available, forward stepwise inclusion was selected as the most appropriate regression method for this analysis. Forward inclusion was used on the job satisfaction variable with the individual variables and supervisory variables serving as the predictor variables.

Due to the small number of data points available on group leaders, regression analysis was not used to analyze the job satisfaction of these individuals.

#### 3.8.5 Test of Means

As a result of the analysis it is hoped that distinctions may be made between productive and nonproductive individuals. In an attempt to determine differences within laboratory groups, tests of means were utilized to test for differences in the individual and supervisory variables between the productive and nonproductive groupings.

Due to the robustness of the t test (Boneau, 1960), this test was used to test for significant differences between means for both the productive and nonproductive nonsupervisory scientists/engineers and for both the productive and nonproductive group leaders.

#### 3.8.6 Discriminant Analysis of Productivity

The final analysis technique used was discriminant analysis. This analysis was based on a collection of variables and was an attempt to derive discriminant functions which could allow the classification of the nonsupervisory scientists/engineers into productive and nonproductive categories.

Although a number of reasonable SPSS techniques existed, variables which minimized the Wilk's lambda were selected with an F criterion of 3.0 established for both inclusion and deletion of variables. Finally, the prior probabilities used in this study were based on group size.

For the reader unfamiliar with the discriminant analysis results, the maximum chance criterion was provided in the results as a guide to the merit of the discriminant function classification results (Morrison, 1969).

Discriminant analysis was not applied to the group leaders because of an inadequate sample size for the technique.

## CHAPTER 4

### RESULTS

#### 4.1 Overview of Analysis

Due to the large amount of analysis performed on the questionnaire data, the results of the analysis will be presented in a manner which allows a logical flow from the analysis of one area to related areas. Additionally, the amount of the results was increased because of the need to divide the sample into nonsupervisory scientists/engineers and into group leaders. Separate results will be presented for the two groups. For these reasons the following outline will serve as a guide to the analysis results presented in this chapter:

- 4.2 Introduction
  - 4.2.1 Deleted Variables
  - 4.2.2 Statistical Characteristics of the Respondents
- 4.3 Dimensionality of the Measurement Scales
  - 4.3.1 Rotter's I-E Scale
  - 4.3.2 Leader Reward Behavior Instrument
- 4.4 Analysis of Productivity Variables
  - 4.4.1 Productivity Statistics
  - 4.4.2 Correlations Between Output Variables
  - 4.4.3 Correlations Between Productivity and Demographics
  - 4.4.4 Correlations Between Productivity and Predictor Variables
  - 4.4.5 Tests of Means Between Productive/Nonproductive Categories
    - 4.4.5.1 Tests of Means Based on Demographic Variables
    - 4.4.5.2 Tests of Means Based on Predictor Variables
  - 4.4.6 Discriminant Analysis of Productivity Variables

- 4.5 Analysis of Job Satisfaction
  - 4.5.1 Job Satisfaction Statistics
  - 4.5.2 Correlations Between Job Satisfaction and Demographics
  - 4.5.3 Correlations Between Job Satisfaction and Predictor Variables
  - 4.5.4 Regression Analysis
- 4.6 Analysis of Team Development Questions
- 4.7 Summary of Results: Hypotheses Tested
  - 4.7.1 Comparison for Nonsupervisory Scientists/Engineers
  - 4.7.2 Comparison for Group Leaders

## 4.2 Introduction

A preliminary analysis of the returned questionnaires resulted in the deletion of one productivity variable from further analysis. In addition, the productivity variables were approximated, as expected, more by an exponential than a normal distribution. As a result of these distributions, the nonparametric Spearman correlation coefficient was calculated for the productivity variables.

### 4.2.1 Deleted Variables

One productivity variable was deleted from further analysis due to the questionable validity of a number of responses. The variable "oral presentation to technical or professional audiences" (PVAR 7) appeared to be interpreted differently than was originally intended by the researcher. The actual number of such presentations reported by some of the respondents was inordinately high for a two year reporting (for example, fifty presentations). Since this variable was designed to measure "oral presentations" at professional symposiums, it was clear that this variable

was not interpreted by the respondents as it was originally designed and thus, deletion was valid for this variable.

This inflated productivity value could have been caused by either the respondents reporting productivity for a time period greater than a two year reporting period or by including any form of briefing or presentation as a part of this output.

The former problem was taken into account during the initial analysis of the questionnaire. A maximum number of fifteen published papers, ten unpublished manuscripts, 20 technical reports or technical memorandums, 20 new or improved processes (PVAR 5) and 20 hardware/software specifications (PVAR 6) was considered a reasonable maximum amount which could be produced in a two year period. Respondents which exceeded these quantity values were deleted from any analysis dealing with productivity as a relatively continuous measure, but were used in analysis dealing with nonproductive or productive dichotomies. This deletion resulted in the loss of three nonsupervisory scientists and engineers and one group leaders for the correlation analysis and did not significantly affect the results.

#### 4. 2. 2 Statistical Characteristics of the Respondents

Tables III and IV identify the general demographic characteristics of the nonsupervisory scientists/engineers and of the group leaders surveyed. The coding scheme for these variables may be found in Appendix B.

TABLE III  
Demographic Characteristics of the Respondents

Variable <sup>1</sup> Abbreviations	Mean/Standard Deviation/Range	
	Nonsupervisory N = 272	Group Leaders N = 54
AGE	36.6/9.1/22-64	42.4/6.5/31-64
YRSSEC	5.9/5.2/0-27	7.6/6.8/0-26
YRSIS	3.5/4.0/0-20	2.8/3.0/0-13
NCWR	32.0/37.2/0-100	16.6/21.4/0-75
NCWD	55.9/39.5/0-100	34.3/33.6/0-100
CONM	22.2/27.4/0-100	9.9/13.0/0-50
YEXP	12.0/8.4/0-38	17.9/7.6/0-40

<sup>1</sup> See Table II for explanations of abbreviations

TABLE IV  
Group Characteristics

Variable Abbreviations	Subcategory	Number of Respondents 2	
		Nonsupervisory	Group Leaders
GRADE	GS 6, 7, 8, or 2nd Lt	15	0
	GS 9, 10, or 1st Lt	17	0
	GS II	22	0
	GS I2 or Captain	107	4
	GS I3 or Major	100	28
	GS I4 or Lt Colonel	11	21
	GS I5 or Colonel	0	1
EDCTN	BS Degree	55	9
	BS +	77	9
	MS Degree	62	14
	MS +	57	10
	Ph. D.	21	12
MILCIV	Military	64	8
	Civilian	208	46

1 See Table II for explanation

2 N = 272 for nonsupervisory; N = 54 for group leaders

### 4.3 Dimensionality of the Measurement Scales

In order to test the dimensionality of the measures for this sample, principal factoring without iteration with varimax rotation was applied to Rotter's I-E scale and the Leader Reward Behavior Instrument. The following criteria were used throughout the factor analyses unless otherwise noted: 1) the number of factors retained was equal to the number of principal components whose eigenvalues were greater than one and 2) items were considered to "load" on a rotated factor if their loadings on that factor were .40 or greater. In each case, previous studies provided data which allowed the comparison of the factor analysis conducted on this sample with other research efforts.

#### 4.3.1 Rotter's I-E Scale

In his formulation of the I-E scale, Rotter conducted two factor analyses (Rotter, 1966). The first analysis, involving some 400 cases, indicated that much of the variance was included in a general factor. Several additional factors involved only a few items, and only a small degree of variance for each factor could be isolated. A similar result was obtained by Franklin (1963) where all of the items loaded significantly on a general factor which accounted for 53% of the total scale variance.

The Pearson product moment correlation coefficients obtained by correlating the individual Rotter questions are contained in Appendix C.

These coefficients reveal that many questions were significantly inter-related. A factor analysis of the 23 questions which make up the total Rotter score resulted in seven factors.

Appendix D contains the results of the factor analysis including the eigenvalue for each factor and the varimax rotated factor matrix.

Table V provides a summary of the factor analysis. The items (R1 to R29) correspond to the questions (1 to 29) contained in Appendix A (Part B).

TABLE V  
Rotter I-E Scale Factor Analysis (N=273)

Factor 1	Factor 2	Factor 3	Factor 4
R3(.43)	R4(.57)	R2(.67)	R9(.61)
R12(.73)	R6(.64)	R18(.43)	R13(.47)
R17(.67)	R11(.53)	R21(.76)	R15(.59)
R22(.73)	R16(.71)		
R29(.46)	R25(.45)		
	R28(.64)		
Factor 5	Factor 6	Factor 7	
R7(.61)	R10(.70)	R5(.60)	
R20(.66)	R23(.75)		
R26(.61)			

The results of Table V clearly indicate that the Rotter I-E scale is multidimensional for this sample, a contradiction to Rotter's claim that the scale measures the one dimension of general control. Other

researchers (Gurin, 1969; Cherlin, 1974) have found that the characteristics of the population sampled may affect the structure of the factors obtained. In particular, Cherlin found two factors which he referred to as general control and political control. If these same terms were applied to the present analysis, the only clear-cut factor is Factor 1 which corresponds to Cherlin's political control. The remaining factors reveal no distinct separation of items into categories. Although the scale does not measure one dimension and therefore it would be invalid to identify internals or externals, it was decided that the total Rotter score might provide a valuable prediction of productivity and job satisfaction and, therefore, was used in additional analyses.

#### 4.3.2 Leader Reward Behavior Instrument (LRBI)

The Pearson correlation coefficients obtained by correlating the individual LRBI questions with each other are contained in Appendix E. These coefficients reveal that many questions were significantly inter-related. A factor analysis of these questions resulted in three new factors being identified with eigenvalues greater than one. Very little variance was explained by the third factor and it was eliminated in order to compare the results of this study with the original analysis by Johnson (1973). Table VI provides the eigenvalues and associated percent of explained variance.

TABLE VI

## Eigenvalues of LRBI Factor Analysis

Factor	Eigenvalue	Percentage of Variation	Cumulative Percentage
1	8.81286	40.1	40.1
2	2.53789	11.5	51.6
3	1.07063	4.9	56.5

The data included in Table VII contains the rotated factor matrix derived from this sample and the factor matrix derived by Johnson (1973) in the original factor analysis of the instrument.

TABLE VII

## Leader Reward Behavior Factor Analysis

	Sample Analysis		Johnson Analysis	
	Factor 1	Factor 2	Factor 1	Factor 2
L1	.79	-.08	.71	-.07
L2	-.22	.52	-.17	.49
L3	.71	-.15	.70	-.10
L4	.58	.30	.52	.32
L5	-.04	.50	-.06	.33
L6	.78	.07	.72	.06
L7	.00	.68	-.01	.56
L8	.77	.13	.70	.07
L9	.55	.03	.62	-.03
L10	.83	-.01	.77	-.01
L11	.25	.73	.23	.60
L12	.19	.71	.08	.65
L13	.76	.06	.75	-.02
L14	.81	.03	.75	.01
L15	.84	.00	.78	-.01
L16	.70	.22	.59	.24
L17	.20	.53	.12	.39
L18	.66	.38	.56	.41
L19	.62	.11	.64	.13
L20	.67	-.07	.62	-.06
L21	.63	.21	.41	.17
L22	.74	.25	.51	.23

As identified by Johnson, Factor 1 was termed positive reward behavior and Factor 2, punitive reward behavior. The factor analysis results indicate that L2, L5, L7, L11, L12, L17 load only on the second factor while the remaining items load only on the first factor.

Clearly, the results of the factor analysis reveal two distinct factors: Factor 1 which can be labeled "Positive Reward Behavior", representing the relationship between good performance and leader-administered rewards; and Factor 2 which can be labeled "Punitive Reward Behavior", representing the relationship between low job performance and leader corrective behavior.

#### 4.4 Analysis of Productivity Variables

The analysis of productivity for the respondents was based on six categories. Table II previously identified those six categories. The seventh productivity variable identified in Table II, "oral presentations", was deleted from analysis for reasons previously discussed. Since the analysis was conducted on two groups (nonsupervisory scientists/engineers and group leaders), the analysis results for these groups is presented separately.

##### 4.4.1 Productivity Statistics

Table VIII identifies the statistical data for the six output categories for the nonsupervisory scientists/engineers and for the group leaders.

TABLE VIII

Productivity Statistics

Variable	Mean/Standard Deviation/Maximum Output/Percentage of Responses with No Output	Group Leaders (N=54)
	Nonsupervisory (N=272)	
PVAR 1	.71/1.6/15/67.3%	.82/1.2/5/57.4%
PVAR 2	.63/1.3/10/69.1%	.87/1.4/6/59.3%
PVAR 3	.67/1.6/20/64.0%	.85/1.7/9/61.1%
PVAR 4	.97/1.4/7/53.3%	1.82/3.4/20/50.0%
PVAR 5	.20/.5/3/85.7%	.41/.9/4/75.9%
PVAR 6	2.86/4.2/40/33.8%	5.33/8.4/50/29.6%

#### 4.4.2 Correlations Among Output Variables

Table IX identifies the Spearman correlations among the six output categories for the nonsupervisory scientists/engineers and for the group leaders.

TABLE IX  
Correlations Among Outputs

Nonsupervisory Scientists/Engineers (N=269)						
	PVAR1	PVAR2	PVAR3	PVAR4	PVAR5	PVAR6
PVAR1	1.000	.256*	.231*	-.064	.144*	.094
PVAR2		1.000	.166*	.151*	.267*	.182*
PVAR3			1.000	.075	.207*	.174*
PVAR4				1.000	.091	.134**
PVAR5					1.000	.261*
PVAR6						1.000
Group Leaders (N=53)						
	PVAR1	PVAR2	PVAR3	PVAR4	PVAR5	PVAR6
PVAR1	1.000	.394*	.199	.220	.086	-.073
PVAR2		1.000	.237**	.290**	.091	.104
PVAR3			1.000	.379*	.409*	.138
PVAR4				1.000	.318*	.294**
PVAR5					1.000	.285**
PVAR6						1.000
*P less than or equal to .01						
**P less than or equal to .05						

Table IX indicates, for the nonsupervisory scientists/engineers, that significant correlations exist between the publication of journal articles and unpublished manuscripts, the publication of journal articles and the writing of technical reports, the publication of journal articles and new or improved processes, products, techniques, and patents or patent application, the writing of unpublished manuscripts and the writing of technical memorandums, the writing of unpublished manuscripts and new or improved products, processes, techniques and patents or patent application, the writing of unpublished manuscripts and the output associated with contract monitoring, the writing of technical reports and new or improved products, processes, techniques, and patents or patent application, the writing of technical reports and the output associated with contract monitoring, the writing of technical memorandums and the output associated with contract monitoring, and new or improved processes, products, techniques and patents or patent application and output associated with contract monitoring. Although these correlations are significant, they are weak, indicating little association among the various productivity variables under consideration. Thus, it would appear to be appropriate to analyze these variables separately.

For the group leaders, Table IX indicates that significant, although weak, correlations exist between the publication of journal articles and unpublished manuscripts, the writing of technical reports and the writing

of technical memorandum, and the writing of technical reports and new or improved processes, products, techniques and patents or patent application for the group leaders. Thus, as was the case with the nonsupervisory scientists/engineers, it would appear to be appropriate to analyze these variables separately.

#### 4.4.3 Correlations Among Productivity and Demographics

Table X identifies the Spearman correlations among the six output categories and the nine demographic variables for the nonsupervisory scientists/engineers and for the group leaders.

TABLE X  
Productivity Correlations With Demographic Variables

Nonsupervisory Scientists/Engineers (N=269)						
	PVAR1	PVAR2	PVAR3	PVAR4	PVAR5	PVAR6
AGE	.094	.037	.218**	-.043	.125*	.113*
GRADE	.196**	.118*	.183**	-.010	.169**	.126*
YRSSEC	.051	.079	.175**	.135*	.133	.226**
YRSIS	-.025	.034	.118*	.114*	.036	.210**
EDCTN	.306**	.165**	.076	-.012	.097	-.006
NCWR	.068	.132*	.130*	.126	.069	.019
NCWD	-.005	-.064	-.109*	-.062	.010	.027
CONM	.068	-.062	.013	-.039	-.067	.212*
YEXP	.138*	.095	.208**	.012	.147*	.148**
Group Leaders (N=53)						
AGE	-.085	.018	.000	.078	.017	-.015
GRADE	.084	.133	.109	-.079	.150	-.015
YRSSEC	-.090	-.102	-.088	-.238*	.066	.062
YRSIS	.209	.075	-.090	-.141	-.085	-.059
EDCTN	.406**	.409**	.271	.201	.182	-.057
NCWR	.446**	.148	.162	.150	.169	-.042
NCWD	-.129	.024	-.056	-.015	.152	.142
CONM	.252*	.230	.197	.088	-.011	.433**
YEXP	-.133	-.043	-.003	-.057	.073	-.124
*P less than or equal to .05						
**P less than or equal to .01						

For the nonsupervisory scientists/engineers, Table X identifies a significant negative correlation between the percentage of time spent in development and the number of technical reports written (PVAR3). Whether this information indicates that the amount of time spent in development activities can inhibit this type of output requires further investigation. The positive correlation between the amount of time spent in research and the number of technical reports written indicates that technical reports are associated with research activities.

For the group leaders, Table X identifies a significant positive correlation between the amount of time spent in research and the number of published journal articles. Surprisingly, a significant positive correlation exists between the amount of time spent in contract monitoring and the number of published journal articles.

#### 4.4.4 Correlations Among Productivity and Predictor Variables

Table XI lists the Spearman correlations among the productivity variables and the predictor variables for the nonsupervisory scientists/engineers and the group leaders. Due to the number of missing values, the sample size corresponding to the predictor variables is in parenthesis beside the variable abbreviations.

TABLE XI

## Productivity Correlations With Predictor Variables

Nonsupervisory Scientists/Engineers						
Predictor Variables <sup>1</sup>	PVAR1	PVAR2	PVAR3	PVAR4	PVAR5	PVAR6
ROT(225)	.031	.051	.062	.096	.138*	-.019
HOP(269)	.052	.064	-.036	-.095	.040	-.080
SBDQC(255)	-.006	.042	-.024	-.046	.003	-.104*
SBDQI(255)	-.117*	-.104*	-.092	-.097	-.026	-.015
LRBP(261)	-.020	.060	-.080	-.031	-.019	-.047
LRBN(260)	-.008	-.058	-.013	-.135*	.061	.018
Group Leaders						
ROT(45)	-.024	.089	-.082	.045	.057	.107
HOP(53)	.020	-.224	-.010	.026	.186	.202
SBDQC(48)	-.159	-.086	.024	.002	.071	.128
SBDQI(49)	-.048	-.179	-.088	.032	.041	.208
LRBP(50)	-.215	-.126	-.004	-.046	.029	.104
LRBN(50)	-.031	-.117	.284*	.000	.249*	-.087
1 See Table II for explanation of abbreviations						
* P less than or equal to .05						
** P less than or equal to .01						

For the nonsupervisory scientists, Table XI identifies a significant, but weak, correlation that exists between the concept measured by the Rotter scale and new or improved processes, products, techniques, and patents or patent application. The justification for this correlation would only be speculation since difficulty exists in determining what actually is measured by Rotter's scale.

Additionally, two rather surprising results are the significant negative correlations between initiating structure and published journal articles, and initiating structure and unpublished manuscripts. These correlations indicate that a supervisor high in initiating structure is

associated with lower output in these two types of productivity. A parallel correlation is the significant negative relationship between punitive leader reward behavior and technical memorandum. This correlation also indicates that a supervisor high in punitive reward behavior is associated with lower technical memorandum output.

Consideration by the supervisor, however, also tends to inhibit one type of output. A significant negative correlation exists between consideration and the output associated with contract monitoring. Thus, a supervisor high in consideration is associated with lower contract monitoring output.

For the group leaders, Table XI identifies only two significant correlations, both involving the individual's perception of his supervisor's negative reward behavior. Negative leader reward behavior is significantly positively correlated with both technical reports (PVAR3) and new or improved processes, products, techniques, and patents or patent application (PVAR5). These positive correlations indicate that the perception by the group leaders that their supervisors are likely to use punitive reward behavior for low performance in these two categories tends to be associated with these two types of output.

#### 4.4.5 Tests of Means Between Productive/Nonproductive Categories

Although the correlation coefficients identified many significant relationships between the productivity variables and both the demographic and the predictor variables, no consistent set of variables were found

which were uniform across the entire set of productivity variables. Due to the exponential distributions associated with the productivity variables and the number of responses with no output, the two groups (the nonsupervisory scientists/engineers and the group leaders) were divided into productive and nonproductive groups as previously defined. Tests of means were then used to analyze group differences. Due to the volume of analysis material, the results are presented in two sections: first, productive/nonproductive versus the demographic variables, and then, productive/nonproductive versus the predictor variables.

#### 4.4.5.1 Tests of Means Based on Demographic Variable

Table XII identifies the results of tests of means between the productive and nonproductive categories based on the demographic variables for the nonsupervisory scientists/engineers.

Table XII identifies GRADE as being the demographic variable for which a significant difference exists between the productive and nonproductive categories for each productivity variable except for technical memorandums (PVAR4). Additionally, a significant difference exists between the productive/nonproductive groups for published journal articles (PVAR1) on EDCTN and YEXP, for unpublished manuscripts on EDCTN, for technical reports on AGE, YRSSEC, and YEXP, for new or improved processes, products, techniques and patents or patent application on YEXP, and for output associated with contract monitoring on YEXP. No significant differences existed between the productive and nonproductive groups for technical memorandum (PVAR4).

TABLE XII

Productive / Nonproductive

Variable	Group*	Mean/Probability					
		PVARI	PVAR2	PVAR3	PVAR4	PVAR5	PVAR6
AGE	1	36.1/.182	36.5/.861	35.2/.001	37.0/.402	36.2/.078	35.1/.055
	2	37.6	36.7	39.1	36.1	39.0	37.3
GRADE	1	3.9/.001	3.9/.022	3.9/.035	4.0/.662	4.0/.011	3.7/.003
	2	4.4	4.2	4.2	4.1	4.5	4.2
YRSSEC	1	5.8/.712	5.7/.458	5.2/.005	5.4/.098	5.6/.058	4.6/.002
	2	6.0	6.2	7.0	6.4	7.3	6.5
YRSIS	1	3.7/.074	3.4/.902	3.2/.177	3.1/.196	3.3/.427	2.8/.075
	2	2.9	3.5	3.8	3.7	3.9	3.7
EDCTN	1	2.4/.000	2.5/.002	2.6/.320	2.6/.774	2.6/.135	2.6/.517
	2	3.2	3.0	2.7	2.6	2.9	2.7
YEXP	1	11.3/.049	11.6/.298	10.8/.002	11.9/.915	11.5/.029	10.3/.016
	2	13.4	12.8	14.1	12.0	14.7	12.9
*Group 1 Nonproductive:		For PVARI (N=183), PVAR2 (N=188), PVAR3 (N=174), PVAR4 (N=145), PVAR5 (N=233), and PVAR6 (N=92).					
2 Productive:		For PVARI (N=89), PVAR2 (N=84), PVAR3 (N=98), PVAR4 (N=127), PVAR5 (N=39), and PVAR6 (N=180).					

Table XII identifies the results of tests of means between the productive and nonproductive categories based on the demographic variables for the group leaders.

Table XIII identifies significant differences between productive and nonproductive group leaders on the various productivity variables. EDCTN was found to be a significant variable for identifying differences between productive and nonproductive group leaders on published journal articles, unpublished manuscripts, and technical reports. No significant differences were identified between productive and nonproductive group leaders on technical memorandums and new or improved processes, products, techniques and patents or patent application. YEXP was found to be significantly different between productive and nonproductive group leaders on the output associated with contract monitoring.

#### 4.4.5.2 Tests of Means Based on Predictor Variables

Table XIV identifies the results of tests of means between the productive and nonproductive categories based on the predictor variables of ROT, HOP, SBDQC, SBDQI, LRBP, and LRBN for the nonsupervisory scientists and engineers.

TABLE XIII

## Productive/Nonproductive Group Leaders

Variable	Group*	Mean/Probability					
		PVARI	PVAR2	PVAR3	PVAR4	PVAR5	PVAR6
AGE	1	43.1/.270	42.5/.828	42.4/.852	43.3/.269	42.1/.755	45.0/.102
	2	41.2	42.1	42.1	41.3	42.8	41.2
GRADE	1	5.3/.704	5.2/.340	5.3/.493	5.4/.534	5.3/.489	5.5/.123
	2	5.3	5.4	5.4	5.2	5.4	5.2
YRSSEC	1	8.3/.402	8.0/.591	8.2/.378	9.3/.058	7.1/.380	9.2/.257
	2	6.6	7.0	6.5	5.8	9.0	6.9
YRSIS	1	2.2/.170	2.7/.992	2.9/.556	3.1/.414	2.8/.742	3.3/.395
	2	3.4	2.7	2.4	2.4	2.5	2.5
EDCTN	1	2.6/.004	2.6/.004	2.8/.037	2.7/.062	3.0/.226	3.3/.535
	2	3.7	3.7	3.6	3.4	3.5	3.0
YEXP	1	18.8/.263	18.1/.768	17.8/.950	18.2/.736	17.5/.541	21.1/.035
	2	16.5	17.5	17.9	17.5	19.0	16.4
*Group 1	Nonproductive:	For PVARI (N=31),	PVAR2 (N=32),	PVAR3 (N=33),	PVAR4 (N=27),		
		PVAR5 N=41),	and PVAR6 (N=16)				
2	Productive:	For PVARI (N=23),	PVAR2 (N=22),	PVAR3 (N=21),	PVAR4 (N=27),		
		PVAR5 (N=13),	and PVAR6 (N=38).				

TABLE XIV

Productive / Nonproductive

Variable	Group*	Number of Cases/Mean/Probability			
		PVARI	PVAR2	PVAR3	PVAR6
ROT	1	155/8.0/.518	162/7.9/.387	146/7.9/.369	
	2	72/8.4	65/8.5	81/8.5	
HOP	1	183/18.7/.451	188/18.7/.669	174/18.8/.785	
	2	89/19.0	84/18.9	98/18.7	
SBDQC	1	175/72.0/.693	179/71.5/.258	165/72.8/.513	
	2	83/72.9	79/74.1	93/71.4	
SBDQI	1	175/36.9/.059	179/36.7/.150	165/36.8/.135	
	2	83/34.6	79/35.0	93/35.1	
LRBP	1	178/82.0/.745	184/81.1/.098	169/83.1/.339	
	2	86/82.8	80/84.9	95/80.8	
LRBN	1	177/22.6/.702	183/22.8/.193	169/22.8/.334	
	2	86/22.3	80/21.8	94/22.0	
		PVAR4	PVAR5	PVAR6	
ROT	1	122/7.8/.335	194/7.9/.041	72/8.2/.744	
	2	105/8.4	33/9.6	155/8.0	
HOP	1	145/19.0/.208	233/18.7/.494	92/19.0/.493	
	2	127/18.5	39/19.7	180/18.7	
SBDQC	1	135/73.3/.305	221/72.1/.652	85/73.6/.371	
	2	123/71.2	37/73.5	173/71.7	
SBDQI	1	134/36.9/.176	221/36.2/.915	84/36.1/.981	
	2	124/35.4	37/36.0	174/36.2	
LRBP	1	141/82.4/.852	228/82.3/.851	89/82.3/.952	
	2	123/82.0	36/81.7	175/82.2	
LRBN	1	141/23.1/.072	227/22.4/.476	89/22.0/.359	
	2	122/21.8	36/23.2	174/22.8	
* Group 1	Nonproductive				
2	Productive				

Surprisingly, only one difference was found between the productive and nonproductive groups over all predictor variables and productivity variables. ROT was identified as a distinguishing variable for new or improved processes, products, techniques and patents or patent application (PVAR5). A significant difference was found between the productive or more external group as defined by the I-E scale and the nonproductive or more internal group as defined by the I-E scale.

Table XV identifies the results of tests of means between the productive and nonproductive categories based on the predictor variables of ROT, HOP, SBDQC, SBDQI, LRBP, and LRBN for the group leaders.

TABLE XV

Productive/Nonproductive Group Leaders

Variable	Group*	Number of Cases/Mean/Probability		
		PVAR1	PVAR2	PVAR3
ROT	1	27/6.9/.957	29/6.8/.993	27/7.1/.729
	2	19/6.8	17/6.8	19/6.5
HOP	1	31/19.6/.784	32/20.3/.103	33/19.8/.765
	2	23/19.9	22/18.9	21/19.6
SBDQC	1	30/72.8/.241	29/71.6/.618	31/70.6/.973
	2	19/67.4	20/69.4	18/70.8
SBDQI	1	30/37.4/.432	29/38.5/.031	31/37.3/.445
	2	20/35.7	21/34.1	19/35.7
LRBP	1	29/85.5/.010	30/81.9/.328	32/80.2/.819
	2	22/72.2	21/76.7	19/79.0
LRBN	1	29/25.3/.458	30/25.5/.293	32/23.0/.026
	2	22/23.8	21/23.4	19/27.4
		PVAR4	PVAR5	PVAR6
ROT	1	25/6.8/.941	35/6.8/.936	14/6.9/.974
	2	21/6.9	11/7.0	32/6.8
HOP	1	27/20.0/.600	41/19.4/.185	16/19.3/.476
	2	27/19.5	13/20.7	38/19.9
SBDQC	1	25/69.5/.590	37/69.6/.390	15/66.9/.254
	2	24/71.9	12/74.0	34/72.4
SBDQI	1	25/36.7/.985	38/36.5/.679	15/36.1/.700
	2	25/36.7	12/37.5	35/37.0
LRBP	1	26/80.3/.817	38/78.6/.454	16/76.6/.426
	2	25/79.1	13/83.1	35/81.2
LRBN	1	26/24.4/.813	38/23.8/.158	16/24.8/.930
	2	25/24.9	13/27.0	35/24.6
* Group 1	Nonproductive			
2	Productive			

Table XV identified significant differences for three of the productivity variables based on the predictor variables. A significant difference exists between the productive and nonproductive group leaders based on the LRBP variable for published journal articles (PVAR 1). The productive group leaders perceived their supervisors as exhibiting lower positive reward behavior than did the nonproductive group leaders. This result may indicate a perception by the productive group leaders that they are not being rewarded for performance in this category.

A significant difference based on SBDQI was identified for unpublished manuscripts (PVAR2). In this case the productive group leaders indicated a lower perception of initiating structure than did the nonproductive group leaders.

For technical reports (PVAR3), a significant difference existed between productive and nonproductive group leaders based on LRBN. The productive group leaders perceive their supervisors as exhibiting higher punitive reward behavior than did the nonproductive group leaders. This result may indicate a perception by the productive group leaders that unless their performance in PVAR3 is sufficient, their supervisors will take punitive reward action for low performance.

#### 4. 4. 6 Discriminant Analysis of Productivity Variables

Discriminant analysis was applied to each of the productivity variables in an attempt to derive sets of predictor variables which would be valuable in significantly predicting whether an individual is

productive or nonproductive. Additionally, discriminant analysis was applied to the respondents in an attempt to classify them as productive or nonproductive based on these functions.

Three measures of "goodness" are presented in the analysis. First, the significance of each variable in the discriminant function is included in the appropriate table. Second, a comparison is made between the percent correctly classified by the discriminant and the percentage of respondents which could be correctly classified by chance (maximum chance criterion). Third, the canonical correlation associated with each discriminant function is provided. This correlation, when squared, is a rough measure of the percentage of the variance explained in each of the productivity variables by the discriminant function. In a general sense, the derived variables were weak, although significant, predictors of productivity and of a respondent's classification.

Additionally, the reader is cautioned that upward bias may have resulted in the classification process since the same individuals used to calculate the discriminant functions were also used in this process. This procedure was necessary due to an inadequate sample sizing for splitting the sample into two groups.

As was previously stated, discriminant analysis was applied only to the nonsupervisory scientists/engineers resulting in a sample size of 214.

The discriminant analysis results for published journal articles (PVARI) are contained in Table XVI.

TABLE XVI

Discriminant Analysis of PVARI

Significant Variable	Step Entered	Significance	Standardized Coefficient
EDCTN	1	.000	.68129
GRADE	2	.000	.59628
YRSIS	3	.000	-.45475

These three significant variables resulted in the correct classification of 148 or 69.2 percent of the respondents. This classification procedure was slightly better than the maximum chance criterion of 67 percent, although the canonical correlation for the discriminant function was .37116. Therefore, the discriminant function is significant, although weak in predicting this output.

The discriminant analysis results for unpublished manuscripts (PVAR2) are contained in Table XVIII.

TABLE XVII

Discriminant Analysis of PVAR2

Significant Variable	Step Entered	Significance	Standardized Coefficient
EDCTN	1	.001	1.20495

The one significant variable of EDCTN resulted in an extremely weak canonical correlation of .02968. The discriminating function resulted in the correct classification of 150 or 70.1 percent of the respondents. Since the maximum chance criterion for this productivity variable was 70 percent, the 70.1 percent classification result is not too impressive.

Table XVIII identifies the discriminant analysis results for technical reports (PVAR3).

TABLE XVIII  
Discriminant Analysis of PVAR3

Significant Variable	Step Entered	Significance	Standardized Coefficient
AGE	1	.000	8.78359

The use of the AGE variable in the discrimination function resulted in the correct classification of 60.3 percent or 129 of the respondents. This percentage was considerably less than the maximum chance criterion of 64 percent. The canonical correlation for the function is also unimpressive with a value of .24906. These results indicate that strictly by chance individuals could be classified better than by use of the AGE variable in a discriminating function. Therefore, the discriminant function would be of little value as a predictor.

The discriminant analysis results for technical memorandum are contained in Table XIX.

TABLE XIX

## Discriminant Analysis of PVAR4

Significant Variable	Step Entered	Significance	Standardized Coefficient
LRBN	1	.028	.79148
YRSSEC	2	.014	-.66686

The classification of respondents based on the variables of LRBN and YRSSEC resulted in the correct classification of 56.5 percent or 121 of the respondents. Although this correct classification result was slightly higher than the maximum chance criterion of 53 percent, the canonical correlation was only .19937. This result indicates that the function would aid in classifying individuals, but would not be a powerful aid in explaining the percentage of variance associated with PVAR4.

Table XX identifies the results for new or improved processes, products, techniques and patents or patent application (PVAR5).

TABLE XX

## Discriminant Analysis of PVAR5

Significant Variable	Step Entered	Significance	Standardized Coefficient
GRADE	1	.009	.81473
ROT	2	.003	.66264

The discriminating function based upon the variables of GRADE and ROT resulted in a canonical correlation of .23397. The classification process based on this function resulted in the correct classification of 85.0 percent or 182 of the respondents, a result equal to the maximum chance criterion of 85.0. Therefore, the discriminant function would not be a valuable aid in either classifying respondents or in explaining variance in PVAR5.

The discriminant analysis results for the output associated with contract monitoring (PVAR6) are contained in Table XXI.

TABLE XXI

Discriminant Analysis of PVAR6

Significant Variable	Step Entered	Significance	Standardized Coefficient
GRADE	1	.000	1.15417

The use of GRADE in a discriminating function resulted in the correct classification of 74.8 percent of the respondents. Although the canonical correlation was .03841, the function correctly classified respondents slightly higher than the maximum change criterion of 70 percent. Thus, the discriminant function explained little of the variance associated with PVAR6, but could aid in the classification of respondents.

#### 4.5 Analysis of Job Satisfaction

As a parallel to the study of productivity, the study of job satisfaction investigates work performance from the viewpoint of a worker's fulfillment or satisfaction with the job. This satisfaction with the job was identified in Section 4.4 by the total Hoppock score (HOP) as not being associated with productivity either in a beneficial or detrimental manner. Additionally, tests of means revealed no significant differences between productive and nonproductive respondents.

The purpose of this section, therefore, is to identify variables which have a significant association with job satisfaction for this sample. As in the productivity analysis, results for the nonsupervisory scientists/engineers and the group leaders are presented separately.

##### 4.5.1 Job Satisfaction Statistics

Table XXII identifies the statistical data for the job satisfaction variable (HOP) for the nonsupervisory scientists/engineers and the group leaders.

TABLE XXII

Job Satisfaction Statistics

Variable	Mean/Standard Deviation/Maximum Job Satisfaction	
	Nonsupervisory (N=272)	Group Leaders (N=54)
HOP	18.8/3.4/26	19.8/3.1/25

A comparison of the job satisfaction means indicates that the group leaders are more satisfied as a group than the nonsupervisory scientists/engineers. This difference in job satisfaction is statistically significant at the .05 level.

#### 4.5.2 Correlations Between Job Satisfaction and Demographics

Table XXIII identifies the Pearson correlations between job satisfaction and the nine demographic variables for the nonsupervisory scientists/engineers and for the group leaders.

TABLE XXIII  
Job Satisfaction Correlations With Demographic Variables

Variables	Nonsupervisory (N=272)	Group Leaders (N=54)
	HOP	HOP
AGE	-.011	.038
GRADE	-.001	-.055
YRSSEC	-.026	.134
YRSIS	-.048	-.124
EDCTN	.1034*	-.276*
NCWR	-.024	-.003
NCWD	.1425**	.016
CONM	-.022	-.201
YEXP	-.030	-.045

\*P less than or equal to .05  
\*\*P less than or equal to .01

Table XXIII identifies a significant positive correlation between job satisfaction and both educational level (EDCTN) and the amount of time spent in development activities (NCWD). Thus, both EDCTN and NCWD are associated with higher job satisfaction.

For the group leaders, Table XXIII identifies a significant negative correlation between job satisfaction and educational level (EDCTN). This correlation indicates that the higher the educational level, the lower the job satisfaction. This result is in direct conflict with the nonsupervisory

scientists/engineers where higher educational level was associated with higher job satisfaction. The implications of this finding are discussed in Chapter 5.

#### 4.5.3 Correlations Between Job Satisfaction and Predictor Variables

Table XXIV lists the Pearson correlations between job satisfaction and the predictor variables for the nonsupervisory scientists/engineers and for the group leaders. Due to the number of missing values, the sample size corresponding to the predictor variables is in parenthesis beside the variable abbreviation.

TABLE XXIV

Job Satisfaction Correlations With Predictor Variables

Nonsupervisory Scientists/Engineers	
Predictor Variables	HOP
ROT (227)	-.237**
SBDQC (258)	.216**
SBDQI (258)	.084
LRBP (264)	.172**
LRBN (263)	.070
Group Leaders	
ROT (46)	-.142
SBDQC (49)	.276*
SBDQI (50)	-.031
LRBP (51)	.304*
LRBN (51)	.126
I See Table II for Explanation	
*P less than or equal to .05	
**P less than or equal to .01	

For the nonsupervisory scientists/engineers, Table XXIV identifies as a significant negative correlation between the concept measured by the Rotter scale and job satisfaction. This correlation indicates that an external as defined by Rotter would have lower job satisfaction than an internal. Also, a significant positive correlation exists between job satisfaction and consideration (SBDQC). This correlation indicates that the higher the supervision is perceived as being considerate the higher the job satisfaction. Finally, Table XXIV identifies a significant positive relationship between job satisfaction and positive leader reward behavior. This correlation indicates that a supervisor who is perceived to exhibit positive reward behavior for good performance tends to have higher satisfied subordinates.

Similarly for the group leaders, Table XXIV identifies significant positive correlations between job satisfaction and both consideration (SBDQC) and positive leader reward behavior (LRBP). These positive relationships indicate that supervisors who are perceived to be considerate and that supervisors who are perceived as rewarding good performance would both tend to have higher job satisfied group leaders.

#### 4.5.4 Regression Analysis

Table XXV is a summary of the regression analysis of job satisfaction for the nonsupervisory scientists/engineers. Due to the number of missing values, listwise deletion of these values was used, thus, the correlation coefficients necessary to conduct this analysis are slightly

different than those presented in Sections 4.5.2 and 4.5.3. These correlations may be found in Appendix F. As previously stated in Chapter 3, regression analysis of job satisfaction was conducted on only the nonsupervisory scientists/engineers (N=214).

TABLE XXV

Regression Analysis For Job Satisfaction

Step	Variable <sup>1</sup>	R Multiple	Sign of Beta Coefficient	Final Partial F	Significance
1	SBDQC	.28387	+	18.58131	.000
2	ROT	.35677	-	11.29018	.001
1 See Table II for explanation of abbreviations					

Regression analysis revealed two variables which were significant in predicting job satisfaction, SBDQC and ROT. The concept measured by the I-E scale was found to be negatively related to job satisfaction as was indicated by the correlation coefficient of -.239 (Appendix F). Consideration by the supervisor (SBDQC) was found to be positively related to job satisfaction by the regression and correlation analysis ( $r = .283$ ). The combination of these two variables resulted in an explanation of 13 percent of the variance in job satisfaction. The result indicates weak prediction of job satisfaction by the demographic and predictor variables.

#### 4.6 Analysis of Team Development Questions

Two questions requested by laboratory management to determine the effectiveness of their current team development program are included in Appendix A, Part E. These questions were designed to determine the

awareness of this program by non-participants and differences between individuals identified as participants in the program versus non-participants. For purposes of this analysis, the group leaders and nonsupervisory scientists/engineers were combined into one sample.

Of the 326 respondents, 68 or 21 percent were aware of the team development program. Table XXVI identifies the demographic and predictor variables which represent significant differences between aware and not aware groups.

TABLE XXVI  
Analysis of Awareness Question

Variable	Group*	Number of Cases/Means/Probability
AGE	1	258/37.2/.149
	2	68/38.9
GRADE	1	258/4.2/.004
	2	68/4.6
YRSSEC	1	258/6.2/.878
	2	68/6.3
YRSIS	1	258/3.6/.008
	2	68/2.4
EDCTN	1	258/2.7/.339
	2	68/2.9
YEXP	1	258/12.8/.542
	2	68/13.6
PVAR1	1	258/.33/.298
	2	68/40
PVAR2	1	258/.31/.259
	2	68/.38
PVAR3	1	258/.36/.539
	2	68/.40
PVAR4	1	258/.50/.095
	2	68/.38
PVAR5	1	258/.14/.123
	2	68/.22

TABLE XXVI  
(Continued)

Variable	Group*	Number of Cases/Means/Probability
ROT	1	215/7.9/.806
	2	58/8.1
HOP	1	258/18.8/.027
	2	68/19.8
SBDCQ	1	244/71.4/.118
	2	63/75.0
SBDQI	1	244/35.9/.207
	2	64/37.5
LRBP	1	249/80.6/.015
	2	66/86.8
LRBN	1	248/22.7/.169
	2	66/23.8
* Group 1 Not Aware 2 Aware		

Of the 68 respondents aware of the program, 26 or 8 percent of the 326 respondents participated in the program. Table XXVII identifies the demographic and predictor variables which represent significant differences between participants and nonparticipants.

TABLE XXVII  
Analysis of Participation Question

Variable	Group*	Number of Cases/Mean/Probability
AGE	1	300/37.6/.964
	2	26/37.5
GRADE	1	300/4.3/.199
	2	26/4.6
YRSSEC	1	300/6.3/.264
	2	26/5.0
YRSIS	1	300/3.5/.000
	2	26/1.6
EDCTN	1	300/2.7/.017
	2	26/3.3
YEXP	1	300/13.0/.901
	2	26/12.8

TABLE XXVII  
(Continued)

Variable	Group*	Number of Cases/Mean/Probability
PVAR1	1	300/.33/.188
	2	26/.46
PVAR2	1	300/.32/.501
	2	26/.38
PVAR3	1	300/.37/.528
	2	26/.31
PVAR4	1	300/.48/.180
	2	26/.35
PVAR5	1	300/.15/.100
	2	26/.31
PVAR6	1	300/.67/.791
	2	26/.69
ROT	1	249/8.0/.338
	2	24/7.0
HOP	1	300/18.8/.004
	2	26/20.8
SBDQC	1	281/71.8/.212
	2	26/75.9
SBDQI	1	282/36.2/.478
	2	26/37.4
LRBP	1	289/81.3/.088
	2	26/87.9
LRBN	1	288/22.8/.417
	2	26/23.8
* Group 1 Nonparticipants		
2 Participants		

Although Tables XXVI and XXVII identify some significant demographic differences between the groups, by far the most significant difference between the aware/not aware and the participants/nonparticipants groups is in job satisfaction. Both the aware and the participant groups indicate significantly higher job satisfaction. Although it is impossible to determine whether the team development program is responsible for this difference, the dichotomized groups vary only slightly, but not

significantly on all other variables. No differences existed between groups based on productivity for all productivity measures.

#### 4.7 Summary of Results: Hypotheses Tested

The purpose of this section is to compare the productivity and job satisfaction results with the hypotheses presented in Chapter I. Due to the separate analysis conducted on the nonsupervisory scientist/engineers and on the group leaders the comparison of results to hypotheses will be presented separately for these two groups.

##### 4.7.1 Comparison for Nonsupervisory Scientists/Engineers

The following hypotheses with applicable results are provided:

Hypothesis I. A positive relationship exists between productivity and job satisfaction.

Results: This hypothesis was not supported by the results at the .01 level for any productivity variables (Table XI). Additionally, no significant difference was determined between productive and nonproductive personnel based on job satisfaction (Table XIV).

The results are similar to those reported by Vroom (1964) where virtually no relationship was found between job performance and job satisfaction. The most appropriate answer to the dilemma of the relation between production and job satisfaction appears to have been offered by Brayfield and Crockett (1955), who described it as one of concomitant variation rather than cause and effect. They assume that

individuals are motivated to achieve certain goals whose achievement results in satisfaction. Productivity is seldom a goal in itself but is more commonly a means to goal attainment. High satisfaction and high production can be expected to occur together when productivity is perceived as a means to certain important goals. Under other conditions the relationship may be negative or there may be none at all. The possibility exists that in the surveyed environment, productivity may not be perceived as a means to certain important goals desired by the scientists and engineers.

Hypothesis 2. A positive relationship exists between productivity and an internal.

Results: This hypothesis applies to the total Rotter score since the measure of internal/external by the I-E scale may be invalid. The hypothesis was not supported at the .01 level for all productivity variables (Table XI). In fact for one productivity variable (PVAR5), a lower Rotter score was related to the nonproductive personnel (Table XIV). Due to the uncertainty of the significance of the total Rotter score, no justification is provided for this result.

Hypothesis 3 A positive relationship exists between job satisfaction and an internal.

Results: A significant relationship was found at the .01 level with the total Rotter score (Table XXIV). This negative relationship indicates that the higher the job satisfaction, the more internal the individual would be as measured by the I-E scale.

Pryer and Distefano (1971) and Lichtman (1970) also found some significant correlations between the total Rotter score and job satisfaction at some employee levels. Their findings and the present results indicate that the total Rotter score may be significantly related to job satisfaction, but the concept which is measured by this score remains undetermined.

Hypothesis 4. A positive relationship exists between productivity and job satisfaction and positive leader reward behavior. A negative relationship exists between both productivity and job satisfaction and punitive leader reward behavior.

Results: The first part of this hypothesis was not supported by the results at the .01 level for any productivity variables (Table XI). Additionally, no significant difference was determined between productive and nonproductive personnel based on positive leader reward behavior (Table XIV). However, for job satisfaction, the first part of this hypothesis was found to be significant at the .01 level (Table XXIV).

Sims and Szilagyi (1975) found a positive relationship between positive leader reward behavior and performance evaluation, however, their measure of performance indicated not only quantity of work (productivity), but also eight other factors. It can only be conjectured, but this result suggests that the scientists/engineers may not be rewarded on the basis of productivity but on the basis of some other measure of performance.

Sims and Szilagyi also found a positive relationship between job satisfaction and positive leader reward behavior as did this study.

The second part of this hypothesis was not supported at the .01 level for any productivity variables (Table XI). In one case (PVAR4), a negative relationship existed at the .05 level (Table XVI). No significant difference was determined between productive and non-productive personnel based on punitive leader reward behavior (Table XIV). Additionally, the second part of this hypothesis was not supported at the .01 level by the job satisfaction results (Table XXIV).

Sims and Szilagyi (1975) reported several significant negative relationships between punitive reward behavior and performance, however, they reported no significant relationship for the professional and technical groups studied. Since scientists/engineers would be considered professional/technical personnel, the current results are consistent with their findings.

Sims and Szilagyi reported no significant relationships of job satisfaction with punitive reward behavior.

Hypothesis 5. A positive relationship exists between both productivity and job satisfaction and the supervisory style of "Consideration".

Results: This hypothesis was not supported at the .01 level for all productivity variables (Table XI). In one case (PVAR6), a negative relationship exists at the .05 level. Additionally, no significant difference was determined between productive and nonproductive based on "Consideration" (Table XIV).

Pelz (1952) found that providing supportive leadership (consideration) for the men is useless if the supervisor always fails to persuade higher management. The result being less rather than more productive employees. Whether this attempt at "consideration" is present in the surveyed laboratory is unknown, but a message for lack of association between "consideration" and productivity may be present in Pelz's finding.

A significant positive relationship was found between job satisfaction and "Consideration" at the .01 level (Table XXIV). This finding is consistent with the study of job satisfaction and consideration by Baumgartel (1956; 1957) who found positive relationships between supportive leadership (consideration) and job satisfaction in research laboratories.

Hypothesis 6 . A negative relationship exists between both productivity and job satisfaction and the supervisory style of "Initiating Structure".

Results: This hypothesis was not supported at the .01 level for all productivity variables (Table XI). In two cases (PVAR 1 and PVAR 2), a negative relationship existed at the .05 level. Additionally, no significant difference was determined between productive and nonproductive personnel based on "Initiating Structure" (Table XIV).

Korman (1966) revealed several studies showing no relationship between initiating structure and performance which supports most of these results.

For the job satisfaction results, this hypothesis was not supported at the .01 level (Table XXIV). This result is also supported by the Korman findings which revealed several studies showing no relationship between initiative structure and job satisfaction.

#### 4.7.2 Comparison for Group Leaders

The following hypotheses with the applicable results for the group leaders are provided. In some cases, the justification or rationale for the results are the same as for the nonsupervisory scientists/engineers. In those cases, the reader is referred to the previous section.

Hypothesis 1. A positive relationship exists between productivity and job satisfaction.

Results: This hypothesis was not supported by the results at the .01 level for any productivity variables (Table XI). Additionally, no significant difference was determined between productive and nonproductive personnel based on job satisfaction (Table XIII).

These results are consistent with the findings of Vroom (1964) and Brayfield and Crockett (1955) discussed in the previous section.

Hypothesis 2. A positive relationship exists between productivity and an internal.

Results: This hypothesis applies to the total Rotter score since the measure of internal/external by the I-E scale may be invalid. The hypothesis was not supported at the .01 level for all productivity variables (Table XI). Additionally, no significant difference was determined between

productive and nonproductive personnel based on the total Rotter score (Table XIII). Due to the uncertainty of the significance of the total Rotter score, no justification is provided for this result.

Hypothesis 3. A positive relationship exists between job satisfaction and an internal.

Results: This hypothesis was not supported at the .01 level (Table XI). This result is in contrast to that determined for the non-supervisory scientists/engineers where a significant relationship was found between job satisfaction and the total Rotter score. In their study of job satisfaction and internal/external Pryer and Distefano (1971) suggested that different employee levels would reveal dissimilar relationships between internal/external scores and job satisfaction. The results of their study and the current results are consistent with this suggestion.

Hypothesis 4. A positive relationship exists between both productivity and job satisfaction and positive leader reward behavior. A negative relationship exists between both productivity and job satisfaction and punitive leader reward behavior.

Results: The first part of this hypothesis was not supported by the results at the .01 level for any productivity variables (Table XI). Additionally, except for PVAR1, no significant difference was determined between productive and nonproductive personnel based on positive leader reward behavior. For PVAR1, the productive personnel perceived their supervisors as exhibiting less positive leader reward behavior than did

the nonproductive personnel at the .01 level (Table XIII). However, for job satisfaction the first part of this hypothesis was found to be significant at the .01 level (Table XXIV).

These results are consistent with the findings by Sims and Szilagyi (1975) discussed in the previous section.

The second part of this hypothesis was not supported by the results at the .01 level for all productivity variables (Table XI). In two cases (PVAR3 and PVAR5), a positive relationship existed at the .05 level (Table XI). Additionally, except for PVAR3, no significant difference was determined between productive and nonproductive personnel based on punitive leader reward behavior. For PVAR3, the productive personnel perceived their supervisors as exhibiting more punitive leader reward behavior than did the nonproductive personnel at the .026 level (Table XIII). Furthermore, for job satisfaction the second part of this hypothesis was not supported by the results at the .01 level (Table XXIV).

The lack of a negative association for professional and technical personnel is consistent with the findings of Sims and Szilagyi (1975).

Hypothesis 5. A positive relationship exists between both productivity, and job satisfaction and the supervisory style of "Consideration".

Results: This hypothesis was not supported at the .01 level for any productivity variables (Table XI). Additionally, no significant difference was determined between productive and nonproductive personnel based on "Consideration" (Table XIII). However, a significant positive relationship was found between job satisfaction and "Consideration" at the .01 level (Table XXIV).

These results are consistent with the findings by Pelz (1952) and Baumgartel (1956; 1957) discussed in the previous section.

Hypothesis 6. A negative relationship exists between both productivity and job satisfaction and the supervisory style of "Initiating Structure".

Results: This hypothesis was not supported at the .01 level for all productivity variables (Table XI). However, one significant difference was determined between productive and nonproductive personnel on PVAR2. The productive personnel perceived their supervisors as exhibiting less "Initiating Structure" than did the nonproductive personnel at the .031 level (Table XIII). No additional significant differences were determined between productive and nonproductive personnel based on "Initiating Structure" (Table XIII). Furthermore, this hypothesis was not supported by the results at the .01 level for job satisfaction (Table XXIV).

These results are consistent with the findings of Korman (1966) discussed in the previous section.

## CHAPTER 5

### DISCUSSION AND CONCLUSIONS

#### 5.1 Introduction

In Chapter 1, the following objectives were stated as guidance for this research effort:

- 1) Using the developed survey, collect data on a sample of scientists/engineers from an AF R&D laboratory.
- 2) Test the relationships among the following factors: productivity, job satisfaction, generalized expectancies for internal versus external control of reinforcement, leader reward behavior, supervisory style, and certain statistical control data such as education, age, experience, etc.
- 3) By using the collected data, attempt to recommend certain laboratory policies which would improve / maintain the current management practices.

The first two objectives have been accomplished; the third objective remains and it is the purpose of this chapter to accomplish this objective by stating the management implications of the tested hypotheses. Prior, however, to discussing this subject with the shortcomings of this effort and recommendations for further research, the validity of the measurement scales used in this study are discussed.

## 5.2 Validity of Measurement Scales

Four well-known measurement scales were used in this study:

- 1) the Supervisory Behavior Description Questionnaire;
- 2) the Leader Reward Behavior Instrument;
- 3) the Hoppock Job Satisfaction measure; and
- 4) the Rotter Internal-External Scale.

With the exception of the Rotter I-E scale, these measures appeared to be valid and reliable.

As indicated in Chapter 4, factor analysis of the Rotter I-E scale resulted in seven factors. One factor resulted in the clear-cut construct of political control while the remaining factors were a combination of personal and general control items.

It can only be conjectured, but the clear-cut loading of the sample on only the political control factor may be an indication of the political environment in which the personnel operate or a high general concern for political matters by the respondents.

However, the existence of seven factors sheds considerable doubt on Rotter's contention that the I-E scale is unidimensional and measures a general perception of control of reinforcement. In fact, the I-E scale is definitely multi-dimensional for this sample and, through comparisons with studies by Gurin (1969) and Cherlin (1974), may be sensitive to population differences.

In conclusion, future researchers should be aware of the questionable validity of the Rotter I-E scale. Due to the obvious multidimensionality of the scale, the question remains as to the nature of the concept being measured.

### 5.3 Implications for Management of the Tested Hypotheses

The nature of the hypotheses reflected the desire to determine supervisory and individual variables which might be associated with productivity and job satisfaction. As with past studies, the variables which are associated with productivity were not consistent, although the variables associated with job satisfaction revealed some consistency.

No single variable was shown to be significantly associated with all six of the productivity variables. The variables identified in Chapter 4 highlighted this inconsistent pattern of association. The correlations provided in Tables XIV and XV showed a significant trend of higher education, more years of experience, and higher grade as being positively associated with productivity. These associated variables would generally be expected.

Table XVI, however, revealed some expected results and one surprising result. Initiating structure was found to be negatively associated with the outputs of journal articles and unpublished manuscripts. This association may be due to the time constraints associated with a structured work situation. Additionally, punitive leader reward behavior was negatively associated with the output of technical memorandum.

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PRODUCTIVITY AND JOB SATISFACTION IN RESEARCH AND DEVELOPMENT: --ETC(U)  
SEP 77 L J CORBIN

UNCLASSIFIED

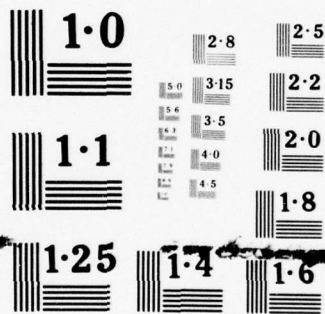
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NATIONAL BUREAU OF STANDARDS  
 MICROCOPY RESOLUTION TEST CHART

Since technical memorandum are basically an individual product, poor performance in this area may be dealt with by more direct leader corrective behavior.

Surprisingly, consideration was negatively associated with the output dealing with contract monitoring. This association may indicate the use of the supervisor's consideration as a crutch for low productivity in this area.

The group leaders revealed two significant correlations between productivity and the predictor variables. Punitive leader reward behavior was positively associated with technical reports and new or improved processes, products, techniques, and patents or patent application. These associations indicate that group leaders perceive that their supervisors will use punitive reward behavior if the output in these categories is low. Whether this perception is due to laboratory policy or not, the answer is unknown because the questionnaire did not record the importance of these outputs to the personnel or management.

The lack of consistent association of productivity variables to predictor variables may be a function of the amount of rewards that are contingent upon productivity in the Civil Service-Military system and/or the amount of control which a supervisor has over rewards in this system. Additionally, both of the supervisory measures used in this study were originally designed for use in civilian industry where the

supervisor tends to have more control over rewards such as pay and promotion. The combination of these two factors may have limited the derived associations between variables.

In contrast to the productivity variables, two predictor variables were positively related to job satisfaction for both the nonsupervisory scientists/engineers and the group leaders. Consideration and positive leader reward behavior were associated with higher job satisfactory for both groups. These findings are consistent with previous studies (House, 1971; Sims and Szilagyi, 1975) and represent the individuals' preferences for a supervisor who establishes a climate of good rapport and two-way communication and who also will reward good performance with leader-administered rewards.

In addition to these two predictor variables, education was associated with job satisfaction for both groups of personnel. Education was positively associated with job satisfaction for nonsupervisory scientists/engineers, possibly indicating an appropriate match of educational background with the job. However, in the case of the group leaders, education was negatively associated job satisfaction. This result may indicate that those group leaders with higher educational levels perceive their jobs as not using this background of knowledge.

Finally, for the nonsupervisory scientists/engineers, a negative association exists between job satisfaction and the total Rotter score. Due to the questionable nature of the concept represented by this score, no justification for this association can be provided.

Thus, the scientists/engineers indicate a preference for supervisors who are considerate and who will reward good performance. Unfortunately, no comparable predictor variables are associated with productivity.

#### 5.4 Implications of Team Development

The team development program for the laboratory was in its infancy stage when the survey was conducted. However, the results indicate a positive relationship between both the awareness of and participation in the program and job satisfaction. The higher job satisfaction could indicate the effectiveness of the program or indicate employee satisfaction at the attention received from laboratory management. Unfortunately, the reasons for the higher job satisfaction were undeterminable from the two team development questions.

Since the awareness question deals primarily with the communication of the program's existence through laboratory channels, the low percentage of aware respondents may indicate a need to improve laboratory communication processes.

Lastly, no differences existed between participants and nonparticipants based on productivity. It would be invalid to conclude that the team development program has had no effect on productivity due to 1) the relatively short existence of the program and 2) the time period associated with the productivity questions.

## 5.5 Shortcomings of Current Research

As mentioned by Stahl (1975), research performed in an environment where the amount of rewards and the control of these rewards based upon performance is limited may have been a handicap in determining variable relationships. Thus, the limited association of the supervisory characteristics and productivity variables may have been influenced by the Civil Service-Military system.

The small number of respondents resulted in the inability to factor analyze the SBDQ. Thus, the dimensionality of this measure in relation to the sample was not determined.

The use of the Rotter I-E scale may have influenced the response rate. In the questionnaire section provided for respondent comments, numerous completed and uncompleted questionnaires were highly critical of the intent and validity of the scale. Additionally, the Rotter I-E scale was the most frequently unanswered portion of the questionnaire with approximately 17 per cent of the returned questionnaires being blank in this section.

## 5.6 Recommendations for Future Research

The following suggestions for future research are provided based upon the shortcomings of this research effort and the researcher's perception of needed efforts.

Further study should concentrate on the validity and reliability of the Rotter I-E scale. This scale is often used as a measure of the

internal/external concept and is employed as a valid instrument. The current study shows the scale to be invalid however, due to the emphasis on and the implications of the internal/external concept, additional research should continue the investigation of the Rotter I-E scale.

Due to the possible influence of the Civil Service-Military system on the reward concepts measured in this study, this study should be replicated in industrial and university research and development laboratories. Such research would provide additional information on the relation of rewards to productivity and job satisfaction.

The influence of the team development program should be incorporated into a longitudinal study. This study should focus on the effects of team development programs on job satisfaction and productivity over an extended time frame.

The comments provided by the respondents and the results of the awareness team development question both indicate a need for the study of intralaboratory communications as it relates to productivity and job satisfaction.

Finally, a study of additional organizational variables such as job challenge and autonomy should be incorporated into future studies of government research and development laboratories as they relate to productivity and job satisfaction. As indicated by respondents comments, there was widespread concern about job content and difficulty. These job characteristics may prove to be related more to productivity than were the supervisory characteristics.

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APPENDIX A

QUESTIONNAIRE

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



REPLY TO  
ATTN OF: CC

63 APR 1977

SUBJECT: A Study of Productivity and Job Satisfaction in  
the AF R&D Laboratories (Charge Nr: 99949801)

TO: AFFDL Scientist/Engineers

1. Capt Larry Corbin, an AFIT student, is conducting a survey of the R&D Laboratories by means of the attached questionnaire. The data from this survey should help to identify those individual and organizational factors which impact upon productivity and job satisfaction. Capt Corbin needs your help in collecting this data through your timely and thorough completion of this questionnaire.

2. The envelope provided should return your answers directly to Capt Corbin through base distribution and anonymity should be maintained throughout his investigation. If there are any questions, please contact Capt Corbin at 52549. A summary of the survey results will be provided to all interested respondents.

3. I believe we can all profit from a study of this type and your assistance in completing the survey is requested.

ALBERT E. PREYSS, Colonel, USAF  
Commander

1 Atch  
Questionnaire  
w/return envelope

Dear Survey Participant,

I am asking for your voluntary cooperation in a study concerned with productivity and job satisfaction in Air Force R&D Laboratories.

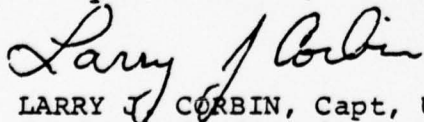
Your responses will be kept in the strictest confidence and your anonymity is guaranteed. All questionnaire data will be reported in aggregate form only. Your name was derived from a roster of all AFFDL scientists/engineers and there will be no attempt to relate your name to the completed questionnaire.

When you have completed your questionnaire, place it in the attached self-addressed envelope, seal the envelope, and place the envelope in Base distribution. I will provide a summary of the results of my survey to any interested respondents. If such a summary is desired, please send a request to me under separate cover to Capt Larry Corbin, AFIT/ENS, Wright-Patterson AFB, OH 45433 through Base distribution (this method will assure anonymity).

The number in the bottom left corner of this survey is a USAF control number only and is required on all surveys within the AF. The same number is on all questionnaires and in no can it be used to identify the respondent.

This study is being conducted in partial fulfillment of the requirements for my master's degree in Systems Management with AFIT. Your cooperation in completing and returning this questionnaire by 1 May 1977 is vital to the completion of this study. The data and analysis for this study is totally dependent on the quantity, quality, and completeness of your responses. The quantity of questionnaires is as important as the quality of responses in order to provide a sufficient sample size of scientists/engineers within AFFDL to draw valid conclusions about productivity and job satisfaction.

I apologize for the amount of time and effort required to complete this questionnaire, but I feel, as Colonel Preyss does, that this study can be of benefit to all scientists/engineers and your time and labor is greatly appreciated. Thank you again for your valuable assistance.



LARRY J. CORBIN, Capt, USAF  
Graduate Student in Systems Management  
Air Force Institute of Technology

USAF SCN 77-77

PRIVACY STATEMENT

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

a. Authority

(1) 5 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 aimed at illuminated and providing inputs to the solution of problems of interest to the Air Force and/or DOD.

c. Routine 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 theses and may also be included in published articles, reports, or texts. Distribution of the results of the research, based on the survey data, whether 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 any individual who elects not to participate in any or all of this survey.

MEASUREMENTS OF PRODUCTIVITY AND RELATED INDIVIDUAL  
VARIABLES IN THE AIR FORCE FLIGHT DYNAMICS LABORATORY

PART A

INSTRUCTIONS: Please complete the following:

- A. Age (in years using your last birthday) \_\_\_\_\_
- B. Current Grade (GS level or Military grade) \_\_\_\_\_
- C. Years in Current Section \_\_\_\_\_
- D. Years under immediate supervisor (i.e. Group Leader  
or Branch Chief (round to nearest year) \_\_\_\_\_
- E. Educational Level (Circle highest degree) B.S. B.S.+  
M.S. M.S.+ Ph.D. Other (please specify) \_\_\_\_\_
- F. Nature of Current Work (% of time per category): ADPO \_\_\_\_\_,  
Research \_\_\_\_\_, Development Engineering \_\_\_\_\_, Systems Program  
Office Support \_\_\_\_\_, Supervisory,  
Other (please specify) \_\_\_\_\_
- G. Percent of total working time contract monitoring \_\_\_\_\_
- H. Years of Scientific/Engineering experience (research,  
consulting, etc.) since first degree (nearest year) \_\_\_\_\_
- I. How many of the following have you authored, presented,  
prepared, etc., over the past two years?
1. Published papers in professional/technical journals \_\_\_\_\_
  2. Unpublished manuscripts \_\_\_\_\_
  3. Technical Reports \_\_\_\_\_
  4. Technical Memorandums \_\_\_\_\_
  5. New or improved processes, products, and techniques,  
and patents or patent applications \_\_\_\_\_
  6. Hardware/software specifications, test reports,  
test plans, statements of work, requests for  
proposals \_\_\_\_\_
  7. Oral presentations to technical or professional  
audiences \_\_\_\_\_
- J. Are you a group leader? YES NO

PART B

INSTRUCTIONS: This is a questionnaire to find out the way in which certain important events in our society affect different people. Each item consists of a pair of alternatives lettered a or b. Circle the letter which corresponds to the statement which you more strongly believe to be the case as far as you're concerned. Try to respond to each item independently when making your choice. There are no right or wrong answers: this is a measure of personal belief.

Item

- 1a. Children get into trouble because their parents punish them too much.
- b. The trouble with most children nowadays is that their parents are too easy with them.
- 2a. Many of the unhappy things in people's lives are partly due to bad luck.
- b. People's misfortunes result from the mistakes they make.
- 3a. One of the major reasons why we have wars is because people don't take enough interest in politics.
- b. There will always be wars, no matter how hard people try to prevent them.
- 4a. In the long run people get the respect they deserve in this world.
- b. Unfortunately, an individual's worth often passes unrecognized no matter how hard he tries.
- 5a. The idea that teachers are unfair to students is nonsense.
- b. Most students don't realize the extent to which their grades are influenced by accidental happenings.
- 6a. Without the right breaks one cannot be an effective leader.
- b. Capable people who fail to become leaders have not taken advantage of their opportunities.
- 7a. No matter how hard you try some people just don't like you.
- b. People who can't get others to like them don't understand how to get along with others.
- 8a. Heredity plays the major role in determining one's personality.
- b. It is one's experiences in life which determines what they're like.
- 9a. I have often found that what is going to happen will happen.
- b. Trusting to fate has never turned out as well for me as making a decision to take a definite course of action.

- 10a. In the case of the well prepared student there is rarely if ever such a thing as an unfair test.
- b. Many times exam questions tend to be so unrelated to course work that studying is really useless.
- 11a. Becoming a success is a matter of hard work, luck has little or nothing to do with it.
- b. Getting a good job depends mainly on being in the right place at the right time.
- 12a. The average citizen can have an influence in government decisions.
- b. This world is run by the few people in power, and there is not much the little guy can do about it.
- 13a. When I make plans, I am almost certain that I can make them work.
- b. It is not always wise to plan too far ahead because many things turn out to be a matter of good or bad fortune anyhow.
- 14a. There are certain people who are just no good.
- b. There is some good in everybody.
- 15a. In my case getting what I want has little or nothing to do with luck.
- b. Many times we might just as well decide what to do by flipping a coin.
- 16a. Who gets to be the boss often depends on who was lucky enough to be in the right place first.
- b. Getting people to do the right thing depends upon ability, luck has little or nothing to do with it.
- 17a. As far as world affairs are concerned, most of us are victims of forces we can neither understand, nor control.
- b. By taking an active part in the political and social affairs the people control world events.
- 18a. Most people don't realize the extent to which their lives are controlled by accidental happenings.
- b. There really is no such thing as "luck".
- 19a. One should always be willing to admit mistakes.
- b. It is usually best to cover up one's mistakes.
- 20a. It is hard to know whether or not a person really likes you.
- b. How many friends you have depends upon how nice a person you are.
- 21a. In the long run the bad things that happen to us are balanced by the good ones.
- b. Most misfortunes are the result of lack of ability, ignorance, laziness, or all three.

- 22a. With enough effort we can wipe out political corruption.  
b. It is difficult for people to have much control over the things politicians do in office.
- 23a. Sometimes I can't understand how teachers arrive at the grades they give.  
b. There is a direct connection between how hard I study and the grades I get.
- 24a. A good leader expects people to decide for themselves what they should do.  
b. A good leader makes it clear to everybody what their jobs are.
- 25a. Many times I feel that I have little influence over the things that happen to me.  
b. It is impossible for me to believe that change or luck plays an important role in my life.
- 26a. People are lonely because they don't try to be friendly.  
b. There's not much use in trying too hard to please people, if they like you, they like you.
- 27a. There is too much emphasis on athletics in high school.  
b. Team sports are an excellent way to build character.
- 28a. What happens to me is my own doing.  
b. Sometimes I feel that I don't have enough control over the direction my life is taking.
- 29a. Most of the time I can't understand why politicians behave the way they do.  
b. In the long run the people are responsible for bad government on a national as well as on a local level.

PART C

INSTRUCTIONS: The following questions deal with your perceptions of your job. Select and circle the number of the answer which you feel best applies to your job.

A. Which one of the following shows how much of the time you feel satisfied with your job?

1. Never.
2. Seldom.
3. Occasionally.
4. About half of the time.
5. A good deal of the time.
6. Most of the time.
7. All of the time.

B. Choose the one of the following statements which best tells how well you like your job.

1. I hate it.
2. I dislike it.
3. I don't like it.
4. I am indifferent to it.
5. I like it.
6. I am enthusiastic about it.
7. I love it.

C. Which one of the following best tells how you feel about changing your job?

1. I would quit this job at once if I could.
2. I would take almost any other job in which I could earn as much as I am earning now.
3. I would like to change both my job and my occupation.
4. I would like to exchange my present job for another one.
5. I am not eager to change my job, but I would do so if I could get a better job.
6. I cannot think of any jobs for which I would exchange.
7. I would not exchange my job for any other.

D. Which one of the following shows how you think you compare with other people?

1. No one dislikes his job more than I dislike mine.
2. I dislike my job much more than most people dislike theirs.
3. I dislike my job more than most people dislike theirs.
4. I like my job about as well as most people like theirs.
5. I like my job better than most people like theirs.
6. I like my job much better than most people like theirs.
7. No one likes his job better than I like mine.

PART D

INSTRUCTIONS: Please complete the following by placing the appropriate letter from the key on the line provided which best describes your immediate supervisor's behavior (i.e., group leader or branch chief).

KEY

A. Always    B. Often    C. Occasionally    D. Seldom    E. Never

- \_\_\_\_\_ 1. He refuses to give in when people disagree with him.
- \_\_\_\_\_ 2. He does personal favors for the subordinates under him.
- \_\_\_\_\_ 3. He encourages overtime work.
- \_\_\_\_\_ 4. He expresses appreciation when one of us does a good job.
- \_\_\_\_\_ 5. He is easy to understand.
- \_\_\_\_\_ 6. He tries out his new ideas.
- \_\_\_\_\_ 7. He demands more than we can do.
- \_\_\_\_\_ 8. He rules with an iron hand.
- \_\_\_\_\_ 9. He helps his subordinates with their personal problems.
- \_\_\_\_\_ 10. He criticizes poor work.
- \_\_\_\_\_ 11. He criticizes his subordinates in front of others.
- \_\_\_\_\_ 12. He talks about how much should be done.
- \_\_\_\_\_ 13. He stands up for his subordinates even though it makes him unpopular.
- \_\_\_\_\_ 14. He insists that everything be done his way.
- \_\_\_\_\_ 15. He encourages slow-working subordinates to greater effort.
- \_\_\_\_\_ 16. He sees that a subordinate is rewarded for a job well done.
- \_\_\_\_\_ 17. He waits for his subordinates to push new ideas before he does.
- \_\_\_\_\_ 18. He rejects suggestions for changes.

KEY

A. Always    B. Often    C. Occasionally    D. Seldom    E. Never

- \_\_\_ 19. He assigns people under him to particular tasks.
- \_\_\_ 20. He asks for sacrifices from his subordinates for the good of the entire department.
- \_\_\_ 21. He changes the duties of people under him without first talking it over with them.
- \_\_\_ 22. He insists that his subordinates follow standard ways of doing things in every detail.
- \_\_\_ 23. He treats people under him without considering their feelings.
- \_\_\_ 24. He sees to it that people under him are working up to their limits.
- \_\_\_ 25. He tries to keep subordinates under him in good standing with those in higher authority.
- \_\_\_ 26. He offers new approaches to problems.
- \_\_\_ 27. He resists changes in ways of doing things.
- \_\_\_ 28. He "rides" the subordinate who makes a mistake.
- \_\_\_ 29. He insists that he be informed on decisions made by subordinates under him.
- \_\_\_ 30. He refuses to explain his actions.
- \_\_\_ 31. He lets others do their work the way they think best.
- \_\_\_ 32. He acts without consulting his subordinates first.
- \_\_\_ 33. He stresses being ahead of competing work groups.
- \_\_\_ 34. He stresses the importance of high morale among those under him.
- \_\_\_ 35. He "needles" subordinates under him for greater effort.
- \_\_\_ 36. He backs up his subordinates in their actions.
- \_\_\_ 37. He is slow to accept new ideas.
- \_\_\_ 38. He decides in detail what shall be done and how it shall be done.
- \_\_\_ 39. He treats all his subordinates as his equal.

KEY

A. Always    B. Often    C. Occasionally    D. Seldom    E. Never

- \_\_\_ 40. He emphasizes meeting of deadlines.
- \_\_\_ 41. He criticizes a specific act rather than a particular individual.
- \_\_\_ 42. He is willing to make changes.
- \_\_\_ 43. He makes those under him feel at ease when talking with him.
- \_\_\_ 44. He asks subordinates who have slow groups to get more out of their groups.
- \_\_\_ 45. He is friendly and can be easily approached.
- \_\_\_ 46. He emphasizes the quantity of work.
- \_\_\_ 47. He puts suggestions that are made by subordinates under him into operation.
- \_\_\_ 48. He gets the approval of his subordinates on important matters before going ahead.

Please use the following key to rate your immediate supervisor's use of rewards:

A.....B.....C.....D.....E.....F.....G  
Strongly Disagree                      Undecided                      Strongly Agree

- \_\_\_ 1. Your supervisor would personally pay you a compliment if you did outstanding work.
- \_\_\_ 2. You would receive a reprimand from your supervisor if you were late in coming to work.
- \_\_\_ 3. Your supervisor would lend a sympathetic ear if you had a complaint.
- \_\_\_ 4. Your supervisor would be very much aware of it if there was a temporary change in the quality of your work.
- \_\_\_ 5. Your supervisor would recommend that you should be dismissed if you were absent for several days without notifying the organization or without a reasonable excuse.

KEY

A.....B.....C.....D.....E.....F.....G  
Strongly Disagree                      Undecided                      Strongly agree

- \_\_\_ 6. Your supervisor would see that you will eventually go as far as you would like to go in this organization, if work is consistently above average.
- \_\_\_ 7. Your supervisor would get on you if your work was not as good as the work of others in your department.
- \_\_\_ 8. Your supervisor would recommend that you be promoted if your work was better than others who were otherwise equally qualified.
- \_\_\_ 9. Your supervisor would help you get a transfer if you asked for one.
- \_\_\_ 10. Your supervisor would tell his/her boss if your work was outstanding.
- \_\_\_ 11. Your supervisor would give you a reprimand (written or verbally) if your work was consistently below acceptable standards.
- \_\_\_ 12. Your supervisor would recommend that you get no pay increase if your work was below standard.
- \_\_\_ 13. Your supervisor would show a great deal of interest if you suggested a new and better way of doing things.
- \_\_\_ 14. Your supervisor would give you special recognition if your work performance was especially good.
- \_\_\_ 15. Your supervisor would do all he/she could to help you if you were having problems in your work.
- \_\_\_ 16. Your supervisor's recommendation for a pay increase for you would be consistent with his/her evaluation of your performance.
- \_\_\_ 17. Your supervisor would recommend that you not be promoted to a higher level job if your performance was only average.
- \_\_\_ 18. Your supervisor would encourage you to do better if your performance was acceptable but well below what you were capable of.
- \_\_\_ 19. Your supervisor would recommend additional training or schooling if it would help your job performance.

KEY

A.....B.....C.....D.....E.....F.....G  
Strongly Undecided Strongly agree  
disagree

- \_\_\_ 20. Your supervisor's evaluation of your performance would be in agreement with your own evaluation of your performance.
- \_\_\_ 21. Your supervisor would increase your job responsibilities if you were performing well in your job.
- \_\_\_ 22. Your supervisor would always give you feedback on how your work affects the total service of the organization.

PART E

INSTRUCTIONS: Please answer the following questions yes or no.

1. Are you aware of the organizational development or team development program currently being conducted in the laboratory?
- \_\_\_\_\_
2. Have you participated in this program?
- \_\_\_\_\_

---

Your cooperation in completing and returning this questionnaire is greatly appreciated. The remaining space is provided for your comments regarding the questionnaire (scope, length, intent, etc.).

APPENDIX B

VARIABLE CODING SCHEME

VARIABLE CODING SCHEME

<u>Variable</u> <u>Abbreviation</u>	<u>Value</u>	<u>Code</u>
AGE	Actual Years	Actual Years
GRADE	GS 6, 7, 8 or 2nd Lt	1
	GS 9, 10, or 1st Lt	2
	GS 11	3
	GS 12 or Capt	4
	GS 13 or Major	5
	GS 14 or Lt Colonel	6
	GS 15 or Colonel	7
MILCIV	Civilian	0
	Military	1
YRSSEC	Actual Years	Actual Years
YRSIS	Actual Years	Actual Years
EDCTN	B. S.	1
	B. S. +	2
	M. S.	3
	M. S. +	4
	Ph. D.	5
NCWR	Percentage of Total Work Time	Actual Percentage
NCWD	Percentage of Total Work Time	Actual Percentage
CONM	Percentage of Total Work Time	Actual Percentage
YEXP	Actual Years	Actual Years
PVAR1	Actual Number	Actual Number
PVAR2	Actual Number	Actual Number
PVAR3	Actual Number	Actual Number
PVAR4	Actual Number	Actual Number
PVAR5	Actual Number	Actual Number
PVAR6	Actual Number	Actual Number
PVAR7	Actual Number	Actual Number
GPL	Yes	1
	No	0
R1 to R29	Internal Answer	0
	External Answer	1
H1 to H4	Scale Value	1 thru 7
S1 to S48	Scale Value	0 thru 4
L1 to L22	Scale Value	1 thru 7
AWARE	Yes	1
	No	0
PART	Yes	1
	No	0

APPENDIX C

CORRELATION MATRIX  
FOR  
ROTTER QUESTIONS



CORRELATION MATRIX - ROTTER QUESTIONS  
(Continued)

R2	R26	R28	R29
R3	.164	.133	-.008
R4	.163	.109	.159
R5	.002	.284	.149
R6	.044	.141	.075
R7	.245	.287	.168
R9	.245	.046	.049
R10	.158	.181	.045
R11	.122	.120	.151
R12	.154	.290	.171
R13	.083	.193	.250
R15	.140	.192	.173
R16	.150	.241	.087
R17	.159	.379	.098
R18	.143	.214	.134
R20	.184	.183	.149
R21	.239	.074	.040
R22	.082	.180	.113
R23	.134	.193	.227
R25	.114	.219	.138
R26	.125	.444	.083
R28	1.000	.139	.098
R29		1.000	.175
			1.000

APPENDIX D

FACTOR ANALYSIS  
OF  
ROTTER QUESTIONS

FACTOR ANALYSIS OF ROTTER QUESTIONS

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
R2	-.093	.053	.670	.217	.055	.041	.210
R3	.434	.012	.067	.146	.391	.112	-.342
R4	.101	.572	.368	-.209	.176	.194	-.112
R5	.043	.152	.172	-.004	.109	.069	.602
R6	.059	.637	-.078	.146	.245	.092	.100
R7	.039	.114	.082	-.104	.608	-.077	.428
R9	.037	.068	.050	.606	.192	-.027	-.296
R10	.019	.052	-.097	.175	.213	.705	.216
R11	.165	.529	.023	.330	-.017	.219	.157
R12	.740	.175	-.050	.045	-.096	.102	.171
R13	.251	.235	-.006	.471	-.010	.068	.041
R15	.057	.178	.231	.588	-.079	.170	.109
R16	.113	.709	.015	.077	.071	-.018	.163
R17	.675	.158	.269	.141	.096	-.171	-.082
R18	.246	.085	.484	.262	.101	.072	.414
R20	.076	.129	.228	-.099	.656	.159	-.052
R21	.101	.082	.763	-.008	.097	.000	-.001
R22	.733	.100	.005	.142	.162	-.012	-.003
R23	-.017	.180	.185	.023	.002	.747	-.166
R25	.212	.453	.212	.450	-.019	-.113	.257
R26	.023	.037	-.049	.399	.611	.048	.088
R28	.119	.645	.168	.213	-.068	.084	-.080
R29	.464	.071	-.020	-.030	-.039	.418	.101
Factor Eigenvalue	4.719	1.634	1.422	1.384	1.167	1.122	1.002
Percent of Variance Explained	20.5	7.1	6.2	6.0	5.1	4.9	4.4

APPENDIX E

CORRELATION MATRIX  
OF  
LEADER REWARD BEHAVIOR QUESTIONS

CORRELATION MATRIX - LEADER REWARD BEHAVIOR QUESTIONS

	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10
L1	1.000									
L2	-.175	1.000								
L3	.583	-.200	1.000							
L4	.378	.053	.361	1.000						
L5	-.075	.262	-.050	.033	1.000					
L6	.549	-.124	.467	.517	.015	1.000				
L7	.008	.257	-.066	.202	.264	.040	1.000			
L8	.551	-.021	.448	.509	.072	.662	.082	1.000		
L9	.337	-.063	.381	.305	.103	.385	-.045	.429	1.000	
L10	.698	-.110	.503	.441	-.023	.628	-.001	.664	.475	1.000

	L11	L12	L13	L14	L15	L16	L17	L18	L19	L20
L11	1.000									
L12	.070	1.000								
L13	.577	-.148	1.000							
L14	.691	-.112	.478	1.000						
L15	.589	-.180	.585	.465	1.000					
L16	.550	-.035	.393	.415	.054	1.000				
L17	.163	.069	.063	.213	.118	.142	1.000			
L18	.412	-.057	.369	.500	.111	.541	.198	1.000		
L19	.481	-.102	.469	.335	.075	.428	.098	.427	1.000	
L20	.450	-.112	.497	.311	-.041	.512	-.003	.275	.454	1.000
L1	.170	.224	.073	.292	.261	.205	.297	.240	.121	.103
L2	.222	.073	.396	.056	.654	.013	.607	.339	.553	.194
L3	.077	.292	.518	.075	.562	.339	.194	.508	.454	.466
L4	.320	.261	.396	.605	.441	.553	.314	.441	.262	.114
L5	.215	.205	.518	.075	.635	.303	.414	.397	.158	.071
L6	.264	.297	.071	.612	.213	.306	.183	.525	.446	.459
L7	.466	.240	.525	.329	.441	.554	.224	.493	.444	.513
L8	.249	.121	.390	.765	.635	.614	.162	.562	.531	.557
L9	.194	.103	.579	.212	.213	.545	.312	.498	.433	.448
L10	.203	.531	.164	.175	.186	1.000	1.000	.339	.170	.100
L11	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
L12		1.000								
L13			1.000							
L14				1.000						
L15					1.000					
L16						1.000				
L17							1.000			
L18								1.000		
L19									1.000	
L20										1.000

CORRELATION MATRIX - LEADER REWARD BEHAVIOR QUESTIONS  
(Continued)

	L21	L22
L1	.422	.549
L2	-.086	.038
L3	.392	.500
L4	.392	.469
L5	.049	.114
L6	.480	.602
L7	.126	.162
L8	.442	.579
L9	.360	.443
L10	.464	.591
L11	.354	.340
L12	.239	.288
L13	.425	.519
L14	.469	.547
L15	.543	.610
L16	.428	.539
L17	.200	.215
L18	.520	.581
L19	.412	.398
L20	.365	.476
L21	1.000	.543
L22		1.000

P less than or equal to .05; r greater than or equal to .111  
P less than or equal to .01; r greater than or equal to .145

APPENDIX F

CORRELATION MATRIX  
FOR  
REGRESSION ANALYSIS VARIABLES



CORRELATION MATRIX - REGRESSION ANALYSIS  
(Continued)

LRBP	.245	.729	.242	
LRBN	.096	.014	.502	.220
HOP		SBDQC	SBDQI	LRBP

## VITA

Larry J. Corbin was born on 26 November 1949 in Columbus, Ohio. He graduated from high school in Mt. Vernon, Ohio in 1967. He attended Ohio State University where he received a Bachelor of Science Degree in Mathematics Education in 1971. At that time, he was commissioned a Second Lieutenant in the United States Air Force. He was initially assigned to the 1902 Communications Squadron, Hamilton AFB, California as squadron Air Traffic Control Officer. In 1973, he was reassigned to Kunsan AB, Korea as squadron Air Traffic Control Officer and RAPCON Chief Controller. A subsequent assignment placed him as Chief, Air Traffic Control Operations, 1903 Communications Squadron, Davis-Monthan AFB, Arizona in 1974 until entering the School of Engineering, Air Force Institute of Technology, in 1976.

Captain Corbin is married to the former Susan Ybarra of La Crescenta, California. They have one child; Cathy Lee.

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER AFIT/GSM/SM/77S-2	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) PRODUCTIVITY AND JOB SATISFACTION IN RESEARCH AND DEVELOPMENT: ASSOCIATED INDIVIDUAL AND SUPERVISORY VARIABLES	5. TYPE OF REPORT & PERIOD COVERED MS Thesis	
	6. PERFORMING ORG. REPORT NUMBER	
7. AUTHOR(s) Larry J. Corbin, Capt, USAF	8. CONTRACT OR GRANT NUMBER(s)	
9. PERFORMING ORGANIZATION NAME AND ADDRESS Air Force Institute of Technology (AFIT/EN) Wright-Patterson AFB, Ohio 45433	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS	
11. CONTROLLING OFFICE NAME AND ADDRESS Air Force Institute of Technology (AFIT/EN) Wright-Patterson AFB, Ohio 45433	12. REPORT DATE September 1977	
	13. NUMBER OF PAGES 132	
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report) UNCLASSIFIED	
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE	
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES Approved for public release; IAW AFR 190-17 Jerral F. Guess, Captain, USAF Director of Information		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) PRODUCTIVITY JOB SATISFACTION RESEARCH AND DEVELOPMENT SUPERVISORY		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The relationships of supervisory and individual variables to the productivity and job satisfaction of scientists and engineers in an AF R&D laboratory were explored. Productivity (quantity of output) and job satisfaction (Hoppock) were used as criterion. The Supervisory Behavior Description Questionnaire, the Leader Reward Behavior Instrument, and the Rotter Internal-External Scale of Control of Reinforcement were used as predictors. Information was obtained on 326 scientists/engineers. Factor analysis of the		

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20. Rotter scale indicates that the scale has questionable validity, is multidimensional, and may be sensitive to population differences. For both the nonsupervisory scientists/engineers and the group leaders, the following relationships were found. No relationship was found between productivity and job satisfaction. Although higher education, grade, and experience were associated with higher productivity, no single predictor variable was shown to be significantly associated with all six of the productivity variables, including leader behavior and the total Rotter score. However, consideration and positive leader reward behavior were positively related to job satisfaction. Education was found to be associated to job satisfaction: positively for the nonsupervisory scientists/engineers and negatively for the group leaders. The total Rotter score was negatively associated with job satisfaction for the nonsupervisory scientists/engineers.

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