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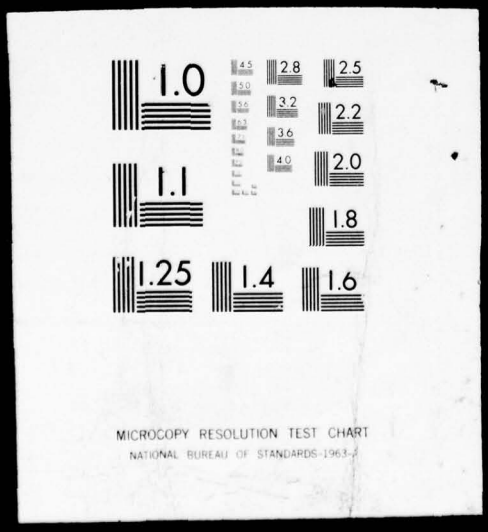


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A STUDY OF CHARACTERISTICS IN THE SUPERVISION OF SCIENTIFIC AND ENGINEERING PERSONNEL

THESIS

GSM/SM/76D-29

George Daugavietis Captain USAF
Ronald S. Harris Captain USAF

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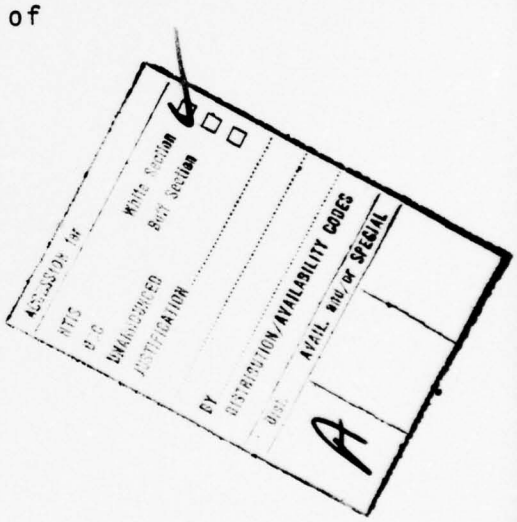
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A STUDY OF CHARACTERISTICS IN THE SUPERVISION OF SCIENTIFIC AND ENGINEERING PERSONNEL

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



by

George Daugavietis
Captain USAF

Ronald S. Harris
Captain USAF

Graduate Systems Management

December 1976

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Preface

This thesis is a study of characteristics in the supervision of scientists and engineers. We have gained new insights into the topical area through many hours of personal discussions with scientists and engineers. We hope this thesis will provide a better understanding of the particular nature of supervision regarding scientists and engineers.

Many people contributed to the success of this thesis. We are indebted to the people who allowed us to visit their organizations, and to the individuals who took time out to be interviewed. Since so many people contributed, to mention only a few would do injustice to the others. We simply say thank you to all the people, in the organizations identified in this study, who helped us in our research efforts.

The efforts of two people deserve special acknowledgment. In particular, a special word of thanks and expression of appreciation are extended to Dr. Raymond H. Klug, our thesis advisor, who gave freely of his assistance and guidance during this research effort. Also, we would like to extend thanks to Captain Michael J. Stahl for the help and insights he provided as second reader.

Finally, our thanks and love go to our wives, Nancy Daugavietis and Diane Harris. Their sacrifice and patience equalled ours. They deserve credit for the successful completion of this research.

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Abstract

Uncertainty exists regarding the key elements in the supervision of scientists and engineers. The literature is not in agreement as to the characteristics of supervision that may set scientists and engineers apart from other groups of people. This thesis examines the supervision of scientists and engineers in order to better understand the particular nature in the supervision of scientific and engineering personnel.

The primary data collection instrument was the face-to-face interviews of first-line supervisors and operatives. In addition to 113 scientists and engineers, 98 non-technical personnel were interviewed for comparison with key elements identifiable with the supervision of scientists and engineers. The comparison and contrast of a non-technical sample group was a distinguishing feature of this thesis.

Characteristics of supervision dealing with "Human Relations", for example, the need for the supervisor (1) to show concern for and interest in the needs of subordinates and (2) to deal with subordinates as individuals, and the need for the supervisor to possess technical competence, were noted as most important by scientists and engineers. Non-technical personnel emphasized the need for the supervisor (1) to listen to and exchange ideas with subordinates, (2) to deal with subordinates as individuals, (3) to possess job knowledge, and (4) to possess such personal qualities as integrity and honesty.

Nine characteristics distinctive to the supervision of scientists and engineers were identified through the comparison of the views of scientific/engineering and non-technical personnel toward supervision. The research found differences between the views of supervisors and operatives in the scientific/engineering and non-technical fields. The major differences between the views of supervisors were in the greater emphasis scientific/engineering supervisors attach to (1) recognition of the capabilities of subordinates, (2) flexibility in dealing with subordinates, (3) defining and communicating goals, (4) providing recognition, and (5) motivation of subordinates to get the job performed, and the greater emphasis non-technical supervisors attach to (1) job knowledge, and (2) such personal qualities as honesty and fairness. The major differences in the views of operatives were in the greater emphasis scientific/engineering operatives attach to (1) treatment of subordinates as individuals, and (2) the freedom for subordinates to set own goals, and the greater emphasis non-technical operatives attach to the personal qualities needed by the supervisor. In addition, the findings of this thesis are both in support and disagreement with the literature.

The results of this thesis are of anticipated use to individual organizations in assessing characteristics of supervision particular to their working environment.

A STUDY OF CHARACTERISTICS IN THE SUPERVISION OF SCIENTIFIC AND ENGINEERING PERSONNEL

I. Introduction

The advent of the industrial age and more recently the beginning of space exploration introduced a high level of technological awareness. Very few facets of society are immune from technological advances. Such concepts as solid-state electronics, solar energy, and miniaturization are familiar words to many people.

One group of people who make significant contributions to developing and maintaining technological expertise are scientists and engineers. To most effectively utilize the talents of scientists and engineers, management must understand the supervision of scientific and engineering personnel. What special guidance exists for the supervision of scientists and engineers? Are scientists and engineers different from other groups of people? Should management deal with scientists and engineers in a manner different from other workers?

The literature is not in agreement as to the key elements in the supervision of scientists and engineers. Further development of management thought and theory requires understanding and accomodating for differences among people and the working environment, and new approaches to supervision may be necessary. Contingency models for leadership and contingency theories of organization are evolving to account

for differences in the effectiveness of leadership and the need to cope with different demands of the environment. However, the literature is not clear as to whether the supervision of scientists and engineers is significantly different from the supervision of other groups of people, for example, non-technical workers.

This study examines the characteristics in the supervision of scientific and engineering personnel. The study analyzes the views of 113 scientists and engineers (supervisors and non-supervisors) in order to particularize and differentiate elements necessary in the supervision of scientists and engineers. Additionally, the views of 98 non-technical personnel (supervisors and non-supervisors) are examined for comparison with the key elements identified with the particular nature of supervision related to scientists and engineers. The comparison and contrast of a non-technical sample group is a distinguishing feature of this study.

Definitions

The following terms are important to an understanding of this study.

Supervisor: an employee who is directly responsible for the work of others, a manager at any level of an organization who is accountable for the performance of one or more subordinates (Ref 1: 6).

Non-Supervisor (Operative Employee): a worker whose tasks directly result in a completed work unit or output of goods or services; one whose tasks do not include supervising people or the work of people (Ref 1: 6).

First-Line Supervisor: an employee who has the formal authority and responsibility for managing the activities of one or more subordinates at the lowest level of the management hierarchy. One who supervises operative employees only (Ref 1: 6).

Scientist: a person engaged in scientific work at a level which requires a knowledge of physical, life, engineering, or mathematical sciences equivalent at least to that required through completion of a 4-year college course with a major in these fields. Excludes psychologists and social scientists (Ref 2: 61).

Engineer: a person engaged in engineering work at a level which requires a knowledge of engineering, physical, life, or mathematical sciences equivalent at least to that required through completion of a 4-year college course with a major in these fields (Ref 2: 61).

Non-Technical Personnel: those persons engaged in work which does not require training in any of the applied sciences.

Background

An understanding of the supervision of scientists and engineers is facilitated by an examination of three basic areas: the literature on the characteristics in the supervision of scientists and engineers, government sponsored studies in similar areas, and the literature regarding the characteristics of the personnel engaged in scientific and engineering pursuits.

The literature on characteristics in the supervision of scientists and engineers represents a variety of answers to the question of what elements are necessary in the supervision of scientific and engineering personnel. Some authors emphasize the human elements. For example, J. E. Walters feels that the human relations aspects within a research team are the most important factors for successful

research (Ref 3: 127). H. A. Collinson also stresses the human aspects when he states that management of research and development is basically management of people (Ref 4: 1). Other authors provide a more elaborate analysis of the supervision of scientists and engineers. In a generalization relative to other professions, the American Management Association indicates five key points in creating an optimum climate for professional people: effective communication, recognition, optimum salary and benefits, freedom and responsibility, and optimum utilization (Ref 5: 127). In a more recent publication, which is the culmination of a two-year study of a specific research organization, John Konig identifies the establishment of an ideal environment for scientists and engineers as one characterized by independence, assignment of real problems, supervision by knowledgeable scientists and administrators, open communication, and generous recognition (Ref 6: 1).

Still other authors offer a somewhat different perspective on the supervision of scientists and engineers. Pfinner and Fels state that the principle problem in the management of scientists and engineers is created by virtue of the fact that scientists and engineers bring to production organizations a set of professional values which are, in many respects, in conflict with traditional organizational and management concepts (Ref 7: 333). This reasoning leads one to the question whether traditional management practices

are applicable in an environment composed primarily of scientists and engineers. However, Hower and Orth, writing during the same time period, point out that

> Whatever the precise nature of the differences between the value orientations of science and management, there is reason to believe that the two sets of values are likely to come closer together (Ref 8: 301).

Finally, some authors define the environment for scientists and engineers as one which promotes a climate for creativity. As one example, the optimum climate for creative research is a blend of several factors which create an atmosphere in which workers can discharge their creative potential with a minimum of distraction and irritation. These factors include recognition of status, facilities and assignments, relation to administration, opportunity for mobility, and importance of research (Ref 9: 362-369).

United States Government studies offer further insights for the understanding of the supervision of scientists and engineers, as well as identify areas which may differentiate the environment for scientists and engineers in the federal sector as compared to the non-government sector. First, the federal government maintains no explicit system of profit and loss statements. Second, the hire and fire decisions are of a different nature in the government as opposed to industry. And third, since scientists and engineers comprise 2-3% of Department of Defense manpower,

the personnel system, which operates around the majority, lacks the required flexibility to permit the establishment or maintenance of a separate environment tailored to scientists and engineers (Ref 10: 3). As another study of government laboratories notes, "one primary requirement in a professional staff is creativity" (Ref 11: 38).

The image of a technical career in the federal government as seen by industrial scientists and engineers provides additional views as to the peculiar nature of the scientific and engineering career fields in the federal government. Donald MacArthur claims that industrial scientists and engineers view their counterparts in government as lacking challenging work and initiative, given too little recognition, and stifled by a bureaucracy of paper work and red tape. In short, a government career is alleged to invite a security orientation (Ref 10: 1).

What are some consequences of the alleged differences in the federal sector of the environment in which scientists and engineers work? The study of MacArthur, noted previously, states that too often longevity appears to count more than achievement, and there is a stagnation from an inadequate supply of new blood filling management positions. The study concludes that such an environment is clearly not conducive to attracting the bright, ambitious, and talented individual (Ref 10: 1). A study by Chandler relates a problem within civilian employment.

> Recognition of a high level of engineering education as a prerequisite to being a successful supervisor confuses and degrades the overall competency of the lower supervisors. This deficiency tends to diminish after the employee becomes more oriented to supervisory work. Many engineers would prefer to remain engineers but reluctantly accept a promotion to supervisory positions to obtain a promotion and pay increase (Ref 12: 33).

Management problems within the federal government are further accentuated by the policy of military rotation applied to technically qualified officers (Ref 13: 15). Lastly, the general environment of federal laboratories, when adverse, is often attributed to weakness in the areas of pay and professional benefits, lack of challenging assignments and professional recognition, and the arbitrary use of bureaucratic regulations (Ref 13: 15). It is interesting to note that, given the apparent differences among scientists and engineers in industry and government, the factors noted are similar to the factors enumerated in the discussion earlier of the literature on characteristics in the supervision of scientists and engineers.

The discussion thus far has emphasized the working environment of the scientist and engineer. However, it is also important to understand the personal characteristics of the people typically engaged in scientific and engineering occupations. As with the previous discussions of the literature, the literature on the personal characteristics of scientists and engineers has a large number of contributors expressing a variety of opinions.

Daniel Roman identifies commonly noted characteristics of scientists and engineers by emphasizing certain human factors which are highly distinct traits of research and development professionals, but not exclusive to the scientific and engineering environment. Among these characteristics are sensitivity to the working environment, curiosity, creativity, and introversion. As a consequence of these traits, Roman characterizes scientists and engineers as people who resent tight controls and require recognition and reward for their achievements (Ref 14: 293-301).

Other authors take a slightly different approach to identifying characteristics of scientists and engineers. Eugene Raudsepp identifies scientists and engineers as part of a larger group of people, namely creative professionals. Some of the personal characteristics Raudsepp lists are tolerance for ambiguity, high motivation, persistence and concentration, ability to analyze and synthesize, and ability to tolerate psychological and physical isolation (Ref 15: 51-67). Wendell French makes a more restrictive analysis with an interesting note. French states that it is necessary to note at the outset that any differences between scientists and engineers and the rest of the work force are differences only in degree, and only in certain dimensions. These dimensions are intelligence and education, personality, and value orientation (Ref 16: 478-479).

The notion of differences among scientists and engineers and other work groups is not reconciled in the literature. For example, Lee Danielson asks the following question to supervisors and non-supervisors in the scientific and engineering areas:

> Do you feel that engineers and scientists as a group differ from other groups of workers like technical, clerical, and manual workers, particularly in regard to their goals, needs, and personality traits? If you do, in what ways are they different? (Ref 17: 7).

This survey finds that 83% of the supervisors and 61% of the non-supervisors feel that there are recognizable differences between themselves and other groups of employees (Ref 17: 10). However, another study of 3,500 scientists and engineers contradicts this contention of differences among scientists/engineers and other workers. The results of the survey show that scientists and engineers

> ...want to work under relatively close administrative controls, have an urgent need to know precisely what management requires of them, exhibit the same personal traits found generally in ambitious non-scientific people, and resent being characterized as business freaks (Ref 5: 157-158).

The issue of characteristics among scientists and engineers if further clouded by authors who question the validity of characterizing scientists and engineers as a homogeneous group of people. Herbert Sheppard notes that any research staff can be divided into what Merton calls the "cosmopolitans" and "locals". The cosmopolitan being one who is oriented toward success as a member of

the profession, with a limited interest in the company. The local being one who is more likely to be observant of company policies and procedures (Ref 18: 374). Norman Kaplan is even more emphatic in asserting that the most widely held myth about scientists and research "is that science is of one piece, that all sciences are pretty much alike" (Ref 19: 105).

Thus far the discussion indicates that the literature on the supervision of scientists and engineers lacks common acceptance. Therefore, further study is important in order to identify and define any distinctive characteristics in the supervision of scientific and engineering personnel. In summary, Wendell French notes four additional reasons for studying the supervision of scientists and engineers. First, the "intensified business competition and rapidly changing world-wide political and military events are placing greater demands for technological innovation." These demands are applicable to the federal sector. Second, "the subject is important because the composition of the work force in many firms and in the country as a whole is shifting to a higher ratio of professionals to other employees." Third, focusing on the management of scientists and engineers is important because organizations which are not doing an effective job of management are likely to find increasing difficulty in recruiting and retaining the keenest minds among this group. And finally, new attention to the

management of scientists and engineers stems from the problems presented by the unique nature of technical/professional jobs (Ref 16:476-477).

Statement of the Problem

This study addresses the lack of agreement in the literature as to the characteristics in the supervision of scientists and engineers that set it apart from the supervision of other groups of people. In general, literary observations regarding the supervision of scientists and engineers reveal sample populations using only scientists and engineers. It appears that much research takes for granted or unquestionably assumes that the supervision of scientists and engineers is significantly different from the supervision of non-technical people without clearly substantiating what the differences are. The problem addressed in this thesis is stated as follows:

> Uncertainty exists regarding the key elements that may distinguish requirements for the supervision of scientific and engineering personnel. There is a need for further investigation to arrive at a better understanding of the issue and for validating or refuting existing claims as to the particular nature in the supervision of scientific and engineering personnel.

Objectives

The primary objective of this thesis is:

1. To ascertain any distinctive characteristics in the supervision of scientific and engineering personnel.

In support of the primary objective are the following secondary objectives:

2. To determine any significant differences in the views of two groups of supervisors (scientific/engineering and non-technical) toward their perceived roles.

3. To determine any significant differences in the views of two groups of operatives (scientific/engineering and non-technical) toward supervision.

An additional objective derives from the apparent disparity of opinions regarding elements identified in the literature as necessary in the supervision of scientists and engineers.

4. To identify and contrast the significant findings as derived in this thesis with the literature.

Scope and Limitations

This research effort identifies distinctive characteristics in the supervision of scientific and engineering personnel. Original data collection by the writers is localized to Wright-Patterson Air Force Base, Ohio. The sample group of scientists and engineers is comprised of military personnel with job descriptions that come under one of the following Air Force Speciality Codes, 26XX and 28XX, and civilian personnel with equivalent job titles. Table I is a list of the job titles that are included in the above codes.

Table I

Air Force Specialty Codes 26XX and 28XX

26XX	28XX
Staff Scientist	Staff Development Engineer
Mathematician	Electronics Engineer
Physicist	Mechanical Engineer
Chemist	Astronautical Engineer
Metallurgist	Aeronautical Engineer
Nuclear Researcher	Aerospace Research Flight Test Engineer
Behavior Scientist	
Scientist, Special	Development Engineer, Special

Further information regarding Air Force Specialty Codes is found in Air Force Regulation 36-23, entitled Officer Career Development. In view of the delimited data base, it is recognized that conclusions derived apply particularly to supervision within the United States Air Force.

This research effort is limited to the time constraints of two academic quarters at the Air Force Institude of Technology. Library research is restricted to sources available within the Dayton, Ohio area.

Assumptions

The following assumptions underlie the research study.

Assumption 1: Replies accurately reflect the views of respondents toward supervision.

Assumption 2: A sufficient number of scientific, engineering, non-technical people within the United States Air Force are stationed at Wright-Patterson Air Force Base to represent a cross section of opinions.

Assumption 3: The study of supervision in the non-technical fields can aid in identifying the particular nature of supervision related to scientists and engineers.

Assumption 4: Scientists and engineers can be categorized as a homogeneous group.

Organization of the Study

This study is arranged into seven chapters. Chapter I is an introduction to the research study. Chapter I includes the objectives and statement of the problem, together with background material. It also includes pertinent working definitions and specifies the scope, limitations, assumptions

of the study and outlines the organization of the study for reporting purposes.

Chapter II describes the Research Methodology. It presents the methods used to gather data for this thesis. The data treatment procedures are also presented.

Chapter III develops initial research findings from data gathered and organized according to four groups of respondents, supervisors and non-supervisors in the scientific/engineering and non-technical fields. The responses of supervisors and non-supervisors, among the scientific/engineering and non-technical fields, are compared and contrasted.

Chapter IV further develops the research findings. Comparative analyses are presented of the two groups of supervisors and the two groups of operatives within the scientific/engineering and non-technical fields. Chapter V presents the discussion of the distinctive characteristics in the supervision of scientists and engineers as well as further research findings. Chapter VI identifies and contrasts the significant findings of this thesis with the prevailing views in the literature. Chapter VII reports the summary, conclusions, and recommendations.

The next chapter, Research Methodology, is the method by which the objectives of this thesis are fulfilled. The Research Methodology involves three phases: literature search, data collection, and data treatment. This discussion concludes the introductory material in this thesis.

II. Research Methodology

The purpose of this chapter is to present the approach and method in which the objectives of this research study are achieved. Three main areas are discussed: (1) Literature Search, (2) Data Collection, and (3) Data Treatment. A discussion of the design and pretest of the interview is included in explaining the primary source of data for this research effort.

Literature Search

The literature search involved a comprehensive examination of pertinent literature relating to the supervision of scientific and engineering personnel. This was primarily accomplished through five excellent libraries located within the area of Dayton, Ohio: (1) the Air Force Institute of Technology Library (Library of the School of Engineering), (2) the Wright State University Library, (3) the University of Dayton Library, (4) the Montgomery County Public Library, and (5) the personal library of Dr. Raymond H. Klug, Professor of Management, Air Force Institute of Technology.

In addition to the search of secondary sources through these libraries, bibliographic searches were accomplished through the Defense Documentation Center, Cameron Station, Alexandria, Virginia, and the Defense Logistics Studies Information Exchange, United States Army Logistics Management Center, Fort Lee, Virginia. These searches specifically addressed the supervision of scientific and

engineering personnel. Additional, up-to-date sources of information in the topical area were provided through the bibliographic searches.

Data Collection

The data collection process for this study is composed of three main elements: (1) Personal Conversations with Notable Researchers, (2) Mail Correspondence, and (3) Personal Interviews. A discussion of each element follows.

Personal Conversations with Notable Researchers. One important aspect of the data collection process included telephone conversations with four noted researchers in this area. A listing of these researchers with addresses and positions follows.

Frank Andrews
Social Psychologist
Institute of Social Research
University of Michigan
Ann Arbor, Michigan

Dr. Lee Danielson
Professor of Industrial Relations
University of Michigan
Ann Arbor, Michigan

Dr. Steven Kerr
Professor of Organizational Behavior
Ohio State University
Columbus, Ohio

John W. Koning, Jr.
Research Scientist
United States Forest Products Laboratory
Madison, Wisconsin

Each of these men has written extensively in the area of the supervision of scientists and engineers. During the conversations each researcher suggested additional articles

and books that were thought to be useful to the writers. Also, two of the researchers expressed concern that much of the work in this area was performed several years ago.

Mail Correspondence. Still another element of the data collection process included letters to other graduate schools, institutions, and researchers. Each letter requested support through access to any studies that were known in this topical area. A list showing the schools, institutions, and researchers that were sent letters is included in Appendix A. A sample copy of the letter requesting information and support appears as Appendix B.

Personal Interview. One very important element of the data collection process entailed the collection of firsthand, current views of 211 personnel toward supervision. While the focus of this study is upon the scientific and engineering community, an important part of this study is the use of the views and observations drawn from a comparable examination of the non-technical area as a basis for comparison and constrast.

In order to achieve the objectives of this thesis the following information was necessary: (1) the views of supervisors in scientific/engineering and non-technical fields as to the skills/tasks necessary in the accomplishment of their jobs, and (2) the views of operatives in scientific/engineering and non-technical fields as to

the skills needed or tasks necessary to be performed by the supervisor. By analyzing and comparing the views of scientific/engineering and non-technical personnel, it was then possible to identify characteristics in the supervision of scientific and engineering personnel.

Having decided upon the type of data necessary to fulfill the objectives of this thesis, it was then necessary to decide upon a method of data collection that would be most suitable. Two primary methods were considered, the questionnaire and the interview. For the purposes of this study, the writers felt that the most effective technique would be the face-to-face interview. It was felt that candor from the personal nature of this method would best provide insights into the true views and attitudes of the interviewees toward supervision. The writers felt the interview would provide the interplay and feedback necessary for the type of questions asked. Therefore, it was selected as the primary tool of data collection.

Thus far, the type of information required for this thesis and the selection of a data collection tool were discussed. In subsequent sections the following are discussed as part of the personal interview approach: (1) Interview Design, (2) Interview Pretest, and (3) the Selection of Interviewees.

Interview Design. One important element in this study was the design of the face-to-face interview, since it is the primary tool of data collection. It was necessary to develop an interview format that would enable the writers to extract from each interviewee the necessary information. In developing the interview, the skill level of the interviewers (writers) was considered.

> To an inexperienced person the interview usually seems a rather simple thing. Actually it is far from that. The technique of interviewing amounts to something much more than merely approaching a number of people and asking a few casual questions. The interview for a scholarly study cannot be conducted in the indiscriminate manner of the sidewalk interviews that we hear on the radio (Ref 20:9).

In view of this caution, the writers decided to utilize a relatively structured interview with open-ended questions to permit voluntary observations and personalized insights. This type of interview also helps to reduce the possibility of misinterpretations by the interviewers.

The formulation of pertinent questions followed the choice of the type of interview. Since two separate groups of personnel (scientific/engineering and non-technical) were to be interviewed, it was necessary to select similar questions for each group so that the responses could be compared and contrasted. Consequently, questions were formulated to solicit information within two areas: (1) questions used to classify the respondents,

and (2) questions used to solicit specific views regarding scientific/engineering and non-technical supervision.

Seven questions were designed to aid in the classifying and sorting of respondents. These questions were also used to prevent the writers from obtaining too large a group from any single organization, career field, military grade, civil service rating, or the major category of supervisor or non-supervisor. A copy of these questions is presented in Appendix C. The actual classifications of the sample interviewed is presented in Appendix D.

The major purpose and emphasis of each interview was accomplished through a series of questions asking the views of each respondent toward supervision. All interviewees were asked three identical questions which follow:

Question 1: In your experience as a(n) (job title) , what have been examples of good supervision?

Question 2: In your experience as a(n) (job title) , what have been examples of inadequate supervision?

Question 3: What supervisory skills, techniques or practices do you feel are most necessary in the supervision of (Scientific/engineering/non-technical personnel)?

a. 1.
2.
3.
etc.

b. How would you rank these in order of importance?

In addition to these three questions, the scientists and engineers were asked one other question which follows:

Question 4: Do you feel that scientists/engineers as a group differ from non-technical workers, particularly in regard to their goals, needs, and personal traits?

a. Yes/No

b. In what ways are they different or similar?

The purpose of questions 1 and 2 was to enable the interviewee to relate and draw from past experiences any examples of both good and inadequate supervision. "Good supervision" and "inadequate supervision" are purposely left undefined for the interviewee in order to better elicit the personalized observations and insights of supervisors and operatives. Another purpose of questions 1 and 2 was to prepare the interviewee for question 3.

Question 3 was designed to extract the views of each interviewee as to the skills, techniques, or practices that were felt to be most necessary in the supervision of the personnel working in that particular job area. Question 3 also provided the interviewee an opportunity to rank responses from most to least important. Questions 1, 2, and 3 survey the scientific/engineering and non-technical disciplines in order to identify characteristics of supervision related to scientific/engineering and non-technical personnel.

The purpose of question 4 was to arrive at a better understanding as to how scientists and engineers perceive themselves, especially as to whether scientists or engineers

consider themselves different from non-technical personnel. Question 4 was based upon a study performed by Professor Lee Danielson (Ref 17: 7). Appendix E contains an example of the non-technical interview work sheet, while Appendix F contains an example of the scientific/engineering interview work sheet.

Another part of the interview pertaining only to scientists and engineers was a supplemental questionnaire. The questionnaire consisted of a list of four characteristics that are commonly associated with the scientific and engineering environment. These characteristics are: communication with colleagues in the same discipline (government, industry, or education); communication with supervisors; recognition for outstanding achievement; and freedom to develop and apply ideas to solve problems. Each respondent was asked to rate the importance of each characteristic in a scientific and engineering environment, and then the extent to which supervision provides for the characteristic. In addition, each respondent was encouraged and given the opportunity to name other characteristics that were felt to be important in a scientific and engineering environment. An example of the supplemental questionnaire appears in Appendix G.

Interview Pretest. After the initial design of the interview, it was then necessary to conduct trial interviews to provide an opportunity for the writers (1) to

develop interviewing skills, and (2) to test the utility of responses and to improve or change the structure of questions. The pretest was conducted with five staff engineers employed with the Engineering Operations Division, Aeronautical Systems Division, and with five non-technical personnel assigned to the Consolidated Base Personnel Office, Air Force Institute of Technology. In particular, the engineers represented a high level of experience in both supervisory and non-supervisory positions. After the completion of each interview, the writers solicited the help of each interviewee as to ways in which the questions or the interview delivery could be improved. Several constructive comments were received and incorporated. Because of comments of the test group as well as responses to the questions, it was felt necessary to conduct the interviews on an individual basis.

The trial interviews were conducted with both writers present. However, only one of the writers actually conducted each interview. This afforded the writers an opportunity to observe one another. The writers attempted to record all responses verbatim. During the trial interviews the writers became satisfied that each was conducting the interview in a similar method, thus ensuring that the results would not be influenced because of differences in the abilities of each interviewer. A nearly equal number of respondents

was interviewed from each test group by each respective interviewer to ensure that either interviewer did not bias responses.

The Selection of Interviewees. The interviews were administered to personnel at Wright-Patterson Air Force Base, Ohio. This installation was selected primarily because of the availability of numerous military and civilian personnel in the scientific and engineering career fields, and the virtually plentiful number of personnel in the non-technical fields. It was determined that a representative cross section of opinions could be obtained from these personnel.

The approach used by the writers to identify and gain access to the needed personnel was to obtain organization charts of the Air Force Wright Aeronautical Laboratories (AFWAL), Aeronautical Systems Division (ASD), and Air Force Logistics Command Headquarters (AFSC). The Plans Directors, shown on the AFWAL organization chart for each of the four laboratories, were then contacted on an individual basis. At each meeting the writers explained the purpose of the research and solicited the permission and cooperation of the laboratory. The Plans Director from each laboratory was most cooperative and aided the writers in selecting those divisions which would have the types of personnel needed.

From this point the chain of command was followed. Next the Division Chief was contacted, followed by the Branch Chief, and then the individual interviewee. The Branch Chief assisted in the random selection of individuals to satisfy objectivity requirements of this study. As such, the interviewees represented a cross section of experience and represented a mixture from the military and civilian structure. In most cases the Branch Chief notified the personnel in advance and explained the nature of the study. This aided greatly in gaining the cooperation of the interviewee. The writers then contacted the interviewees and arranged an interview time.

The method for gaining access to the non-technical group of respondents worked in a similar fashion. Organizations were identified by the writers from organizational charts, and then the organizational directors were contacted. The same format for identifying and contacting individuals was utilized as with the scientific and engineering respondents. Some non-technical personnel that were interviewed worked in the support areas of the laboratories. A list of the organizations which participated in this study is presented in Appendix H.

Each interview began with a brief statement of the purpose of the research study. Each individual was also assured of the anonymity of all remarks. Most respondents appeared genuinely interested in the study and gave freely

of time to participate. The average time for each scientific/engineering interview was thirty-five minutes, while the average time for the non-technical interview was fifteen minutes. The longer interview of scientists and engineers was due to question 4 and the supplemental questionnaire.

Data Treatment

The data treatment phase of this research effort consisted of analyzing the views of scientific/engineering and non-technical personnel toward supervision. Primary data for this thesis were obtained by interviews with 211 scientific/engineering and non-technical personnel. The overall approach taken to perform the necessary analyses is conceptually represented by Figure 1.

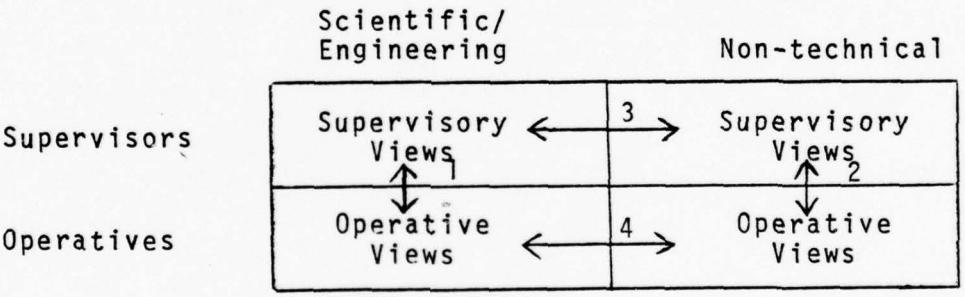


Fig. 1. A Schematic Representation of the Methodology of Defining Views for Comparison as Used in this Thesis

Figure 1 aids in the understanding of the individual and comparative analyses that are performed in Chapters III, IV, and V. A detailed explanation of Figure 1 follows.

Initially, the data are identified with one of four distinct groups of people:

1) Supervisors of scientific and engineering personnel

2) Scientific and engineering operatives

3) Supervisors of non-technical personnel

4) Non-technical operatives

The responses of each group are compiled and analyzed to determine any consensus or pattern of opinions. Tabular presentations of responses with frequency of occurence are used.

Next, the following comparative analyses are used to gain further insights into the necessary elements in the supervision of scientific and engineering personnel:

1) The supervisory and operative views within the scientific/engineering field are compared and contrasted (see 1, Figure 1).

2) The supervisory and operative views within the non-technical field are compared and contrasted (see 2, Figure 1).

3) The supervisory views between the scientific/engineering and non-technical fields are compared and contrasted (see 3, Figure 1).

4) The operative views between the scientific/engineering and non-technical fields are compared and contrasted (see 4, Figure 1).

In particular, the comparative analyses involved the use of questions 1, 2, and 3 (Appendix E). For questions 1 and 2, the responses listed and compared are the most frequently mentioned by the respondents. Most frequently mentioned responses are the responses noted at least an average number of times within a group of respondents (supervisors or operatives). For example, in question 1,

scientific/engineering supervisors mentioned 159 responses among 31 different subclassifications. Therefore, the average response rate for scientific/engineering supervisors to question 1 is 5.13 (159÷31).

Question 3 involved the ranking of responses from most to least important. The presentation and comparison of responses to question 3 involves the use of a weighting factor scheme to arrive at a total relative value for responses ranked as number one, number two, and number three. Rankings beyond three are not considered since the number of responses per rank fall significantly below the number of people interviewed. The number of responses in any one position can exceed the number of interviewees because the respondents were allowed to designate more than one response for each level of importance.

The weighting factor scheme used for question 3 assigns a weight of 3 to items ranked as number one, 2 to items ranked as number two, and 1 to items ranked as number 3. This is an arbitrary weighting scheme based on the implicit assumption that items ranked number one are three times as important as items ranked number three. Although the writers realize from some of the comments of the respondents that this is not always the case, it is felt the relative weights provide a reasonable method of combining common characteristics among the top three rankings. Also, the sum total of all relative weights equals 600 (round off error) for either group (supervisors or operatives).

A relative weight for responses within each rank position is arrived at by multiplying the percentage of times the response appears in a particular rank times the weighting factor for that rank. Relative weights are then collected for similar items among all the ranks (1st, 2nd, 3rd) to arrive at a total relative weight for each item.

Question 4 (Appendix F) and the supplemental questionnaire (Appendix G) pertain only to the scientific and engineering interviewees, and are not used in any comparative analyses. The analysis of question 4 simply involved calculating the percentage of yes and no responses by supervisors and operatives. Also, comments as to why the interviewee answered yes or no to question 4 are included.

The procedures used to present the findings of the supplemental questionnaire are as follows. For question 1 thru 4 of the questionnaire, a mean value for parts A and B is arrived at by multiplying the number of responses for each position times the assigned value for each position. The assigned values are 5 for a, 4 for b, 3 for c, 2 for d, and 1 for e. These totals are summed for a thru e, and the total is divided by the total number of responses to obtain a mean value for parts A and B of each question.

The comparative analysis between the supervisory and operative views in each field is presented in Chapter III. Chapter IV presents the comparative analysis between supervisors in each field and between operatives in each field.

A comparative analysis between scientists/engineers and non-technical personnel is performed in Chapter V, as well as an analysis of question 4 and the supplemental questionnaire. Furthermore, the research findings from this thesis are compared with the literature in Chapter VI.

This concludes the discussion of the research methodology. The next chapter presents a comparative analysis of the supevisory and operative views in each field.

III. Research Findings - Part I

Chapter III presents the first part of the presentation and analyses of interview responses. Chapter III presents comparative analyses between the views of supervisors and operatives in the scientific/engineering and non-technical fields (see 1 and 2, Figure 1, p. 26). It includes a summary of responses given by the scientific/engineering and non-technical personnel to questions 1, 2, and 3. It is recognized that every response is important to at least one individual. However, comments cannot be specifically made for every response; therefore, a complete listing of responses to questions 1, 2, and 3 is found in Appendixes J and I. Subsequent chapters develop further analyses using the findings of this chapter as well as the responses to question 4 and the supplemental questionnaire.

The categorization of responses to questions 1, 2, and 3 is based, in part, on a model developed by Glueck and Thorp (Ref 21: 6). Although Glueck and Thorp develop a general model of the management of research, the writers determined that the model is appropriate for use in categorizing the responses of scientists/engineers and non-technical personnel. The categories used are the following:

Human Relations
Working Environment
Goals and Requirements
Management Related Activities
Performance Evaluation
Qualities of the Supervisors
    Job Related
    Personal
Other

Within the preceding categories are subclassifications that represent the characteristics of supervision identified by the respective groups of people. Several iterations were used in categorizing the large number of responses. Although one may consider further combinations of responses appropriate, the categorizations presented most accurately reflect the intent of this study and the meaning of the replies of the respondents.

Responses to questions 1, 2, and 3 are identified according to the four groups of people noted in Figure 1, page 26. Comparisons between supervisors and operatives in the scientific/engineering and non-technical fields are presented in conjunction with the enumeration of responses of supervisors and operatives. Each question is repeated in the text of the chapter for the convenience and recall of the reader.

Comparative Analyses Between the Supervisory and Operative Views of Scientists and Engineers

This section presents comparative analyses between the responses of scientific/engineering supervisors and operatives to questions 1, 2, and 3. The summary responses used for questions 1 and 2 are the most frequently mentioned responses of the respondents. Presentation of the responses to question 3 involves the use of a weighting factor scheme. Most frequently mentioned responses and the weighting factor scheme are described in the data treatment section of Chapter II.

Discussion of Examples of Good Supervision. The discussion of examples of good supervision is based upon the responses to question 1. Question 1 follows:

> Question 1: In your experiences as a(n) (job title), what have been examples of good supervision?

One must realize that the replies to question 1 (for both scientific/engineering and non-technical personnel) are based on the experiences of the respondents. The responses are useful as preliminary insights into characteristics of supervision that are important and which one must consider in analyzing the scientific and engineering disciplines. However, the similarities and differences in responses of supervisors and operatives must be viewed in light of the experiences of the respondents and not necessarily as a statement of philosophy about what may or may not be required in the supervision of scientists and engineers.

The following two tables summarize the responses of scientific/engineering supervisors and operatives to question 1. The supervisory responses represent the categorization of 159 responses among 31 different subclassifications from 41 supervisors. The operative responses represent the categorization of 262 responses among 37 different subclassifications from 72 operatives.

Table II

Most Frequently Mentioned Responses to Question 1 by Scientific/Engineering Supervisors (Average Response Rate = 159÷31=5.13)

Subclassifications	Responses Frequency	Responses Percentage
Technical competence	18	11.32
Listens to and exchanges ideas with subordinates	13	8.18
Provides recognition	12	7.55
Provides freedom for job accomplishment	11	6.92
Personal qualities of supervisor	9	5.66
Concern for and interest in the needs of subordinates	8	5.03
Defines goals	7	4.40
Provides guidance on what is expected	7	4.40
Administrative Skills	6	3.77

Table III

Most Frequently Mentioned Responses to Question 1 by Scientific/Engineering Operatives (Average Response Rate = 262÷37=7.08)

Subclassifications	Responses Frequency	Responses Percentage
Provides freedom for job accomplishment	34	12.98
Technical competence	24	9.16
Provides guidance on what is expected	22	8.40
Concern for and interest in the needs of subordinates	19	7.25
Personal qualities of supervisor	15	5.73
Listens to and exchanges ideas with subordinates	13	4.96
Keeps subordinates informed	13	4.96
Provides recognition	13	4.96
Administrative skills	12	4.58
Provides responsibility and authority	12	4.58
Supports subordinates in their activities	12	4.58
Deals with subordinates as individuals	9	3.44
Recognizes capabilities of subordinates	8	3.05

Supervisors and operatives observed similar characteristics of good supervision in the areas of:

technical competence
concern for and interest in the needs of subordinates
personal qualities of supervisor
recognition
administrative skills
listening to and exchanging ideas with subordinates

Differences between supervisors and operatives are in the areas of freedom for job accomplishment and guidance on what is expected (observed more by operatives than supervisors).

The general categories noted in the beginning of this chapter are now presented to show the entire range of responses from scientific/engineering supervisors and operatives. The percentage of times that characteristics are mentioned under the general categories is as follows:

	Supervisors	Operatives
Human Relations	23.26%	22.14%
Working Environment	23.90	37.61
Goals and Requirements	10.06	10.69
Management Related Activities	10.71	3.04
Performance Evaluation	10.07	4.96
Qualities of the Supervisor	2.01	20.62
Other	0.	1.14

The preceding figures reveal similar observations by supervisors and operatives in the areas of:

Human Relations
Goals and Requirements
Qualities of the Supervisor

Tables II and III noted previously seem to substantiate the above observation. The operatives, however, noted more

characteristics in the area of "Working Environment", while the supervisors placed more emphasis on "Management Related Activities" and "Performance Evaluation".

The above discussion indicates that supervisors and operatives are divided as to observations of good characteristics of supervision. Differences occur where one would normally expect. Some interesting observations are worthy of note.

Although emphasis on human relations aspects are similar with supervisors and operatives, the greater attention given to listening and exchanging ideas with subordinates by supervisors is encouraging; one might expect the operatives to be more sensitive to the idea of supervisors listening to the ideas of subordinates. Aspects of the working environment are noted to a greater degree by operatives as would be expected. Operatives especially noted freedom in job accomplishment. Consistent with the position of supervisors is the greater awareness given to 'Management Related Activies" by supervisors. Additionally, "Performance Evaluation" is noted to a greater extent by supervisors, as one might expect. The lesser awareness to "Performance Evaluation" by operatives along with a greater attention to the guidance provided by supervisors seems to indicate that operatives look for an environment where guidance is provided but evaluation is kept to a minimum.

Discussion of Examples of Inadequate Supervision.

The discussion of examples of inadequate supervision is based upon the respones to question 2. Question 2 follows:

Question 2: In your experiences as a(n) (job title), what have been examples of inadequate supervision?

As in question 1, the responses to question 2 are based upon the experiences of the respondents. Similarities and differences in responses must be viewed in light of the experiences of the respondents and not necessarily as a statement of philosophy about what may or may not be required in the supervision of scientists and engineers.

The following two tables summarize the responses of scientific/engineering supervisors and operatives to question 2. The supervisory responses represent the categorization of 118 responses among 22 different subclassifications from 41 supervisors. The operative responses represent the categorization of 192 responses among 36 subclassifications from 72 operatives.

Table IV

Most Frequently Mentioned Responses to Question 2 by Scientific/Engineering Supervisors (Average Response Rate = 118÷22=5.36)

Subclassifications	Responses Frequency	Responses Percentage
Opposite of question 1	15	12.71
Fails to communicate downwards or listen to ideas of subordinates	13	11.00
Too strong administrative control	13	11.00
Does not provide adequate guidance	11	9.32
Inability to make or understand consequences of a decision	10	8.47
Lack of technical competence	8	6.78
Lack of support and interest in work of subordinates	7	5.93
Lack of interest in needs of subordinates	6	5.08

Table V

Most Frequently Mentioned Responses to Question 2 by Scientific/Engineering Operatives (Average Response Rate = 192÷36=5.33)

Subclassifications	Responses Frequency	Responses Percentage
Does not provide adequate guidance	19	9.90
Opposite of question 1	12	6.25
Fails to communicate or consider subordinate ideas	12	6.25
Lack of concern and interest in subordinate needs	12	6.25
Lack of understanding of management techniques	12	6.25
Does not recognize problems	12	6.25
Requires too many administrative details	11	5.73
Becomes too involved in technical matters	10	5.21
Personal qualities of supervisor	7	3.65
Fails to recognize individual capabilities	7	3.65
Poorly defines goals	7	3.65
Lacks technical competence	6	3.13
Does not pass on information to subordinates	6	3.13
Lack of recognition	6	3.13

Consideration of negative characteristics of supervision enables one to further identify characteristics in the supervision of scientists and engineers. The utility of question 2 is the extent to which the responses deviate from the responses to question 1.

The two previous tables suggest significant differences between the responses of supervisors and operatives. Observations of supervisors and operatives are similar only in the following areas:

lack of guidance provided
lack of interest in the needs of subordinates
lack of technical competence

Supervisors noted more observations than operatives in the area of failing to listen to the ideas of subordinates. The lack of similarity is evidence that supervisors and operatives view characteristics of supervision differently.

Supervisors and operatives mentioned characteristics under the general categories, noted in the beginning of this chapter, the following percentage of times:

	Supervisors	Operatives
Human Relations	19.47%	18.23%
Working Environment	25.40	25.50
Goals and Requirements	9.32	13.55
Management Related Activities	13.55	15.62
Performance Evaluation	4.24	4.17
Qualities of Supervisor	11.86	12.51
Other	16.10	10.41

These figures indicate a general agreement as to the main areas of observation for supervisors and operatives. Supervisors and operatives agree in four areas:

Working Environment
Management Related Activities
Performance Evaluation
Qualities of the Supervisor

Among the other three areas, two ("Human Relations" and "Other" characteristics) are observed more by supervisors (19.47% vs 18.23% and 16.10% vs 10.41%), and "Goals and Requirements" is observed more by operatives (13.55% vs 9.32%).

The major importance of question 2 is in the extent to which the question deviates from the responses in question 1. The following observations are worth noting. In general, less agreement in responses between supervisors and operatives is evident in question 2 than in question 1. Although all areas mentioned most frequently by supervisors and operatives in question 2 are also part of the most frequently mentioned category in question 1, no consistent pattern of responses is evident. Examination of the frequency of responses among the general categories between supervisors and operatives offers a somewhat different perspective than is seen in individual characteristics alone. Among the general categories, only "Management Related Activities" and "Performance Evaluation" change in relative observations among supervisors and operatives from question 1 to question 2. It appears that underlying similarities between the responses of supervisors and operatives, not evidenced in individual responses, do exist.

The responses to questions 1 and 2 provide a large number of characteristics of supervision. From the

good and inadequate aspects of supervision, both supervisors and operatives emphasize the areas of "Human Relations", "Working Environment", and "Qualities of the Supervisor". However, when individual characteristics are considered, the similarities/differences are not clear. Thus, it is difficult to arrive at a consensus or importance attached to specific characteristics by either supervisors or operatives, and it is necessary to consider the responses to question 3 in order to identify the most important characteristics of supervision.

Discussion of the Important Characteristics in the Supervision of Scientists and Engineers. The discussion of the important characteristics in the supervision of scientists and engineers is based upon the responses to question 3. Question 3 follows:

> Question 3: What supervisory skills, techniques, or practices do you feel are most necessary in the supervision of (scientific/engineering/non-technical personnel)?
>
> a. 1.
> 2.
> 3.
> etc.
>
> b. How would you rank these in order of importance?

The following table presents the responses of supervisors and operatives in the scientific/engineering fields according to the general categories identified in the introduction of this chapter. The discussion and analysis that follows Table VI elaborates on the specific characteristics named under each category. Characteristics preceded by an asterisk (*) are common to supervisory and operative responses.

Table VI

Total Relative Weight, by Category, of Items Ranked Number One, Two, or Three by Scientific/Engineering Supervisors and Operatives

Category	Total Relative Weight Supervisors(S)	Operatives(O)
Human Relations	181.17	191.61
Working Environment	131.98	79.03
Goals and Requirements	56.25	54.78
Management Related Activities	37.70	88.50
Performance Evaluation	30.09	14.85
Qualities of the Supervisor	157.18	167.08
Other	5.76	4.77
	600.13	600.62

The characteristics identified under the general category of "Human Relations" are the following:

Human Relations	S	O
*Deals with subordinates as individuals	11.57	89.01
*Concern for and interest in the needs of subordinates	44.06	28.64
*Recognizes capabilities of subordinates	34.03	22.17
*Motivates subordinates to get the job done	28.57	23.64
*Listens to and exchanges ideas with subordinates	27.38	24.85
*Establishes a good working relationship (rapport) with subordinates	2.44	3.30
Is flexible in dealing with subordinates	28.86	
Understands subordinates	4.26	
	181.17	191.61

Supervisors and operatives identify characteristics of supervision dealing with "Human Relations" with nearly equal importance (181.17 vs. 191.61). Both groups note

the importance of recognizing individual capabilities, motivating, and listening to and exchanging ideas with subordinates. Establishing a good working environment is noted of much lesser importance by both supervisors and operatives. Differences between supervisory and operative responses are noteworthy in the areas of dealing with subordinates as individuals and flexibility in dealing with subordinates. Although both responses are similar, operatives consider dealing with subordinates as individuals of greater importance than supervisors. Supervisors and operatives consider "Human Relations" a very important aspect of supervision. The only difference between the two groups appears to be the operatives need for a more positive commitment, i.e. dealing with subordinates as individuals, rather than a need for flexibility in dealing with subordinates. The impact of this difference is overcome, to some extent, by the greater importance supervisors place on showing interest in subordinates and their work.

The characteristics identified under the general category of "Working Environment" are the following:

Working Environment	S	O
*Supports subordinates in their activities	23.12	13.95
*Provides freedom for job accomplishment	22.51	18.82
*Places trust and confidence in subordinates	19.75	2.94
*Shows interest in subordinates and their work	17.02	3.30
*Keeps subordinates informed	16.43	5.50
*Provides authority and responsibility	15.81	16.01
*Involves subordinates in decision process	8.20	1.47
*Knows accomplishments of subordinates and organization (keeps informed)	2.44	5.80
*Provides an environment that does not inhibit research and development	2.44	2.94
Provides training for subordinates	4.26	
Provies sufficient work		3.30
Supports subordinates in their decisions		2.50
Provides meaningful tasks		2.50
	131.98	79.03

Although characteristics under the "Working Environment" are similar for supervisors and operatives, a disparity exists between supervisors and operatives as to the relative importance of all characteristics dealing with the working environment. It is interesting that operatives place less importance than supervisors on characteristics dealing with the working environment. Overall, the major differences are found in the following areas:

support for subordinates
freedom for job accomplishment
trust and confidence
involving subordinates in the decision process

Freedom for job accomplishment and trust and confidence in subordinates are more important to supervisors than operatives. One would normally expect operatives to place at least the same emphasis on the above characteristics as supervisors. The disparity is partially explained in the next paragraph; however, supervisors may be overly concerned with characteristics that have always been assumed to be of utmost importance to operatives.

The category of "Goals and Requirements" explains some of the inconsistencies raised in the previous discussion. The characteristics identified under "Goals and Requirements" are the following:

Goals and Requirements	S	O
*Defines/communicates goals	31.30	3.30
*Provides guidance on what is expected	20.69	15.21
*Relates goals to a specific job	4.26	
Provides freedom for subordinates to set own goals		36.27
	56.25	54.78

The most important characteristic for operatives, in the "Goals and Requirements" category, is freedom to set own goals. Freedom to set own goals goes beyond freedom for job accomplishment. Operatives appear to be saying that it is not enough to provide freedom in the job, supervisors must also provide freedom for one to set goals. The greater importance given by supervisors to defining goals and providing guidance are consistent

with supervisory and operative responses to job freedom and freedom to set own goals. Supervisors emphasize defining goals, providing guidance, and then giving job freedom. Operatives look for freedom to set own goals directly.

The characteristics identified under the general category of "Management Related Activities" are the following:

Management Related Activities	S	O
*Able decision maker	8.52	6.60
*Understanding of management techniques	6.70	9.90
*Exhibits day to day awareness	5.76	
*Is able to direct problems as a team effort	5.76	
*Able organizer	4.26	
*Able to judge importance of projects	4.26	
*Keeps upper management informed	2.44	
Interfaces with upper management in selling programs of the organization		10.00
Business knowledge		7.50
Able to identify overall problems		7.50
Is able to handle the military and civilian personnel systems		6.60
Provides effective communication outside the organization		5.88
Able to prioritize information		5.00
Coordinates people and resources to accomplish tasks		4.41
Gets people to agree on technical matters		3.30
Does managing rather than dollar chasing		3.30
Understands mission of the organization		3.30
Communicates accomplishments of organization to upper management		3.30
Stays with decision made		2.50
Has a total picture of a project (dollars and manpower necessary)		3.97
Provides answers or finds them out		2.50
Assumes responsibility for group output		1.47
Builds a balanced organization		1.47
	37.70	88.50

"Management Related Activities" provide a large number of different responses by supervisors and operatives with no one characteristic being very important to either group. The significant point is that operatives clearly identify a wider range of characteristics than supervisors. Although the responses dealing with "Management Related Activities" are the result of different comments from a large number of people, the operatives place considerable importance on management skills. The total relative weight given by operatives to "Management Related Activities" exceeds that of characteristics within the "Working Environment" (88.5 vs. 79.03). An important conclusion is that operatives recognize the necessity of management skills, skills often considered unnecessary or of a relatively low importance in a highly technical environment.

A comparison of responses under "Performance Evaluation" offers further interesting insights. The characteristics identified under the general category of "Performance Evaluation" are the following:

Performance Evaluation	S	O
*Provides recognition	30.09	13.38
Provides feedback on performance		1.47
	30.09	14.85

Recognition is noted as a more important characteristic by supervisors than operatives. This result provides an

indication that scientists and engineers are motivated more from within and do not need the amount of external incentive that is presumed more important by supervisors.

Characteristics identified under the general category of "Qualities of the Supervisor" are the following:

Qualities of the Supervisor	S	O
Job Related		
*Technical Competence	84.14	114.85
*Basic communicative skills	24.95	12.71
*Administrative skills	9.76	19.31
*Leadership qualities	11.55	2.50
*Personal qualities (honesty, integrity, fairness, etc.)	26.78	17.71
	157.18	167.08

Characteristics under "Qualities of the Supervisor" are rated similarly by supervisors and operatives (157.18 vs 167.08). The most important characteristic identified by supervisors and operatives is technical competence. The operatives probably consider technical competence more important than supervisors since the perceptions of the two groups are different, the management orientation of supervisors, the work orientation of operatives.

This concludes the discussion of the individual categories. "Other" characteristics are not considered due to the low relative weight.

The summary of the general categories according to the relative importance given by supervisors and operatives is as follows:

	Supervisors	Operatives
Human Relations	1	1
Working Environment	3	4
Goals and Requirements	4	5
Management Related Activities	5	3
Performance Evaluation	6	6
Qualities of the Supervisor	2	2
Other	7	7

The basic differences are in the importance attached to characteristics dealing with the "Working Environment", "Goals and Requirements", and "Management Related Activities". As was noted in the discussion previously, there are no differences within each category among specific characteristics of supervision.

It is also important to consider the most important characteristics of supervision irrespective of categories. Appendix K provides a complete listing of characteristics, noted in Table VI (p. 42), in order of most important to least important. Technical competence predominates over all other characteristics for both supervisors and operatives. Although many other characteristics are mentioned, both supervisors and operatives are clear in the selection of the most important characteristic. Rated second in importance by operatives is dealing with subordinates as individuals (89.01). For supervisors, concern for and interest in subordinates (44.06) is rated second to technical competence. Among the remaining characteristics named with relative weights greater than

ten, only one characteristic, flexibility in dealing with subordinates, is unique to supervisor responses, and only two, provides freedom for subordinates to set own goals and interfaces with upper management in selling the programs of the organization, are unique to operative responses. The responses of scientific/engineering supervisors and operatives, therefore, indicate a general agreement as to the most important characteristics of supervision.

The remaining sections of Chapter III present a discussion of the responses of the non-technical personnel. The format used to present the responses is similar to the methods already employed in this chapter.

Comparative Analyses Between the Supervisory and Operative Views of Non-technical Personnel.

A comparison of responses between supervisors and operatives in the non-technical area for questions 1, 2, and 3 of the interview is now presented. The identical type of analysis for each question that is used with the responses from the scientific/engineering group is repeated. One should refer to the data treatment section of Chapter II for a review and explanation of the method of analysis for each question.

Discussion of Examples of Good Supervision. Question 1 involved soliciting from the respondents examples of good supervsion from experiences in past and present jobs. Question 1 follows:

> Question 1: In your experience as a(n) (job title), what have been examples of good supervision?

The following two tables summarize the responses of non-technical supervisors and operatives to question 1. In total, there are 157 responses to question 1 from the 40 non-technical supervisors among 31 different subclassifications, and 197 responses to question 1 from the 58 non-technical operatives among 29 different subclassifications.

Table VII

Most Frequently Mentioned Responses to Question 1 by Non-technical Supervisors (Average Response Rate = 157÷31=5.06).

Subclassifications	Responses Frequency	Percentage
Personal Qualities	24	15.29
Concern for and interest in the needs of subordinates	19	12.10
Deals with subordinates as individuals	13	8.28
Job knowledge	11	7.01
Provides freedom for job accomplishment	9	5.73
Provides feedback on performance	7	4.46
Listens to and exchanges ideas with subordinates	7	4.46
Supports subordinates in their activities	7	4.46
Provides guidance on what is expected	7	4.46
Trains subordinates or provides them an opportunity to receive training	6	3.82
Provides recognition	6	3.82

Table VIII

Most Frequently Mentioned Responses to Question 1 by Non-technical Operatives (Average Response Rate = 197÷29=6.79).

Subclassifications	Responses Frequency	Percentage
Concern for and interest in the needs of subordinates	25	12.69
Provides freedom for job accomplishment	22	11.17
Personal qualities	16	8.12
Listens to and exchanges ideas with subordinates	11	5.58
Provides guidance on what is expected	10	5.08
Deals with subordinates as individuals	9	4.57
Provides challenging and interesting work	9	4.57
Job knowledge	9	4.57
Supports subordinates in their activities	8	4.06
Works with subordinates to get the job done	8	4.06
Provides authority and responsibility	7	3.55
Keeps subordinates informed	7	3.55

An examination of the two previous tables shows that supervisors and operatives experienced similar examples of good supervision in the following six areas:

concern for and interest in the needs of subordinates
listening to and exchanging ideas with subordinates
support of subordinates in their activities
providing guidance on what is expected
job knowledge
dealing with subordinates as individuals

Differences between supervisors and operatives are in the areas of providing freedom for job accomplishment (observed more by operatives than supervisors) and the personal qualities that make for a good supervisor (observed more by supervisors than operatives). One should not be surprised that operatives emphasized the importance of freedom for job accomplishment more than supervisors, since operatives are in a better position to observe or judge the amount of freedom given in any particular job.

The general categories noted in the beginning of this chapter are now presented to show the entire range of responses from non-technical supervisors and operatives. The percentage of times that characteristics are mentioned under the general categories is as follows:

	Supervisors	Operatives
Human Relations	33.11%	28.43%
Working Environment	24.20	45.69
Goals and Requirements	4.46	6.61
Management Related Activities	4.47	2.04
Performance Evaluation	8.28	2.54
Qualities of the Supervisor	24.21	13.20
Other	1.28	1.52

The above figures indicate similar observations by supervisors and operatives except in the categories of "Working Environment" and "Qualities of the Supervisor".

Characteristics of good supervision involving "Human Relations" are named approximately an equal number of times by supervisors and operatives. The total responses by supervisors show the greatest emphasis in the area of "Human Relations", which is frequently recognized as one of the more important elements of supervision. Operatives place emphasis on human relations, but operatives are more concerned about the "Working Environment". Operatives want a working environment created by the supervisor where characteristics are found such as freedom to perform tasks, challenging and interesting work, and support for subordinates. Additionally, supervisors noted to a greater extent the category of "Qualities of the Supervisor." Supervisors stress the need for such personal qualities as fairness, setting a good example, and honesty.

Over the entire range of responses supervisors and operatives from the non-technical area name similar examples of good supervision. The similarity of responses indicates a common attitude toward characteristics of good supervision between non-technical supervisors and operatives.

Discussion of Examples of Inadequate Supervision.

Question 2 involved soliciting from the respondents examples of inadequate supervision from experiences in past and present jobs. Question 2 follows:

> Question 2: In your experiences as a(n) (job title), what have been examples of inadequate supervision?

The following two tables summarize the responses of supervisors and operatives to question 2. The responses noted below are the most frequently mentioned by the respondents. In total, there are 99 responses to question 2 from 40 non-technical supervisors among 26 subclassifications, and 155 responses from the 58 non-technical operatives among 32 different subclassifications. As with scientists and engineers, the utility of question 2 is the extent to which responses deviate from responses to question 1.

Table IX

Most Frequently Mentioned Responses to Question 2 by Non-technical Supervisors (Average Response Rate = 99 ÷ 26 = 3.81)

Subclassifications	Responses Frequency	Responses Percentage
Personal qualities	14	14.0
Does not get involved in the work but still takes the credit	11	11.0
Does not listen to nor exchange ideas with subordinates	9	9.0
Opposite of question 1	9	9.0
Provides no guidance on what is expected	5	5.0
Inability to make or understand consequences of a decision	9	9.0
Lack of job knowledge	5	5.0
Provides little freedom in job accomplishment	4	4.0
Does not recognize capabilities of subordinates	4	4.0
Lack of concern for and interest in the needs of subordinates	4	4.0

Table X

Most Frequently Mentioned Responses to Question 2 by Non-technical Operatives (Average Response Rate = 155÷32=4.84)

Subclassifications	Responses	
	Frequency	Percentage
Personal qualities	23	14.84
Lack of concern for and interest in needs of subordinates	18	11.61
Provides no recognition	14	9.03
Inability to make or understand consequences of decisions	11	7.10
Opposite of question 1	10	6.45
Does not listen nor exchange ideas with subordinates	9	5.81
Lack of job knowledge	8	5.16
Provides little freedom in job accomplishment	7	4.52
Does not provide authority and responsibility	6	3.87
Does not support subordinates	5	3.23
Does not get involved in the work	5	3.23
Provides no guidance on what is expected	5	3.23

An examination of the two previous tables reveals a similarity between supervisors and operatives as to experiences involving examples of inadequate supervision. Negative characterisitics that are similar between the two groups are as follows:

- negative personal qualities
- lack of guidance provided
- lack of job knowledge
- lack of freedom in job accomplishment
- failure to listen to and exchange ideas with subordinates
- inability to make decisions

In other negative characteristics named by both groups, supervisors noted more observations in the area of the

supervisor not getting involved in the work. Operatives noted more observations in the area of lack of concern for and interest in the needs of subordinates.

Supervisors and operatives mentioned negative characteristics under the categories, noted at the beginning of this chapter, the following percentage of times:

	Supervisors	Operatives
Human Relations	21.00%	20.01%
Working Environment	28.00	25.21
Goals and Requirements	5.00	3.23
Management Related Activities	10.00	14.20
Performance Evaluation	4.00	9.03
Qualities of the Supervisor	20.00	21.30
Other	12.00	7.75

The above information further indicates the similarity in observations of negative characteristics between supervisors and operatives.

Given that the importance of question 2 is the extent to which the question deviates from the responses in question 1, the following observations are worth noting. In general, more agreement between supervisors and operatives is evident in question 2 than question 1. The general categories of question 2 are very similar, while the general categories of question 1 show differences in the categories of "Working Environment" and "Qualities of the Supervisor".

Specific characteristics are named in question 2 by supervisors and operatives that are not named in question 1. Supervisors name two negative characteristics that

are not considered in question 1: (a) supervision which does not get involved in the work of subordinates and (b) supervision which does not recognize the capabilities of subordinates. Operatives note supervision which does not get involved in the work and which is unable to make or understand the consequences of decisions. Operatives also place emphasis on supervision which provides no recognition. In addition, a shift of emphasis among supervisors and operatives is noted between questions 1 and 2 in one area. The aspect of concern for the needs of subordinates is mentioned more by operatives in question 2, but is observed equally by supervisors and operatives in question 1.

Although a large number of characteristics of supervision are identified through the responses to question 1 and 2, a consensus or importance attached to certain characteristics, by either supervisors or operatives, is difficult to determine. The purpose of questions 1 and 2 is to identify characteristics of good and inadequate supervision represented by experiences of the interviewees, and also to provide a base for the interviewee to draw upon in identifying the most important characteristics of supervision. Therefore, in order to identify the most important characteristics of supervision, one must consider the responses to question 3.

Discussion of the Important Characteristics in the Supervision of Non-technical Personnel. Question 3 involved soliciting from the respondents the characteristics most necessary in the supervision of non-technical personnel. Question 3 follows:

> Question 3: What supervisory skills, techniques, or practices do you feel are most necessary in the supervision of (scientific/engineering/non-technical) personnel?
>
> a. 1.
> 2.
> 3.
> etc.
>
> b. How would you rank these in order of importance?

The following table presents the responses of supervisors and operatives from the non-technical fields according to the general categories identified in the introduction to Chapter III. The discussion and analysis that follows elaborates on the specific characteristics named under each category. Characteristics preceded by an asterisk (*) are common to supervisory and operative responses.

Table XI

Total Relative Weight, by Category, of Items Ranked as Number One, Two, or Three by Non-technical Supervisors and Operatives

Category	Total Relative Weight Supervisors (S)	Operatives (O)
Human Relations	145.80	186.23
Working Environment	116.88	96.50
Goals and Requirements	16.90	37.30
Management Related Activities	43.80	21.25
Performance Evaluation	5.00	30.18
Qualities of the Supervisor	269.12	228.67
Other	2.50	0.00
	600.00	600.13

The characteristics identified under the general category of "Qualities of the Supervisor are the following:

Qualities of the Supervisor	S	O
Job Related		
*Job knowledge	139.15	110.83
Basic communicative skills	31.06	
Administrative competence		4.56
Leadership qualities		7.94
Personal		
*Integrity, sets a good example, fair, diplomatic, flexible, level-headed, positive attitude, etc.	98.91	105.34
	269.12	228.67

The above figures show that both supervisors and operatives place the greatest emphasis on "Qualities of the Supervisor". However, supervisors place more importance on this category than operatives (269.12 vs 228.67). The emphasis given this category is explained by the

inclusion of job knowledge and personal qualities, which are ranked overall as numbers one and two respectively by both groups. Supervisors place more emphasis than operatives on the importance of job knowledge, while personal qualities that a supervisor needs to possess are considered of equal importance between the two groups. The greater importance given job knowledge by supervisors may be explained partially by some supervisors indicating that the promotion to the particular supervisory jobs was because of experience. Also, the level of supervison utilized in the sample is first line or working level supervision, which usually has a more direct contact with subordinates than higher levels of supervision. In addition, supervisors place greater emphasis on the necessity of communicative skills (oral and written) as desirable personal qualities of the supervisor. The importance that supervisors place on communicative skills is perhaps due to the supervisor knowing the importance of communication as a middle man between operatives and higher levels of management.

The category of "Human Relations" is given the second highest relative weight by both groups of supervisors. The characteristics identified under the general category of "Human Relations" are the following:

Human Relations	S	O
*Concern for and interest in the needs of subordinates	50.58	30.95
*Listens to and exchanges ideas with subordinates	43.68	28.10
*Deals with subordinates as individuals	27.02	37.73
*Recognizes the capabilities of subordinates	9.88	17.03
*Motivates subordinates to get the job done	9.76	27.27
*Establishes a good working relationship (rapport) with subordinates	4.88	11.70
Listens to problems of subordinates		18.73
Has the ability to get along with people		14.72
	145.80	186.23

Operatives place more importance on this category than supervisors (186.23 vs 145.80). Each group places considerable emphasis on three identical areas: concern for and interest in the needs of subordinates, listening to and exchanging ideas with subordinates, and dealing with subordinates as individuals. Supervisors place more emphasis on the needs of subordinates and listening to and exchanging ideas with subordinates, while operatives place more emphasis on dealing with subordinates as individuals. One may explain the particular emphasis by supervisors and operatives on separate characteristics of "Human Relations" by the desire of subordinates for individual treatment, while the supervisor appears to be more concerned with group considerations. Operatives also place more emphasis than supervisors on motivating subordinates to get the job done, recognizing the capabilities of

subordinates, and establishing a good working relationship with subordinates. Operatives introduce two characteristics not mentioned by supervisors: listening to the problems of subordinates and the ability to get along with people. Operatives definitely recognize the importance of human relation skills as an integral part of supervision.

The characteristics identified under the general category of "Working Environment" are the following:

Working Environment	S	O
*Provides freedom for job accomplishment	17.14	9.09
*Keeps informed of what subordinates are doing	14.64	5.17
Shows interest in subordinates and their work	10.00	
*Gains the respect and support of subordinates	7.38	13.65
*Supports subordinates in their activities	7.38	18.92
*Trains subordinates or provides them an opportunity to receive training	7.14	4.56
*Places trust and confidence in subordinates	4.88	3.38
*Provides authority and responsibility	4.88	11.51
Provides for a creative atmosphere	9.76	
Trains subordinates to function independently	9.76	
Looks after the safety of subordinates	7.14	
Involves subordinates in the decision process	7.14	
Firm but flexible in job accomplishment	7.14	
Has the ability to bring unity and coordination into the organization	2.50	
Provides challenging and interesting work		6.95
Gets subordinates to work together		6.78
Acts as a buffer to filter extraneous work		4.56
Makes subordinates feel important		3.38
Keeps subordinates informed		3.38
Is available when needed		3.38
Creates a good working environment		1.79
	116.88	96.50

The category of "Working Environment" is projected as being more important to supervisors than operatives (116.88 vs 96.50). Overall significant differences are found in the following areas:

providing freedom for job accomplishment
keeping informed of what subordinates are doing
supporting subordinates in their activities
gaining the respect and support of subordinates
providing authority and responsibility

Supervisors place greater emphasis on two of the above characteristics: freedom for job accomplishment and keeping informed of what subordinates are doing. Supervisors express the need to give subordinates freedom to perform tasks, but on the other hand, supervisors want to know what tasks the subordinates are performing. Operatives place greater emphasis on the need for the supervisor to support or back the subordinates in activities, instead of usually taking the side of management when conflicts arise.

The category of "Management Related Activities" provides a variety of different responses by supervisors and operatives. The characteristics identified under the general category for "Management Related Activities" are the following:

Management Related Activities	S	O
*Decision making ability	16.90	7.94
Understanding of management techniques	12.38	
Knowledgeable in the role of the organization in mission accomplishment	12.02	
Possesses ability to deal with upper management	2.50	
Good organizer		6.35
Has adequate supervisory training		3.38
Effectively manages people (time-off, etc.)		1.79
Minimum number of workers per supervisor		1.79
	43.80	21.25

Supervisors place more emphasis on this category than operatives (43.80 vs 21.25). The only identical characteristic mentioned by both groups is the ability of the supervisor to make decisions, which is not surprisingly given more importance by supervisors. Supervisors also attach importance to the understanding of management techniques and to understanding the role of the organization in mission accomplishment. Operatives name such characteristics as adequate supervisory training and the ability to organize.

The characteristics identified under the general category of "Goals and Requirements" are the following:

Goals and Requirements	S	O
*Provides guidance on what is expected	16.90	24.80
Makes subordinates aware of organizational goals		4.56
Maintains stated objectives		4.56
Fosters goal congruence		3.38
	16.90	37.30

Operatives place more emphasis than supervisors (37.30 vs 16.90) on the category of "Goals and Requirements". The only identical characteristic named by both groups is providing guidance, which is given greater emphasis by operatives. Operatives express the desire to know exactly what is expected in the job. The only characteristic named by supervisors is providing guidance, while operatives name three other characteristics: making subordinates aware of organizational goals, maintaining stated objectives, and fostering goal congruence. Operatives are expressing a desire for goals and guidance that supervision appears to neglect.

The characteristics identified under the general category of "Performance Evaluation" are the following:

Performance Evaluation	S	O
*Provides recognition	2.50	22.05
*Provides feedback on performance	2.50	3.57
Provides discipline		4.56
	5.00	30.18

Lastly, the category of "Performance Evaluation" is given more emphasis by operatives (30.18 vs 5.00). Operatives attach more importance than supervisors to the need for the supervisor to provide recognition. Operatives feel that recognition for good work is essential and motivates subordinates to do a better job. The fact that only one supervisor out of forty mentioned the need to provide recognition as an important element of supervision is

an admission by supervisors that recognition is not an essential, supervisory characteristic in a non-technical environment.

It is also important to consider the most important characteristics of supervision irrespective of the categories of responses. Appendix L provides a listing of characteristics, noted in the discussion of question 3, in order of most important to least important. Supervisors and operatives clearly name job knowledge and personal qualities of the supervisor as the most important characteristics. Among the remaining characteristics with relative weights greater than ten, four are unique to supervisory responses and two are unique to operative responses. The four supervisory responses are: (1) basic communicative skills, (2) understanding management techniques, (3) knowledgeable of the role of the organization in mission accomplishment, and (4) interest in subordinates and their work. The two operative responses are: (1) listening to problems of subordinates, and (2) ability to get along with people. Except for the previous characteristics, agreement exists between the responses of non-technical personnel as to the most important characteristics of supervision.

Chapter Summary

In summary, the scientific/engineering supervisors and operatives agree that the most important characteristics of supervision are in the areas of "Human Relations"

and "Qualities of the Supervisor". Supervisors and operatives disagree on the third most important area. Supervisors note characteristics dealing with the "Working Environment" while operatives note "Management Related Activities". "Goals and Requirements" and "Performance Evaluation" are mentioned least often by supervisors and operatives. Within "Human Relations", supervisors and operatives disagree only as to the relative importance given to dealing with subordinates as individuals and flexibility in dealing with subordinates. Dealing with subordinates as individuals is the second most important characteristic mentioned by operatives whereas flexibility in dealing with subordinates is mentioned only by supervisors. "Qualities of the Supervisor" contains the most important characteristic mentioned by supervisors and operatives, namely, technical competence.

The main differences between supervisors and operatives with respect to characteristics dealing with the "Working Environment" are in two areas. Supervisors place greater emphasis than operatives on supporting subordinates in their activities and placing trust and confidence in subordinates.

The important differences in "Management Related Activities" are due to the large number of unique responses among all the respondents. However, operatives clearly recognize the importance of management related skills.

Supervisors and operatives from the non-technical area agree as to the relative importance of the six general categories. The categories of "Qualities of the Supervisor" and "Human Relations" are ranked respectively first and second in importance by both supervisors and operatives. However, supervisors place more emphasis than operatives on "Qualities of the Supervisors", while operatives place more emphasis than supervisors on "Human Relations". The category of "Working Environment" is ranked third in importance by both supervisors and operatives, with supervisors placing more importance than operatives on the working environment. The remaining three categories are not ranked in the same order of importance by both supervisors and operatives. The categories of "Goals and Requirements" and "Performance Evaluation" are stressed more by operatives than supervisors, while supervisors place more emphasis than operatives on the category of "Management Related Activities". In noting specific characteristics named under each category, one important observation is necessary. Supervisors and operatives list job knowledge and personal qualities as first and second respectively in importance among all characteristics.

This concludes the research findings dealing with comparative analyses between the views of supervisors and operatives in the scientific/engineering and non-technical

fields. The next chapter, Research Findings - Part II, presents comparative analyses between the views of supervisors (scientific/engineering and non-technical fields) and between the views of operatives (scientific/engineering and non-technical fields).

IV. Research Findings - Part II

Chapter IV presents comparative analyses between the views of supervisors in the scientific/engineering fields and supervisors in the non-technical fields, and similar comparisons between operatives in the same fields (see 4 and 3, Figure 1, p. 26). The comparative analyses in this chapter are based on the responses of supervisors and operatives identified in Chapter III.

The methods of presentation and analyses are the same as utilized in Chapter III. A detailed description of the techniques of analyses is presented in the data treatment section of Chapter II.

Comparative Analyses Between the Views of Two Groups of Supervisors (Scientific/Engineering and Non-technical)

A comparison between the views of supervisors to questions 1, 2, and 3 follows.

Discussion of Examples of Good Supervision. The discussion of examples of good supervision is based upon the responses to question 1. Question 1 follows:

> Question 1: In your experiences as a(n) (Job Title), what have been examples of good supervision?

The following two tables are extracted from Chapter III and provide the basis for comparison and analysis of the responses of supervisors to question 1.

Table II

Most Frequently Mentioned Responses to Question 1 by Scientific/Engineering Supervisors (Average Response Rate = 159÷31=5.13)

Subclassifications	Responses	
	Frequency	Percentage
Technical Competence	18	11.32
Listens to and exchanges ideas with subordinates	13	8.18
Provides recognition	12	7.55
Provides freedom for job accomplishment	11	6.92
Personal qualities of supervisor	9	5.66
Concern for and interest in the needs of subordinates	8	5.03
Defines goals	7	4.40
Provides guidance on what is expected	7	4.40
Administrative Skills	6	3.77

Table VII

Most Frequently Mentioned Responses to Question 1 by Non-technical Supervisors (Average Response Rate = 157÷31= 5.06)

Subclassifications	Responses	
	Frequency	Percentage
Personal Qualities of Supervisor	24	15.29
Concern for and interest in the needs of subordinates	19	12.10
Deals with subordinates as individuals	13	8.28
Job Knowledge	11	7.01
Provides freedom for job accomplishment	9	5.73
Listens to and exchanges ideas with subordinates	7	4.46
Supports subordinates in their activities	7	4.46
Provides guidance on what is expected	7	4.46
Trains subordinates or provides then an opportunity to receive training	6	3.82
Provides recognition	6	3.82

Supervisors in the scientific/engineering and non-technical fields observe similar characteristics of good supervision in the following areas:

Technical competence/job knowledge
Listens to and exchanges ideas with subordinates
Recognizes capabilities of subordinates
Provides freedom for job accomplishment
Provides guidance on what is expected

Differences between the two groups of supervisors are in the areas of personal qualities and concern and interest in the needs of subordinates, both observed more by non-technical supervisors.

The general categories noted in the introduction to Chapter III are presented to show the entire range of responses from supervisors. The percentage of times that characteristics are mentioned under the general categories is as follows:

	Scientific/ Engineering	Non-technical
Human Relations	23.26%	33.11%
Working Environment	23.90	24.20
Goals and Requirements	10.06	4.46
Management Related Activities	10.01	4.47
Performance Evaluation	10.07	8.28
Qualities of the Supervisor	22.01	24.21
Other	0.00	1.28

The above figures indicate a general agreement in the following areas:

Working Environment
Performance Evaluation
Qualities of the Supervisor

Both groups of supervisors identify freedom for job accomplishment as the most observed characteristic of good

supervision under "Working Environment". Among the "Qualities of the Supervisor", the most frequently mentioned characteristic of a good supervisor, by scientific/engineering supervisors, is in the area of technical competence, while for non-technical supervisors, the most frequently mentioned characteristic of a good supervisor is in the area of personal qualities. The responses indicate that a high degree of technical competence is necessary for the supervisor of scientists and engineers. Differences in relative number of responses exist in the areas of "Human Relations", "Goals and Requirements", and "Management Related Activities". The difference in "Human Relations" is accounted for by the greater number of responses of non-technical supervisors in the area of concern for and interest in the needs of subordinates.

The experiences of scientific/engineering and non-technical supervisors provide many similar observations of characteristics of good supervision. The responses of the two groups of supervisors indicate that good characteristics of supervision are applicable to a wide range of personnel. However, when one considers the observations according to the general categories, the similarities are not as evident. "Working Environment", "Qualities of the Supervisor", and Performance Evaluation" are the only categories for which there is general agreement among both groups of supervisors.

Discussion of Examples of Inadequate Supervision.

The discussion of examples of inadequate supervision is based upon the responses to question 2. Question 2 follows:

> Question 2: In your experiences as a (n) (job title), what have been examples of inadequate supervision?

The following two tables are extracted from Chapter III and provide the basis for comparison and analysis of the responses of supervisors to question 2.

Table IV

Most Frequently Mentioned Responses to Question 2 by Scientific/Engineering Supervisors (Average Response Rate = 118÷22=5.36)

Subclassifications	Responses Frequency	Percentage
Opposite of question 1	15	12.71
Fails to communicate downward or listen to ideas of subordinates	13	11.00
Too strong administrative control	13	11.00
Does not provide adequate guidance	11	9.32
Inability to make or understand consequences of a decision	10	8.47
Lack of technical competence	8	6.78
Lack of support and interest in work of subordinates	7	5.93
Lack of interest in needs of subordinates	6	5.08

Table IX

Most Frequently Mentioned Responses to Question 2 by Non-technical Supervisors (Average Response Rate = 99÷26=3.81)

Subclassifications	Responses Frequency	Percentage
Personal qualities of supervisor	14	14.0
Does not get involved in the work but still takes the credit	11	11.0
Does not listen to or exchange ideas with subordinates	9	9.0
Opposite of question 1	9	9.0
Provides no guidance on what is expected	5	5.0
Inability to make or understand consequences of a decision	9	9.0
Lack of job knowledge	5	5.0
Provides little freedom in job accomplishment	4	4.0
Does not recognize capabilities of subordinates	4	4.0
Lack of concern for and interest in the needs of subordinates	4	4.0

An examination of the two preceding tables indicates that observations of both groups of supervisors are similar only in the following areas:

Lack of guidance on what is expected
Lack of technical competence/job knowledge
Lack of concern for and interest in the needs of subordinates

Scientific/engineering and non-technical supervisors mentioned characteristics under the general categories, noted in the introduction to Chapter III, the following percentage of times:

	Scientific/ Engineering	Non-technical
Human Relations	19.47%	21.00%
Working Environment	25.40	28.00
Goals and Requirements	9.32	5.00
Management Related Activities	13.55	10.00
Performance Evaluation	4.24	4.00
Qualities of the Supervisor	11.86	20.00
Other	16.10	12.00

The above figures indicate a general agreement between the observations of scientific/engineering and non-technical supervisors. The only discernable difference is in the area of "Qualities of the Supervisor".

Given that the importance of question 2 is the extent to which responses are different from the responses to question 1, the following observations are worth noting. Analysis of the most frequently mentioned responses to questions 1 and 2 reveals that only two responses, technical competence/job knowledge and concern for and interest in the needs of subordinates, occur among all the responses of scientific/engineering and non-technical supervisors. On the other hand, the relative position of responses among the general categories changes very little between questions 1 and 2. A difference occurs only in the area of "Qualities of the Supervisor", where non-technical supervisors mention a larger number of negative characteristics than scientific/engineering supervisors, but the same number of good characteristics of supervision are observed by both groups in question 1.

The responses to question 1 and 2 provide an extensive number of characteristics of supervision. From both the positive and negative points of view, scientific/engineering and non-technical supervisors provide similar observations in the areas of "Human Relations", "Working Environment", and "Qualities of the Supervisor". However, within each of the above categories different characteristics of supervision are mentioned by both groups of supervisors. Therefore, in order to identify the important characteristics of supervision, it is necessary to consider the responses to question 3.

Discussion of the Important Characteristics of Supervision. The discussion of the important characteristics in the supervision of scientists/engineers and non-technical personnel is based upon the responses to question 3. Question 3 follows:

> Question 3: What supervisory skills, techniques, or practices do you feel are most necessary in the supervision of(scientific/engineering/non-technical) personnel?
>
> a. 1.
> 2.
> 3.
> etc.
>
> b. How would you rank these in order of importance?

The following table presents the responses of supervisors in the scientific/engineering and non-technical fields according to the general categories identified in the introduction to Chapter III. It is an extraction

and recombination of the characteristics named by supervisors in Tables VI and XI of Chapter III. The discussion and analysis that follows Table XII elaborates on the specific characteristics identified under each category. Characteristics preceded by an asterisk (*) are common to the supervisory responses of scientific/engineering and non-technical personnel.

Table XII

Total Relative Weight, by Category, of Items Ranked as Number one, Two, or Three by Scientific/Engineering and Non-technical Supervisors

Category	Total Relative Weight Scientists/ Engineers (SE/S)	Non-technical (NT/S)
Human Relations	181.17	145.80
Working Environment	131.98	116.88
Goals and Requirements	56.25	16.90
Management Related Activities	37.70	43.80
Performance Evaluation	30.09	5.00
Qualities of the Supervisor	157.18	269.12
Other	5.76	2.50
	600.13	600.00

The characteristics identified under the category of "Human Relations" are the following:

Human Relations	SE/S	NT/S
*Concern for and interest in the needs of subordinates	44.06	50.58
*Listens to and exchanges ideas with subordinates	27.38	43.68
*Deals with subordinates as individuals	11.57	27.02
*Motivates subordinates to get the job done	28.57	9.76
*Establishes a good working relationship (rapport) with subordinates	2.44	4.88
*Recognizes capabilities of subordinates	34.03	9.88
Flexible in dealing with subordinates	28.86	
Understands subordinates	4.26	
	181.17	145.80

Characteristics of supervision under the category of "Human Relations" are emphasized more by the scientific/engineering supervisors than the non-technical supervisors (181.17 vs 145.80). However, both groups identify the same characteristics except for two. The difference in relative weight is accounted for by the scientific/engineering supervisors greater relevance attached to motivating subordinates, recognizing the capabilities of subordinates, and flexibility in dealing with subordinates. The "Human Relations" category is the most important category for scientific/engineering supervisors and second most important for non-technical supervisors.

The characteristics identified under the category of "Working Environment" are the following:

Working Environment	SE/S	NT/S
*Provides freedom for job accomplishment	22.51	17.14
*Supports subordinates in their activities	23.12	7.38
*Shows interest in subordinates and their work	17.02	10.00
*Provides training for subordinates	4.26	7.14
*Places trust and confidence in subordinates	19.75	4.88
*Provides authority and responsibility	15.81	4.88
*Involves subordinates in decision process	8.20	7.14
Keeps subordinates informed	16.43	
*Knows accomplishments of subordinates and organization (keeps informed)	2.44	14.64
Provides an environment that does not inhibit research and development	2.44	
Gains the respect and support of subordinates		7.38
Provides for a creative environment		9.76
Trains subordinates to function independently		9.76
Looks after the safety of subordinates		7.14
Has the ability to bring unity and coordination into the organization		2.50
Firm but flexible in job accomplishment		7.14
	131.98	116.88

Scientific/engineering and non-technical supervisors identify characteristics dealing with the "Working Environment" with similar importance (131.98 vs 116.88). However, there is not a general consensus as to which characteristics of supervision are most important in the "Working Environment". Characteristics common to both groups of supervisors are identified with larger relative weights by scientific/engineering supervisors in all cases but two. Non-technical supervisors identify a number of characteristics not mentioned by scientific/

engineering supervisors. The important conclusion in analyzing the "Working Environment" is that, although the importance attached to characteristics of the working environment is similar for scientific/engineering and non-technical supervisors, there exists disagreement as to the relative importance of individual characteristics.

The category of "Goals and Requirements" is of greater importance to scientific/engineering supervisors than non-technical supervisors (56.25 vs 16.90). The characteristics identified under the category of "Goals and Requirements" are the following:

Goals and Requirements	SE/S	NT/S
*Provides guidance on what is expected	20.69	16.90
Defines/communicates goals	31.30	
Relates goals to a specific job	4.26	
	56.25	16.90

Differences in relative importance among characteristics dealing with "Goals and Requirements" exist since defining/communicating goals and relating goals to a specific job are mentioned by scientific/engineering supervisors but not by non-technical supervisors. An interesting observation is that the scientific/engineering supervisors consider guidance and goals of greater importance than non-technical supervisors. One reason for the difference in importance may be the fact that in a highly technical environment, budgetary constraints

and technological uncertainity, restrict the research and development that can be undertaken. Thus, it is often necessary to define the desired output prior to committing large sums of money for technological advancement.

The characteristics identified under "Management Related Activities" are the following:

Management Related Activities	SE/S	NT/S
*Decision making abilities	8.52	16.90
*Understanding of management techniques	6.70	12.38
Exhibits day to day awareness	5.76	
Is able to direct problems as a team effort	5.76	
Able organizer	4.26	
Able to judge importance of projects	4.26	
Keeps upper management informed	2.44	
Knowledgeable in the role of the organization in mission accomplishment		12.02
Ability to deal with upper management		2.50
	37.70	43.80

The category of "Management Related Acitivites" is of nearly equal importance to scientific/engineering and non-technical supervisors (37.70 vs 43.80). However, only two characteristics are common to both groups, decision making ability and understanding of management techniques. An important observation is that both scientific/engineering and non-technical supervisors place a relatively low significance on"Management Related Activities". Among all the categories, "Management Related Activities" is fifth in importance for

scientific/engineering supervisors and fourth in importance for non-technical supervisors.

"Performance Evaluation" offers insights into the aspect of recognition. The characteristics identified under the category of "Performance Evaluation" are the following:

Performance Evaluation	SE/S	NT/S
*Provides recognition	30.09	2.50
Provides feedback on performance		2.50
	30.09	5.00

Recognition is of greater importance to scientific/engineering supervisors than to non-technical supervisors (30.09 vs 2.50). The scientific/engineering supervisors perception of the technical environment or personal qualities of the people may be reasons for the disparity in relative weights given recognition by the two groups of supervisors. Supervisors of scientist or engineers may realize that a technical environment places a burden upon the working scientist or engineer to excel. In return, the scientist or engineer expects to be recognized. In addition, scientific/engineering supervisors may view the working scientist or engineer as possessing different personal qualities than non-technical workers (e.g. achievement orientation and self-motivation); personal qualities which necessitate recognition in the course of job accomplishment.

The characteristics identified under the category of "Qualities of the Supervisor" are the following:

Qualities of the Supervisor	SE/S	NT/S
Job Related		
*Technical competence/job knowledge	84.14	139.15
*Basic communicative skills	24.95	31.06
Administrative skills	9.76	
Leadership Qualities	11.55	0.00
*Personal (integrity, fairness, open-minded etc.)	26.78	98.91
	157.18	269.12

The most important category identified by non-technical supervisors is "Qualities of the Supervisor". It is also the second most important category for scientific / engineering supervisors. Within "Qualities of the Supervisor" is the most important characteristic identified by both groups of supervisors, technical competence/job knowledge. The non-technical supervisors consider "Qualities of the Supervisor" more important than scientific/ engineering supervisors (157.18 vs 269.12) because of the greater importance non-technical supervisors place on job knowledge and administrative skills. Another important observation is that non-technical supervisors did not specifically mention leadership qualities. The fact that non-technical supervisors emphasize personal qualities may be a reason for the absence of references to leadership qualities.

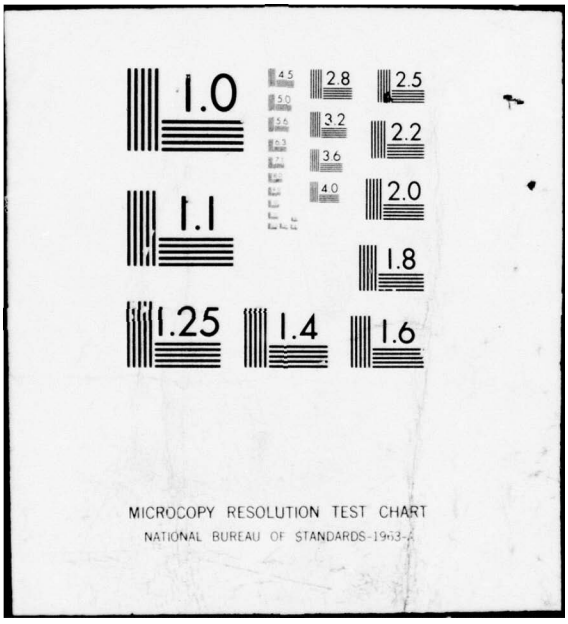
The summary of the general categories according to the relative importance given by scientific/engineering and non-technical supervisors is as follows:

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	Scientific/ Engineering	Non-tech
Human Relations	1	2
Working Environment	3	3
Goals and Requirements	4	5
Management Related Activities	5	4
Performance Evaluation	6	6
Qualities of the Supervisor	2	1
Other	7	7

The above figures indicate that the top three catego for both groups of supervisors are "Human Relations" "Working Environment", and "Qualities of the Supervis As the earlier discussions indicate, there are diffe within each category among specific characteristics supervision, and thus it is important to consider ch teristics of supervision on an individual basis.

The six most important characteristics of super vision identified by scientific/engineering and non-technical supervisors are as follows:

	Scientific/Engineering		Non-Technica
1.	Technical competence	1.	Job knowledge
2.	Concern for and interest in subordinates	2.	Personal qual the supervisо
3.	Recognizes capabilities of subordinates	3.	Concern for a in needs of s
4.	Defines/communicates goals	4.	Listens to an ideas with su
5.	Provides recognition	5.	Basic communi skills
6.	Flexibility in dealing with subordinates	6.	Deals with su as individual

The above characteristics show that scientific/engin supervisors consider a broader base of characteristi The top six characteristics identified by non-techni supervisors are from two categories, "Qualities of t

Supervisor" and "Human Relations". Scientific/engineering supervisors, however, draw from four general categories in the top six characteristics, "Qualities of the Supervisor","Human Relations", "Performance Evaluation", and "Goals and Requirements". The responses of the scientific/engineering supervisors indicate a realization that the scientific/engineering environment is more complex than the non-technical environment, an environment more complex in terms of the people and work involved. As a consequence, scientific/engineering supervisors must utilize a broader base of supervisor characteristics than is required of non-technical supervisors.

The remaining sections of this chapter are a discussion of the responses of the operative personnel. The format used to present the responses is similar to the methods already employed in this chapter.

Comparative Analysis Between the Views of Two Groups of Operatives (Scientific/Engineering and Non-technical)

This section presents comparative analyses between the responses of operatives to questions 1, 2, and 3. The methods of analyses used in Chapter III are repeated.

Discussion of Examples of Good Supervision. The discussion of examples of good supervision is based upon the responses to question 1. Question 1 follows:

> Question 1: In your experiences as a(n) (job title), what have been examples of good supervision?

The following two tables are extracted from Chapter III and provide the basis for comparison and analysis of the responses of operatives to question 1.

Table III

Most Frequently Mentioned Responses to Question 1 by Scientific/Engineering Operatives (Average Response Rate = 262÷37=7.08)

Subclassifications	Responses Frequency	Percentage
Provide freedom for job accomplishment	34	12.98
Technical competence	24	9.16
Provides guidance on what is expected	22	8.40
Concern for and interest in the needs of subordinates	19	7.25
Personal qualities of supervisor	15	5.73
Listens to and exchanges ideas with subordinates	13	4.96
Keeps subordinates informed	13	4.96
Provides recognition	13	4.96
Administrative skills	12	4.58
Provides responsibility and authority	12	4.58
Supports subordinates in their activities	12	4.58
Deals with subordinates as individuals	9	3.44
Recognizes capabilities of subordinates	8	3.05

Table VIII

Most Frequently Mentioned Responses to Question 1 by Non-technical Operatives (Average Response Rate = 197÷29=6.79)

Subclassifications	Responses Frequency	Percentage
Concern for and interest in the needs of subordinates	25	12.69
Provides freedom for job accomplishment	22	11.17
Personal qualities of supervisor	16	8.12
Listens to and exchanges ideas with subordinates	11	5.58
Provides guidance on what is expected	10	5.08
Deals with subordinates as individuals	9	4.57
Provides challenging and interesting work	9	4.57
Supports subordinates in their activities	8	4.06
Works with subordinates to get the job done	8	4.06
Provides authority and responsibility	7	3.55
Keeps subordinates informed	7	3.55

An examination of the two previous tables reveals that operatives in each field experienced examples of good supervision in the following eight areas:

providing freedom for job accomplishment
listening to and exchanging ideas with subordinates
personal qualities of supervisor
keeping subordinates informed
providing authority and responsibility
supporting subordinates in their activities
dealing with subordinates as individuals
providing guidance on what is expected

The only differences between scientific/engineering and non-technical operatives are in the areas of technical competence/job knowledge (observed more by scientific/engineering operatives) and concern for and interest in the needs of subordinates (observed more by non-technical operatives).

The general categories noted at the beginning of Chapter III are presented to show the entire range of responses from operatives. The percentage of times that characteristics are mentioned under the general categories is as follows:

	Scientific/ Engineering	Non-technical
Human Relations	22.14%	28.43%
Working Environment	37.61	45.69
Goals and Requirements	10.69	6.61
Management Related Activities	3.04	2.04
Performance Evaluation	4.96	2.54
Qualities of the Supervisor	20.62	13.20
Other	1.14	1.52

The above figures indicate similar observations by operatives in each field as to experiences of good supervision.

The two previous tables substantiate the similarity of the general categories. Some interesting observations are worthy of note.

Each group of operatives place the greatest emphasis on the category of the "Working Environment". Within the area of the "Working Environment", the characteristic given the most emphasis by all operatives is the freedom for job accomplishment. Operatives in each field want freedom to perform the work without the supervisor looking over the shoulder of the subordinate to see what is being done. Additionally, operatives want to be kept informed, support in the work, guidance when needed, and the authority and responsibility to perform the work.

The category of "Human Relations" is second in importance to the "Working Environment" for operatives in each field. Characteristics as concern for the needs of subordinates, listening to and exchanging ideas with subordinates, and dealing with subordinates as individuals are stressed. Non-technical operatives especially place emphasis on the necessity for the supervisor to show concern for and interest in the needs of the subordinates.

Lastly, operatives in each field emphasize the category of "Qualities of the Supervisor". Scientific/engineering operatives place more emphasis than non-technical operatives on necessary qualities for the supervisor, mainly because the scientific/engineering

operatives value technical competence as a very important quality of a good supervisor. The other categories are of lesser importance to both groups of operatives.

Discussion of Examples of Inadequate Supervision. The discussion of examples of inadequate supervision is based upon the responses to question 2.

Question 2: In your experiences as a(n) (job title), what have been examples of inadequate supervision?

The following two tables are extracted from Chapter III and provide the basis for comparison and analysis of the responses of operatives to question 2.

Table V

Most Frequently Mentioned Responses to Question 2 by Scientific/Engineering Operatives (Average Response Rate = 192÷36=5.33)

Subclassifications	Responses Frequency	Percentage
Does not provide adequate guidance	19	9.90
Opposite of question 1	12	6.25
Fails to communicate or consider subordinate ideas	12	6.25
Lack of concern and interest in subordinate needs	12	6.25
Lack of understanding of management techniques	12	6.25
Does not recognize problems	12	6.25
Requires too many administrative details	11	5.73
Becomes too involved in technical matters	10	5.21
Personal qualities of supervisor	7	3.65
Fails to recognize individual capabilities	7	3.65
Poorly defines goals	7	3.65
Lacks technical competence	6	3.13
Does not pass on information to subordinates	6	3.13
Lack of recognition	6	3.13

Table χ

Most Frequently Mentioned Responses to Question 2 by Non-technical Opeatives (Average Response Rate = 155÷32= 4.84)

Subclassifications	Responses Frequency	Percentage
Personal qualities of supervisor	23	14.84
Lack of concern for and interest in the needs of subordinates	18	11.61
Provides no recognition	14	9.03
Does not support subordinates	5	3.23
Opposite of question 1	10	6.45
Does not listen nor exchange ideas with subordinates	9	5.81
Lack of job knowledge	8	5.18
Provides little freedom in job accomplishment	7	4.52
Does not provide authority and responsibility	6	3.87
Inability to make or understand consequences of a decision	11	7.10
Does not get involved in the work	5	3.23
Provides no guidance on what is expected	5	3.23

The previous two tables indicate a lack of similarity between the responses to scientific/engineering and non-technical operatives as to negative characteristics of supervision. Observations of operatives in each group are similar only in the areas of lack of technical competence/job knowledge and failure to listen to or consider the ideas of subordinates. Differences in views between scientific/engineering and non-technical operatives as to negative characteristics of supervision are in the following four areas:

negative personal qualities
lack of concern for and interest in the needs of subordinates
lack of recognition
lack of guidance provided

Each group of operatives mentioned negative characteristics under the general categories, noted at the beginning of Chapter III, the following percentage of times:

	Scientific/ Engineering	Non-technical
Human Relations	18.23%	20.01%
Working Environment	25.50	25.21
Goals and Requirements	13.55	3.23
Management Related Activities	15.62	14.20
Performance Evaluation	4.17	9.03
Qualities of the Supervisor	12.51	21.30
Other	10.41	7.75

The preceding figures indicate a general agreement as to the main categories of observation for each group of operatives as to negative characteristics of supervision. The only differences are found in two areas. Scientific/engineering operatives observed more examples of inadequate supervision than non-technical operatives in the area of "Goals and Requirements," while non-technical operatives observe more examples of inadequate supervision than scientific/engineering operatives in the area of "Qualities of the supervisor."

Thus far, questions 1 and 2 are discussed. The purpose of questions 1 and 2 is to identify characteristics of good and inadequate supervision represented by experiences of the interviewees, and also to provide

a base for the interviewee to draw upon in identifying the most important characteristics of supervision. Therefore, in order to identify the most important characteristics of supervision, one must consider the responses to question 3.

Discussion of the Important Characteristics of Supervision. Scientific/engineering and non-technical operatives were asked to name the characteristics most necessary in the supervision of the personnel in that particular job area. The specific question follows.

> Question 3: What supervisory skills, techniques, or practices do you feel are most necessary in the supervsion of (scientific/engineering/non-technical) personnel?
>
> a. 1.
> 2.
> 3.
> etc.
>
> b. How would you rank these in order of importance?

Table XIII on page 95 presents the responses of scientific/engineering and non-technical operatives according to the general categories identified in the introduction of Chapter III. Table XIII is an extraction and recombination of the characteristics named by operatives in Tables VI and XI of Chapter III. The discussion and analysis that follows Table XIII elaborates on the specific characteristics identified under each category. Characteristics preceded by an asterisk(*) are common to the operative responses of scientific/engineering and non-technical personnel.

Table XIII

Total Relative Weight, by Category, of Items Ranked as Number One, Two, or Three by Scientific/Engineering and Non-technical Operatives

Category	Total Relative Weight Scientists/ Engineers (SE/O)	Non-technical (NT/O)
Human Relations	191.61	186.23
Working Environment	79.03	96.50
Goals and Requirements	54.78	37.30
Management Related Activities	88.50	21.25
Performance Evaluation	14.85	30.18
Qualities of the Supervisor	167.08	228.67
Other	4.77	0.00
	600.62	600.13

The characteristics identified under the category of "Human Relations: are the following:

Human Relations	SE/O	NT/O
*Deals with subordinates as individuals	89.01	37.73
*Concern for and interest in the needs of subordinates	28.64	30.95
*Recognizes capabilities of subordinates	22.17	17.03
*Motivates subordinates to get the job done	23.64	27.27
*Listens to and exchanges ideas with subordinates	24.85	28.10
*Establishes a good working relationship (rapport) with subordinates	3.30	11.70
Listens to problems of subordinates		18.73
Has ability to get along with people		14.72
	191.61	186.23

An examination of the previous responses shows that scientific/engineering and non-technical operatives identify characteristics of supervision dealing with the category of "Human Relations" with equal importance (191.61 vs 186.23). Both groups stress the following characteristics:

recognizing the capabilities of individuals
showing concern for and interest in the needs of subordinates
motivating subordinates to get the job done
listening to and exchanging ideas with subordinates

Both groups also note dealing with subordinates as individuals, but scientific/engineering operatives place more emphasis than non-technical operatives on the need to deal with subordinates individually. Scientific/engineering operatives indicate that treating each worker individually is extremely important because of the varied educational backgrounds and experiences of each scientist and engineer. In addition, non-technical operatives name the need for the supervisor to listen to the problems of subordinates and to have the ability to get along with people. Scientific/engineering operatives consider "Human Relations" to be the most important category, while non-technical operatives consider "Qualities of the Supervisor" more important than "Human Relations".

The characteristics identified under the category of "Working Environment" are the following:

Working Environment	SE/O	NT/O
*Provides freedom for job accomplishment	18.82	9.09
*Keeps informed of what subordinates are doing	5.80	5.17
*Supports subordinates in their activities	13.95	18.92
*Places trust and confidence in subordinates	2.94	3.38
*Provides authority and responsibility	16.01	11.51
*Keeps subordinates informed	5.50	3.38
Involves subordinates in decision process	1.47	
Provides an environment that does not inhibit research and development	2.94	
Provides sufficient work	3.30	
Supports subordinates in their decisions	2.50	
Provides meaningful tasks	2.50	
Gains the respect and support of subordinates		13.65
Trains subordinates or provides them opportunity to receive training		4.56
Provides challenging and interesting work		6.95
Shows interest in subordinates & their work	3.30	
Gets subordinates to work together		6.78
Acts as a buffer to filter extraneous work		4.56
Makes subordinates feel important		3.38
Is available when needed		3.38
Creates a good working environment		1.79
	79.03	96.50

The category of "Working Environment" is considered of more importance to the non-technical operatives than to the scientific/engineering operatives (96.50 vs 79.03). Both groups place equal importance on the following characteristics:

keeping informed of what subordinates are doing
supporting subordinates in their activities
placing thrust and confidence in subordinates
providing authority and responsibility
keeping subordinates informed

Although both groups mention the need for freedom in job accomplishment, scientific/engineering operatives place more importance than non-technical operatives on the need for freedom. In addition, non-technical operatives emphasize the need for the supervisor to gain the respect and support of the subordinates.

The category of "Goals and Requirements" is given more emphasis by scientific/engineering operatives than non-technical operatives (54.78 vs 37.30). The characteristics identified under the category of "Goals and Requirements" are the following:

Goals and Requirements	SE/O	NT/O
*Provides guidance on what is expected	15.21	24.80
Defines/communicates goals	3.30	4.56
Maintains stated objectives		4.56
Fosters goal congruence		3.38
Provides freedom for subordinates to set own goals	36.27	
	54.78	37.30

The disparity in the category of "Goals and Requirements" is a result of the importance scientific/engineering operatives place on the characteristic of freedom to set own goals. Scientific/engineering operatives want freedom to perform the work, but also the supervisor must provide the freedom for one to set individual goals. In addition, both groups emphasize the need for guidance on what is expected in the job. Also, both groups mention, but place little emphasis, on the need for the stating and communicating of goals.

The characteristics identified under the category of "Management Related Activities" are the following:

Management Related Activities	SE/O	NT/O
*Decision making abilities	6.60	7.94
Understanding of management techniques	9.90	
Interfaces with upper management in selling programs of the organization	10.00	
Business knowledge	7.50	
Able to identify overall problem	7.50	
Is able to handle the military and civilian personnel systems	6.60	
Provides effective communication outside the organization	5.88	
Able to prioritize information	5.00	
Coordinates people and resources to accomplish tasks	4.41	
Gets people to agree on technical matters	3.30	
Does managing rather than dollar chasing	3.30	
Understandings mission of the organization	3.30	
Communicates accomplishments of organization to upper management	3.30	
Stays with decisions made	2.50	
Has a total picture of a project (dollars and manpower necessary)	3.97	
Provides answers or finds them out	2.50	
Assumes responsibility for group output	1.47	
Builds a balanced organization	1.47	
Good organizer		6.35
Has adequate supervisory training		3.38
Effectively manages people (time-off, etc)		1.79
Minimum number of workers per supervisor		1.79
	88.50	21.25

"Management Related Activities" provides a large number of different responses by each group of operatives with no one characteristic being very important to either group. The significant point is that scientific/engineering operatives offer a wider range of characteristics than non-technical operatives (88.50 vs 21.25). The only common characteristic between the two groups is

the need for the supervisor to have an ability to make decisions. The general category of "Management Related Activities" is ranked third in relative importance by scientific/engineering operatives, while non-technical operatives place "Management Related Activities" last in relative importance.

Non-technical operatives attach more importance than scientific/engineering operatives to the category of "Performance Evaluation" (30.18 vs 14.85). The characteristics identified under the category of "Performance Evaluation" are the following:

Performance Evalution	SE/O	NT/O
*Provides recognition	13.38	22.05
*Provides feedback on performance	1.47	3.57
Provides discipline		4.56
	14.85	30.18

Both groups mention the need for recognition, but non-technical operatives place more importance on the need for recognition. Scientific/engineering operatives indicated that the nature of scientific work is motivating and that recognition is found within the work, that is, new discoveries, patents. The type of recognition desired by each group is somewhat different. Non-technical operatives prefer monetary awards or an occassional "pat on the back", while scientific/engineering operatives prefer recognition from the scientific or engineering community or professional societies.

Also, each group mention the need for feedback on performance in the job.

The characteristics identified under the category of "Qualities of the Supervisor" are the following:

Qualities of the Supervisor	SE/O	NT/O
Job Related		
*Technical competence/job knowledge	114.85	110.83
*Administrative competence	19.31	4.56
Basic communicative skills	12.71	7.94
*Leadership qualities	2.50	
Personal	17.71	105.34
	167.08	228.67

The general category of "Qualities of the Supervisor" is ranked highest in relative importance among the categories by non-technical operatives (228.67), while scientific/engineering operatives place "Qualities of the Supervisor" as second in relative importance (167.08). The disparity between the two groups is explained by the emphasis non-technical operatives place on personal qualities of the supervisor (105.34 vs 17.71 for scientific/engineering operatives). Non-technical operatives want a supervisor who is fair, honest, sets a good example, and flexibile, while scientific/engineering operatives do not place such a high level of importance on personal qualities. In addition, both groups of operatives overall place the highest relative importance for specific characteristics on technical competence and job knowledge, which account for the high relative weights given the category of

"Qualities of the Supervisor". Also mentioned by each group is the need for the supervisor to possess administrative and communicative skills.

This concludes the discussion on characteristics under the individual categories. The "other" category is not considered due to the low relative weight.

Chapter Summary

In summary, the scientific/engineering and non-technical supervisors agree as to the most important characteristics of supervision only to the extent that "Human Relations", "Working Environment", and "Qualities of the Supervisor" are the top three categories mentioned by both groups of supervisors. "Human Relations" is first and second in importance for scientific/engineering and non-technical supervisors, respectively. Both groups are also in agreement as to the important characteristics that comprise the "Human Relations" category. "Qualities of the Supervisor" is first and second in importance for non-technical and scientific/engineering supervisors, respectively. The "Qualities of the Supervisor" category contains the most important characteristic mentioned by both groups of supervisors, namely, technical competence/job knowledge. "Working Environment" is the third most important category for the scientific/engineering and non-technical supervisors. No consensus exists as to the most important characteristics in the "Working Environment"

category. For both groups, characteristics associated with "Management Related Activities", "Goals and Requirements", and Performance Evaluation", are of lesser importance than the three categories already mentioned.

Among the most important individual characteristics, scientific/engineering supervisors identify a broader base of characteristics than non-technical supervisors. For example, of the top six characteristics of supervision noted by both groups of supervisors the responses of the scientific/engineering supervisors are from four categories, "Human Relations","Qualities of the Supervisor", "Performance Evaluation", and "Goals and Requirements", whereas the responses of the non-technical supervisors are only from "Qualities of the Supervisor" and "Human Relations".

The scientific/engineering and non-technical operatives agree that the most important characteristics of supervision are in the areas of "Human Relations" and "Qualities of the Supervisor". The area of "Human Relations" is of equal importance to each group, and also is considered most important to scientific/engineering operatives. However, non-technical operatives place the greatest relative importance on "Qualities of the Supervisor". The specific characteristic ranked most important by both groups is technical competence/job knowledge, which is in the area of "Qualities of the Supervisor". The second

most important characteristic named by scientific/engineering operatives is dealing with subordinates as individuals ("Human Relations"), while the second most characteristic named by non-technical operatives is personal qualities ("Qualities of the Supervisor").

Other categories are not ranked of similar importance by both groups. Scientific/engineering operatives rank "Management Related Activities" as last in importance. No single characteristics are ranked of considerable importance in either the categories of "Working Environment" or "Management Related Activities", but instead the categories represent a variety of individual responses.

The remaining categories, "Goals and Requirements" and "Performance Evaluation", are ranked fifth and sixth respectively by scientific/engineering operatives, and fourth and fifth respectively by non-technical operatives. Each group similarly named the need for guidance on what is expected as part of "Goals and Requirements," while each group similarly named the need for recognition as part of "Performance Evaluation".

This concludes the development of research findings dealing with comparative analyses between the views of supervisors in each field and between the views of operatives in each field. The next chapter, Research Findings-Part III, presents the distinctive characteristics in the

supervision of scientific and engineering personnel as derived from the research findings.

V. Research Findings - Part III

The purpose of Chapter V is to develop and present distinctive characteristics in the supervision of scientific and engineering personnel as derived from the research findings. First, a futher analysis of question 3 (Appendix F) is presented as a primary tool to identify and recognize characteristics projected by respondents as being most necessary in the supervision of scientific and engineering personnel. Next, question 4 (Appendix F) is analyzed to identify characteristics of the people engaged in scientific or engineering pursuits. Lastly, results or responses from the supplemental questionnaire (Appendix G) are discussed to develop further insights into the characteristics of the scientific and engineering environment.

Characteristics in the Supervision of Scientists and Engineers

The discussion of distinctive characteristics in the supervision of scientific and engineering personnel is partially based upon a comparison of responses to question 3 between scientists/engineers and non-technical personnel. Question 3 follows:

> Question 3: What supervisory skills, techniques, or practices do you feel are most necessary in the supervision of (scientific/engineering/non-technical) personnel?

a. 1.
2.
3.
etc.

b. How would you rank these in order of importance?

In previous chapters responses were separated into responses by supervisors and operatives in each of the scientific/engineering and non-technical fields. In this section responses are combined to reflect only the responses of a particular field with no distinction between supervisors and operatives.

Table XIV presents the total relative weights of responses to question 3 according to the general categories identified in Chapter III.

Table XIV

Total Relative Weight, by Category, of Items Ranked as Number One, Two, or Three by Scientists/Engineers and Non-technical Personnel

	Scientists/ Engineers(S/E)	Non-technical(N-T)
Human Relations	187.80	170.71
Working Environment	97.99	105.01
Goals and Requirements	55.36	29.13
Management Related Activities	69.82	30.42
Performance Evaluation	20.46	20.00
Qualities of the Supervisor	163.55	243.87
Other	5.12	1.04
	600.10	600.18

An examination of Table XIV indicates that scientists/engineers and non-technical personnel disagree as to the relative importance of three general categories: "Goals and Requirements", "Management Related Activities", and

"Qualities of the Supervisor". Responses to the remaining four general categories appear approximately equal in relative importance.

The discussion that follows elaborates on the specific characteristics that are identifiable within the general categories as being more important or distinctive to the scientific and engineering interviewees. Specific characteristics preceded by an asterisk are common to both scientific/engineering and non-technical responses.

The characteristics identified under the general category of "Human Relations" follow:

Human Relations	S/E	N-T
*Deals with subordinates as individuals	60.83	33.52
*Concern for and interest in the needs of subordinates	34.22	38.65
*Recognizes the capabilities of subordinates	26.48	14.42
*Listens to and exchanges ideas with subordinates	25.72	44.65
*Motivates subordinates to get the job done	25.45	20.68
*Establishes a good working relationship (rapport) with subordinates	3.02	8.96
Is flexible in dealing with subordinates	10.50	
Understands subordinates	1.58	
Has the ability to get along with people		8.79
Listens to problems of subordinates		1.04
	187.80	170.71

The category of "Human Relations" is of similar importance to the two groups. However, the following responses are identified as distinctive characteristics in the supervision of scientists and engineers:

treatment of subordinates as individuals
recognition of the capabilities of subordinates
flexibility in dealing with subordinates

The above characteristics indicate the need for the supervisor to treat each scientist and engineer on an individual basis. Scientists and engineers recognize that the experiences, educational backgrounds, and interests of each individual scientist and engineer are different. Scientists and engineers want the supervisor to recognize the capabilities of each subordinate, to be flexible in dealing with subordinates, and to treat each scientist and engineer on an individual basis. The scientific/engineering supervisor should recognize the differences in the abilities of each scientist and engineer and provide treatment accordingly.

Similarities between the two groups in the category of "Human Relations" are shown by the need for the supervisor to show interest in the subordinates and to motiviate subordinates in job accomplishment. "Human Relations" is overall the most important category for scientists and engineers, while second most important for non-technical personnel.

The characteristics identified under the general category of "Working Environment" follow:

Working Environment	S/E	N-T
*Provides freedom for job accomplishment	20.06	12.51
*Supports subordinates in their activities	17.32	14.17
*Provides authority and responsibility	15.87	8.87
*Keeps subordinates informed	9.17	2.00
*Places trust and confidence in subordinates	9.05	4.00
*Shows interest in subordinates and their work	8.40	4.17
*Involves subordinates in decision process	3.93	2.79
Provides sufficient work	2.10	
Supports subordinates in their decisions	1.58	
*Provides meaningful tasks (challenging and interesting work)	1.58	4.08
*Provides training for subordinates	1.58	5.55
Provides an environment that does not inhibit R & D	2.75	
*Knows accomplishments of subordinates and organization (keeps informed)	4.60	9.04
Gains the respect and support of subordinates		11.38
Provides for a creative atmosphere		4.00
Trains subordinates to function independently		4.00
Gets subordinates to work together		4.00
Looks after the safety of subordinates		2.79
Acts as a buffer to filter extraneous work		2.79
Firm but flexible in job accomplishment		2.79
Makes subordinates feel important		2.00
Is available when needed		2.00
Creates a good working environment		1.04
Has the ability to bring unity and coordination into organization		1.04
	97.99	105.01

The category of "Working Environment" is of similar importance to the two groups. This category provides a wide range of different responses from each group. Although both groups commonly name ten characteristics, there are

no specific characteristics which can be identified as distinctive to the supervision of scientists and engineers. Both groups similarly emphasize the need for the supervisor to provide freedom in job accomplishment, to provide authority and responsibility, and to support subordinates in their activities. The category is overall ranked third in importance among the general categories by both groups.

The general category of "Goals and Requirements" is ranked fifth in importance by both groups. However, scientists and engineers place more emphasis on this category than non-technical personnel. Characteristics identified under the category follow:

Goals and Requirements	S/E	N-T
Provides freedom for subordinates to set own goals	23.07	
*Provides guidance on what is expected	17.19	21.55
Defines and communicates goals	13.52	
Relates goals to a specific job	1.58	
Makes subordinates aware of organizational goals		2.79
Maintains stated objectives		2.79
Fosters goal congurence		2.00
	55.36	29.13

The difference between the groups for this category is accounted for by the emphasis scientists and engineers attach to the need for the supervisor to provide freedom for subordinates to set individual goals, and for the supervisor to define and communicate organizational goals. Scientists and engineers emphasize the need for freedom in the job. The need for freedom is shown by the emphasis

placed on freedom to set own goals and freedom to perform the work (found under the category of "Working Environment").

Scientists and engineers also want to know the organizational goals in order to identify and know toward what purpose the work is directed. Therefore, the need for freedom in setting goals and the need for defining goals are identified as distinctive characteristics in the supervision of scientists and engineers. Lastly, both groups similarly emphasize the need for the supervisor to provide guidance on what is expected in the job.

Scientists and engineers emphasize characteristics of "Management Related Activities" more than non-technical personnel. "Management Related Activities" is overall ranked fourth in importance by both groups. Specific characteristics identified under the category are the following:

Management Related Activities	S/E	N-T
*Understanding of management techniques	8.8	5.13
*Ability to make decisions	7.34	11.55
Interfaces with upper management in selling programs of the organization	6.30	
Business knowledge	4.72	
Able to identify overall problems	4.72	
Is able to handle the military and civilian personnel systems	4.20	
Provides effective communication outside the organization	3.67	
Coordinates people and resources to accomplish tasks	2.75	
Has a total picture of a project (dollars and manpower necessary)	2.50	
Exhibits day to day awareness	2.10	
Is able to direct problems as a team effort	2.10	
Gets people to agree on technical matters	2.10	
Does managing rather than dollar chasing	2.10	
Understands mission of the organization	2.10	
Communicates accomplishments of organization to upper management	2.10	
Stays with decisions made	1.58	
Able to prioritize information	3.14	
Provides answers or finds them out	1.58	
Able to judge importance of projects	1.58	
*Good organizer	1.58	3.83
Assumes responsibility for group output	.92	
Builds a balanced organization	.92	
Keeps upper management informed	.92	
Knowledgeable in the role of the organization in mission accomplishment		4.79
Has adequate supervisory training		2.00
Possesses ability to deal with upper management		1.04
Minimum number of workers per supervisor		1.04
Effectively manages people (time-off, etc.)		1.04
	69.82	30.42

The above characteristics show a large number of different responses by each group with no single characteristic indicated as being highly important to either group. A wide range of responses is offered from submissions made by only one or two interviewees, especially in the case of scientists and engineers. Although no individual responses are identified as distinctive characteristics of supervison, "Management Related Activities" collectively is emphasized as a distinctive category in the supervision of scientists and engineers.

Scientists/engineers and non-technical personnel place equal importance on the category of "Performance Evaluation". Characteristics noted under the category are the following:

Performance Evaluation	S/E	N-T
*Provides recognition	19.54	14.08
*Provides feedback on performance	.92	3.13
Provides discipline		2.79
	20.46	20.00

The main characteristic emphasized by both groups is the need for the supervisor to provide recognition. There are no identifiable distinctive characteristics in the supervision of scientists and engineers found under the category of "Performance Evaluation". The general category is overall ranked sixth in importance by both groups.

The general category of "Qualities of the Supervisor" is ranked highest in relative importance by non-technical personnel, while scientists and engineers rank the cate-

gory as second in relative importance. Specific characteristics named under "Qualities of the Supervisor" are the following:

Qualities of the Supervisor	S/E	N-T
Job Related		
*Technical competence/job knowledge	103.60	121.67
*Basic communicative skills	17.19	12.14
*Administrative skills	15.86	2.79
*Leadership qualities	5.78	4.79
*Personal	21.12	102.48
	163.55	243.87

The disparity in importance for the category between the two groups is caused by the importance non-technical personnel give personal qualities of the supervisor, such as fairness, honesty, and setting a good example. Within this category is the most important individual characteristic identified by both groups, technical competence and job knowledge. Scientists and engineers indicated that technical competence was important to the supervisor for two reasons: (1) to aid subordinates when problems arise, and (2) to be able to explain the technical projects to higher management. The only distinctive characteristic identified in the general category is the need for the supervisor to possess administrative skills. Scientists and engineers view the need for the supervisor to possess administrative skills because the supervisor can then handle the administrative details, and not interrupt the scientist or engineer with extraneous and unwanted paperwork.

This concludes the comparison of responses to question 3 used to identify distinctive characteristics in the supervision of scientific and engineering personnel. The next two sections involve the analysis of question 4 and the supplemental questionnaire. A summary of the distinctive characteristics extracted from the comparison of responses to question 3 is included at the end of this chapter. The analysis of question 4 and the supplemental questionnaire are then integrated with results of this section.

Characteristics of Scientists and Engineers

Literature pertaining to the supervision of scientists and engineers indicates that some authors consider scientists and engineers to be clearly different from other groups of workers. Question 4 of the interview is used to arrive at a better understanding of whether scientists and engineers perceive themselves as being different from non-technical workers. Question 4 follows:

> Question 4: Do you feel that scientists/engineers as a group differ from non-technical workers, particularly in regard to their goals, needs, and personal traits?
>
> a. Yes/No
> b. In what ways are they different or similar?

The following discussion is based upon the responses of scientific/engineering personnel to question 4. Responses are divided into two categories: Supervisory Responses and Operative Responses.

Supervisor Responses. The responses of scientific/engineering supervisors show that 68% of the supervisors replied "yes" and 32% of the supervisors replied "no" to question 4. Forty-one scientific/engineering supervisors were interviewed.

Responses from "yes" comments of supervisors projected the following characteristics and observations. Scientists and engineers are analytical, logical, creative, and curious thinkers, and also are more educated and highly specialized than non-technical personnel. Scientists and engineers require more recognition (organization and peer group) and participation in goal setting to satisfy self-esteem. As individuals, scientists and engineers are achievement oriented and highly self-motivated, frequently working more than the normal 40 hours a week. Scientists and engineers want freedom to set the hours of work and want to be left alone in performing the work.

Scientific and engineering supervisors responding "no" to question 4 noted the following observations. People are basically the same, whether a scientist/engineer or a non-technical worker. Scientists/engineers and non-technical personnel have common goals, drives, and needs, and the only differences between the two groups are in degree, not kind.

Operative Responses. The responses of scientific/engineering operatives show that 69.4% of the operatives answered "yes" and 30.6% of the operatives answered "no"

to question 4. Seventy-two scientific/engineering operatives were interviewed.

Responses from "yes" comments of operatives projected the following observations. Scientists and engineers are inquisitive, logical, quantitative, and analytical thinkers. Also, scientists and engineers are highly motiviated in the work toward self-actualization, and set higher goals than non-technical workers. Scientists and engineers have a greater technical education and skill level than non-technical workers. Operatives also view scientists and engineers as needing freedom and independence in the job, needing a creative atmosphere, being achievement oriented, and deriving high satisfaction from discovery. Lastly, scientists and engineers are more interested in work than people relationships.

Scientific and engineering operatives responding "no" to question 4 mainly noted that similar goals and needs exist for scientists/engineers and non-technical personnel.

Characteristics of the Scientific/Engineering Environment

The writers found much of the emphasis in secondary source material centered upon the environment within which scientific and engineering personnel work. The environment is an area that the supervisor needs to consider. The importance of the environment is reflected by Air Force Regulation 80-3, which states that

> The ability to attract and retain outstanding personnel rests not only on the prestige of the organization and research to be done, but on the quality of the facilities and the environment created by management (Ref 22:5).

Therefore, the supplemental questionnaire was formulated to aid in a better understanding of the characteristics of the scientific and engineering environment.

The writers initally selected four characteristics that are commonly associated in the literature with the scientific and engineering environment. Each interviewee was asked to rate the four characteristics as to importance in the scientific and engineering environment, and also to rate the characteristics as to the extent to which supervision provides for the characteristics. The last part of the questionnaire requested each interviewee to identify other characteristics that were felt to be important in establishing an environment conducive to scientific and engineering pursuits.

The following table lists the characteristics that were tested and presents the mean value for each characteristic. The A in the table refers to the mean value for the importance of the characteristic, while B refers to the mean value for the extent to which the characteristic is provided for by supervision. Each mean value can range from 1 to 5, with 5 representing maximum importance and maximum practice. Chapter II (page 29) presents a detailed explanation of the method of analysis for the supplemental questionnaire.

Table XV

Mean Values for Characteristics of the Scientific/ Engineering Environment

Characteristics		Supervisors	Operatives
Communication with colleagues in the same discipline	A	4.15	4.20
	B	4.32	4.31
Communication with supervisor(s)	A	4.41	4.33
	B	3.83	4.31
Recognition for outstanding achievement	A	3.98	3.58
	B	3.90	3.79
Freedom to develop and apply one's own ideas to solve problems	A	4.02	4.19
	B	4.19	4.29

An examination of Table XV shows that each characteristic is rated of "great" importance by scientific/ engineering supervisors and operatives. Respondents state that each characteristic is now being provided to a large extent by supervision. The results of the supplemental questionnaire confirm the importance attached to the four characteristics in establishing an environment conducive to scientific and engineering pursuits.

One purpose in the use of the four characteristics was to aid the interviewee in identifying other characteristics of the working environment. The last question of the questionnaire requested each interviewee to name other characteristics that were felt important as a part of the scientific and engineering environment. Supervisors identified the following additional characteristics:

availability of adequate support facilities (23)
availability of promotional opportunities (7)
a reduction of administrative requirements (4)
individual responsibility and authority (3)
identification with goals of organization (3)
physical environment to perform research and development (3)

Operatives named the following additional characteristics:

availability of adequate support facilities (27)
minimization of administrative details (11)
continuity of personnel in organization (6)
involvement of subordinates in technical decisions (4)
recognition at the organizational level (4)
motivation of workers (4)
availability of in-house research and development (4)
well-defined goals (3)
freedom to pursue own interests (3)
individual responsibility and authority (3)

The numbers in parenthesis indicate the number of interviewees identifying that particular characteristic.

The purpose of the supplemental questionnaire was twofold: first, to test the importance of the four characteristics identified in the literature, and secondly, to identify additional characteristics of the environment. It was shown that the four selected characteristics are important in a scientific/engineering environment. The important conclusion is that only one of the four characteristics is not identified in the analysis of question 3: communication with colleagues in the same discipline.

The additional characteristics that were named by scientists and engineers were not tested by the sample group as to importance or practice. Several of the additional characteristics are also identified in responses to question 3. In particular, the only additional charac-

teristic named by supervisors that is not found in responses to question 3 is the need for opportunities for promotion. The only characteristic identified by operatives that is not found in responses to question 3 is the need for continuity of personnel in the organization. The characteristics identified in the supplemental questionnaire are incorporated in the chapter summary with responses from question 3 to identify distinctive characteristics in the supervision of scientists and engineers.

Chapter Summary

Thus far, previous sections of this chapter focused on three areas: characteristics in the supervision of scientists and engineers, characteristics of scientists and engineers as a group of people, and characteristics of the scientific and engineering work environment. This summary integrates the research findings of the three areas to identify distinctive characteristics in the supervision of scientists and engineers.

The general categories used to classify characteristics show that two of the general categories are distinctive to scientists and engineers: "Goals and Requirements" and "Management Related Activities". Although the remaining categories are similar in importance, except for "Qualities of the Supervisor", individual characteristics are identifiable within the general categories that set the supervision of scientists and engineers apart from the supervision of non-technical personnel.

The general category of "Goals and Requirements" provides two distinctive characteristics. As mentioned previously, scientists and engineers desire freedom to set goals. The other distinctive characteristic is the desire for the supervisor to define and communicate the goals of the organization.

Although the general category of "Management Related Activities" is distinctive to scientists and engineers, there are no individual characteristics that are considered of high importance by scientists and engineers. Instead, twenty characteristics named by scientists and engineers are identified by only one or two interviewees. Scientists and engineers recognize the importance of the supervisor performing the necessary management related work as a part of the job.

Another distinctive characteristic is the need for the scientific/engineering supervisor to possess administrative skills. This characteristic is emphasized in responses to question 3, and further emphasized in the supplemental questionnaire by interviewees stressing the need for the supervisor to reduce and minimize the administrative workload of the scientists and engineers.

Two other distinctive characteristics are identified from the results of the supplemental questionnaire. These characteristics are (1) the desire of scientists and engineers for opportunity to communicate with colleagues in the same discipline, and (2) the need for adequate support

facilities in performing scientific/engineering work.

In addition to noted differences between the two groups, similar characteristics are also identified from the data treatment. Among the general categories, scientists/engineers and non-technical workers view the areas of "Human Relations", "Working Environment", and "Performance Evaluation" with similar importance. Also, the following ten specific characteristics are identified as similar between the two groups:

concern for and interest in the needs of subordinates
motivation of subordinates to get the job done
freedom for job accomplishment
support of subordinates in their activities
providing authority and responsibility
the need for recognition
guidance on what is expected in the job
technical competence/job knowledge
the need for the supervisor to possess communicative skills

This concludes the chapter on distinctive characteristics in the supervision of scientists and engineers. The next chapter presents a comparison of the significant findings derived in this thesis with the literature.

VI. Research Findings Related to the Literature - A Comparative Analysis

Chapter VI presents a comparison of the significant findings derived in this thesis with general themes and views of related literature. This chapter presents a comparative analysis between the research findings identified in Chapter V and the literature regarding characteristics in the supervision of scientists and engineers. A comparative analysis is also presented between the research findings and the literature on the personal characteristics of scientists and engineers. Chapter VI does not attempt to present a comprehensive analysis of the literature, a topic worthy of separate study, but rather an overview of the literature pertaining to the findings of this thesis.

The literature provides a number of interesting observations in the areas of "Human Relations" and "Qualities of the Supervisor", the two most important categories of supervision identified by scientists and engineers in this study. J. Walters notes human relations aspects as being the most important factors for successful research (Ref 3:127). H. A. Collinson stresses the human aspects in stating that management of research and development is basically management of people (Ref 4:1). The 20th Joint Engineering Conference stated that

> The most valuable resource in any company is human talent. Supervision must learn to identify it and apply it to growing and evolving tasks so that it does not wither and die (Ref 23:105).

In dealing with scientists and engineers, managers must realize the individuality of employees, make observations, and endeavor to make proper assignments and to apply the proper direction and rewards (Ref 24:28). The issue of people is of such importance that it becomes as one author has stated, "an issue of evaluating scientists for the distinctively different function they are performing in the organization" (Ref 25:102).

Among individual characteristics, motivation of personnel and communication are issues in the literature, as well as important characteristics of supervision confirmed by scientists and engineers in this study. Bucher and Reece describe several requirements in the motivation process, such as, interesting and challenging work, feelings of recognition and accomplishment, own satisfaction, and growth as a person (Ref 24:27). Daniel Noble presents a similar list of "motivators". Among the motivators not listed in the previous discussion are explaining why a job is important, letting the employees know what is expected, delegating authority and responsibility, and allowing engineers to participate in the decision process (Ref 26:61-72). Chase emphasizes the aspect of communication in pointing out that

> There can be no management control between these respective levels of discourse until there is a mutual understanding and meaningful exchange of viewpoints between responsible individuals at each level (Ref 27: 126).

Scientists and engineers in this thesis mentioned all of the characteristics identified in the previous discussion. Scientists and engineers also made reference to characteristics of supervision given less prominence in the literature. Scientists and engineers in this thesis noted recognizing capabilities of subordinates, concern for and interest in the needs of subordinates, and flexibility in dealing with subordinates as characteristics in the supervision of scientists and engineers. The results of this thesis are a recognition of specific characteristics often grouped under a general category of discussion in the literature.

Responses dealing with the "Qualities of the Supervisors" were mentioned second to "Human Relations" by scientists and engineers in this thesis as the most important category of supervision. In the literatue, technical competence is an essential characteristic for the supervisor of scientists and engineers. Popper points out that

> Although technical proficiency does not in itself guarantee success as a technical manager, there is no question that such proficiency is essential to the construction of the performance record (Ref 28:56).

A study of electrical engineers for a large electronics company found subordinate support for a project depended upon

expertise, work challenge, authority, fund allocation, and salary adjustments (Ref 23:92). In this thesis, technical competence was the most important characteristic of supervision noted by scientists and engineers.

The literature also identifies leadership qualities of the supervisor. J. W. Slocum rejects the notion that the traditional approach to supervision of rewarding effective performance and punishing ineffective performance is the requisite for effective leadership. Sloan states that

> The effective leader cannot depend upon his organizational postion, but must rely on his own personal motivation and qualifications to control (Ref 29:488).

A government study notes that requirements for maximum organizational effectiveness include the following: excellence of staff and direction provided, maintenance of professional calibre of operations, challenge and urgency of objectives, and professional leadership of supervisors (Ref 30:37).

Even though "Qualities of the Supervisor" was the second most important category of supervisory characteristics mentioned by scientists and engineers in this thesis, one particular characteristic, technical competence, predominated over all other characteristics. The contrast in the responses to characteristics dealing with "Human Relations" and "Qualities of the Supervisor" is significant. Scientists and engineers in this thesis indicate an awareness of the interpersonal qualities of the supervisor, but place less emphasis on the more formal leadership

qualities of the supervisor.

In addition to technical competence and leadership qualities, the literature notes administrative competence of the supervisor. Mayhall argues that a supervisor of scientists and engineers is not only knowledgeable of the research field, but also experienced in the practical management of scientists and engineers (Ref 31:23). Thomason makes a point for the necessity of administrative skills in saying that the supervision of research and development is the application of general principles of supervision (Ref 32: 260). A government study dealing with characteristics of Defense laboratories notes that

> A research environment is the product of a number of elements including freedom to be creative, absence of excessive layers of supervisory management, reduction of "red tape" to the absolute minimum, and high quality professional leadership (Ref 30:29).

Scientists and engineers in this thesis address similar characteristics of supervision dealing with the "Qualities of the Supervisor" as identified in the literature. The following observations are worth noting. Leadership qualities of a supervisor are given lower significance by scientists and engineers in this thesis than is implied in the literature. In addition, scientists and engineers in this thesis noted personal qualities of the supervisor. Personal qualities, such as integrity and honesty, are often overlooked in the literature regarding the supervision of scientists and engineers.

Lastly, the areas of freedom and responsibilty are noted as important aspects in the supervision of scientists and engineers by the literature. Missauk enumerates the most important environmental aspects as work performed by subordinates, the recognition of achievement received, the opportunity to interact with peers, freedom, and the extent of upward influence (Ref 33:321-322). Sounder, however, minimizes the importance of freedom by noting that in a study of scientists and engineers, no statistically significant differences in output levels were found with variations in autonomy (Ref 34:1146-1153).

Scientists and engineers in this thesis identified freedom from two perspectives: freedom in job accomplishment and freedom to set own goals. This distinction is not observed in the literature. Futhermore, the scientists and engineers in this thesis did not recognize the importance of recognition to the extent identified in the literature. Recognition in job accomplishment does not appear to be a necessary motivator for the scientists and engineers interviewed.

The other area of interest in this chapter is a comparison between the research findings and the literature related to personal characteristics of scientists and engineers. The 20th Joint Engineering Management Conference notes that

> The myth that invention and innovation arise from interdisciplinary teams has been rebuked. More often than not they come from a rare breed of people who are creative, fanatic, highly sensitive, and often a bit antisocial as well as being profit-minded and prima donnas (Ref 23:4-4).

In support of the above assessment are the conclusion of Pelz and Andrews that scientists are self-directed, value freedom, are not fully in agreement with the organization in terms of personal interests, and may enjoy that which does not necessarily help to advance in the organization structure (Ref 35:7).

Characteristics of scientists and engineers are also identified in relation to other groups of people. For example, Roman identifies characteristics of scientists and engineers by emphasizing human factors which are highly distinct traits of research and development professionals, but not exclusive to the scientific and engineering environment. The characteristics mentioned are sensitivity to the working environment, curiosity, creativity, and introversion (Ref 14:293-301). Raudsepp identifies characteristics of scientists and engineers as part of a larger group of people, namely creative professionals. Some of the characteristics Raudsepp lists are: tolerance for ambiguity, high motivation, persistence and concentraion, ability to analyze and synthesize, and ability to tolerate psychological and physical isolation (Ref 15:51-67). French states that the difference between scientists and engineers and the rest of the work force are differences only in degree, and only in

the dimensions of intelligence and education, personality, and value orientation (Ref 16:478-499). However, a study by Danielson found that 83% of the scientific/engineering supervisors and 61% of the scientific/engineering operatives felt that there were recognizable differences between scientists and engineers and other groups of workers (Ref 17:10).

An important aspect of the literature on the personal characteristics of scientists and engineers is the question of whether scientists and engineers can be considered a homogeneous group. M. Badawy claims that the professional goals of industrial scientists are directed toward advancement of knowledge and toward research achievements that will bring professional recognition. Engineers, on the other hand, have more or less managerial goals in accord with the goals of the industrial organization (Ref 36:210). Steven Kerr contends there is evidence to suggest that scientists and engineers differ considerably in work goals, needs and job activities and that divergence in research findings may be a result of differences in scientists and engineers. Kerr contends that data for the different occupational groups (scientists/engineers) should be grouped and analyzed separately (Ref 37:279).

This thesis found similar personal characteristics of scientists and engineers identified in the literature. Findings of this thesis substantiate, in part, the results of Lee Danielson. This thesis found that 68% of the supervisors

and 69% of the operatives felt that differences exist between scientists/engineers and non-technical workers. In the study by Danielson, similar views were found among 83% of the supervisors and 61% of the operatives.

The main differences between the literature and the findings of this thesis are in the area of distinguishability of scientists and engineers from other groups of workers. For example, some authors argue that the characteristics of scientists and engineers are associated with research and development professionals, or other professionals. Still others, contend the differences in scientists and engineers and other workers are differences only in degree. Finally, some authors contend that scientists and engineers must be considered separately in research. The perceptions of the scientists and engineers interviewed did not indicate a separate awareness toward association with a particular group of workers beyond the scientific/engineering disciplines.

It is difficult to arrive at any generalizations as to the relative similarities and differences between the research findings and the literature, since it is equally difficult to determine any consensus within the literature. The methodology used in this thesis resulted in an identification of an extensive number of different characteristics in the supervision of scientists and engineers. Such a large differentiation among characteristics of supervision is not found in the literature. This thesis identifies

specific characteristics of supervision often grouped under general categories of discussion in the literature . The areas of strongest agreement between the research findings and the literature are in the technical skills required of the supervisor and the importance of human relations in dealing with scientists and engineers. The differences are in the areas of recognition and leadership qualities where the literature places greater emphasis than was observed in the responses of scientists and engineers interviewed. The responses of scientists and engineers in this thesis did not indicate a separate awareness toward association with a particular group of workers beyond the scientific/ engineering disciplines. In particular, the literature questions whether scientists and engineers can be considered a homogeneous group in research studies.

This concludes the discussion of the comparative analysis between the research findings and the literature. The next chapter presents the summary, conclusions, and recommendations of this thesis.

VII. Summary, Conclusions, and Recommendations

Chapter VII summarizes the research presented in this thesis. Conclusions derived from the research findings are also presented here. Recommendations for further study and suggested inquiry as motivated by this research project complete the presentation of Chapter VII.

Summary

Characteristics peculiar to the supervision of scientists and engineers are not clearly spelled out in the literature or research studies. The literature frequently identifies characteristics in the supervision of scientists and engineers without a clear distinction as to whether the characteristics apply equally to other groups of workers, for example, non-technical people. There is a need to identify distinctive characteristics in the supervision of scientists and engineers.

The objectives of this thesis are framed to help derive a better understanding of the key elements that may distinguish requirements for the supervision of scientists and engineers. The research objectives are as follows:

1. To ascertain any distinctive characteristics in the supervision of scientific and engineering personnel.
2. To determine any significant differences in the views of two groups of supervisors (scientific/engineering and non-technical) toward their perceived roles.

3. To determine any significant differences in the views of two groups of operatives (scientific/engineering and non-technical) toward supervision.

4. To identify and contrast the significant findings as derived in this thesis with the literature.

The introductory material is contained in Chapters I and II. Chapter I presents the necessary background material, states the research objectives, and lists the scope and limitations, assumptions, and working definitions which underlie this research effort. Chapter II outlines the research methodology used. Face-to-face interviews of 113 scientific/engineering personnel and of an additional 98 non-technical personnel provided the primary source of data.

Chapters III and IV involved the categorization and treatment of the responses from scientists/engineers and non-technical personnel. To facilitate analyses, the responses are grouped according to the following general categories:

Human Relations
Working Environment
Goals and Requirements
Management Related Activities
Performance Evaluation
Qualities of the Supervisor
Other

Chapter III is the first part in the presentation and analyses of supervisor and operative responses to questions dealing with the important characteristics in the supervision of scientific/engineering and non-technical personnel.

Comparative analyses are presented between supervisory and operative responses received from respondents drawn from the scientific/engineering and non-technical fields.

Both supervisors and operatives in the scientific/engineering fields perceived and agree that the most important characteristics of supervision lie within the areas of "Human Relations" and "Qualities of the Supervisor". Supervisors and operatives then disagree as to the third most important area. Supervisors stress characteristics dealing with the "Working Environment", while operatives note characteristics dealing with "Management Related Activities" as third most important. Among specific characteristics, the major differences between the views of scientific/engineering supervisors and operatives are the following. Supervisors stress the need for the supervisor (1) to be flexible in dealing with subordinates and (2) to define and communicate organizational goals. Operatives stress the need for the supervisor (1) to deal with subordinates as individuals, (2) to allow freedom for subordinates to set own goals, and (3) to possess technical competence.

Within the non-technical fields, characteristics dealing with "Human Relations", "Qualities of the Supervisors", and "Working Environment" are ranked one, two, and three, respectively, by supervisors and operatives. However, supervisors place more emphasis than operatives

on "Qualities of the Supervisor" and Working Environment". Among specific characteristics, the major differences between the views of non-technical supervisors and operatives are the following. Supervisors stress the need for the supervisor (1) to show concern for and interest in the needs of subordinates, and (2) to possess job knowledge. Operatives stress the need for the supervisor to provide recognition.

Chapter IV presents further analyses of the responses of scientific/engineering and non-technical personnel. Comparative analyses of responses are presented between supervisors in the scientific/engineering and non-technical fields and between operatives in the scientific/engineering and non-technical fields.

Supervisors agree that the most important characteristics of supervision are in the areas dealing with "Human Relations", "Working Environment", and "Qualities of the Supervisor". However, "Qualities of the Supervisor" is the most important category of supervision for non-technical supervisors, whereas, "Human Relations" is the most important category for scientific/engineering supervisors. Among specific characteristics, the major differences between the views of scientific/engineering and non-technical supervisors are the following. Scientific/engineering supervisors stress the need for the supervisor (1) to recognize the capabilities of subordinates, (2) to

be flexible in dealing with subordinates, (3) to define and communicate organizational goals, (4) to provide recognition, and (5) to motivate subordinates to get the job performed. Non-technical supervisors stress the need for the supervisor (1) to possess job knowledge and (2) to possess such personal qualities as fairness and honesty.

Among the scientific/engineering and non-technical operatives, the most important characteristics of supervision are in the areas of "Human Relations" and "Qualities of the Supervisor". "Human Relations" is of equal importance to both groups of operatives, whereas, non-technical operatives place a greater importance on "Qualities of the Supervisor" than scientific/engineering operatives. Characteristics of supervision dealing with "Management Related Activities" are third in importance for scientific/engineering operatives, while characteristics of supervision dealing with the "Working Environment" are third in importance for non-technical operatives. Among specific characteristics, the major differences between the views of scientific/engineering and non-technical operatives are the following. Scientific/engineering operatives stress the need for the supervisor (1) to deal with subordinates as individuals and (2) to allow freedom for subordinates to set own goals. Non-technical operatives stress the need for the supervisor to possess such personal qualities as integrity and honesty.

Chapter V presents research findings related to distinctive characteristics in the supervision of scientists and engineers. A comparison of the general categories used to group specific characteristics results in two general categories being distinctive to the supervision of scientists and engineers: "Goals and Requirements" and "Management Related Activities". Among specific characteristics, nine are identified as being distinctive to the supervision of scientists and engineers:

treatment of subordinates as individuals
recognition of the capabilities of subordinates
flexibility in dealing with subordinates
freedom for subordinates to set own goals
the definition and communication of organizational goals
the need for administrative skills by the supervisor
opportunity for subordinates to communicate with colleagues in the same discipline
adequate support facilities
freedom to develop and apply ideas to solve problems

Chapter VI presents a comparison of the significant findings derived in this thesis with general themes and views of related literature. The methodology used in this thesis resulted in the identification of an extensive number of different characteristics in the supervision of scientists and engineers. Such a large differentiation is not often found in the literature. For example, characteristics of supervision dealing with human relations skills are identified in greater detail in this study than in the literature. The areas of strongest agreement between the research findings and the literature are in the

technical skills required of the supervisor and the importance of human relations in dealing with scientists and engineers. Differences are in the areas of recognition and leadership qualities, where the literature places greater emphasis than is observed in the responses of scientists and engineers interviewed.

Specific conclusions drawn from the research findings are presented in the next section.

Conclusions

The following conclusions are derived from the research findings.

1. There are characteristics that set the supervision of scientists and engineers apart from the supervision of non-technical personnel.

The comparison of interviewee responses between scientists/engineers and non-technical personnel resulted in nine identifiable characteristics distinctive to the supervision of scientists and engineers, as previously identified in the summary portion of this chapter.

2. Most scientists and engineers perceive themselves to be different from non-technical workers.

A majority of scientific/engineering supervisors and operatives interviewed in this study expressed that scientists and engineers are more analytical, logical, achievement oriented, educated, and self-motivated than non-technical workers.

3. Major differences exist between the views of scientific/engineering and non-technical SUPERVISORS toward their perceived roles.

Scientific/engineering supervisors attach greater emphasis than non-technical supervisors to five characteristics:

Recognition of the capabilities of subordinates
Flexibility in dealing with subordinates
The definition and communication of organizational goals
The need for recognition
Motivation of subordinates to get the job performed

Non-technical supervisors attach greater emphasis than scientific/engineering supervisors to two characteristics:

Job knowledge
Personal qualities of the supervisor (honesty, fairness)

4. Major differences exist between the views of scientific/engineering and non-technical OPERATIVES toward supervision.

Scientific/engineering operatives attach greater emphasis than non-technical operatives to two characteristics:

Treatment of subordinates as individuals
Freedom for subordinates to set own goals

Non-technical operatives attach greater emphasis than scientific/engineering operatives to one characteristic:

Personal qualities of the supervisor

5. Major differences exist between the views of SCIENTIFIC/ENGINEERING SUPERVISORS and OPERATIVES toward supervision.

Supervisors attach greater emphasis than operatives to two characteristics:

Flexibility in dealing with subordinates
The definition and communication of organizational goals

Operatives attach greater emphasis than supervisors to three characteristics:

Treatment of subordinates as individuals
Freedom for subordinates to set own goals
Technical competence

6. Major differences exist between the views of NON-TECHNICAL SUPERVISORS and OPERATIVES toward supervision.

Supervisors attach greater emphasis than operatives to two characteristics:

Showing concern for and interest in the needs of subordinates
Job knowledge

Operatives attach greater emphasis than supervisors to one characteristic:

The need for recognition

7. Characteristics in the supervision of scientists and engineers, identified in this thesis, are both in support and disagreement with the literature.

Individual characteristics and groups of characteristics derived in this thesis are identifiable within the literature. However, since the literature often groups characteristics under general categories for discussion, many of the specific characteristics noted in this thesis are not mentioned specifically in the literature.

The stated conclusions satisfy the objectives of this study. The views of scientific/engineering and non-technical workers concerning supervision were examined. The use of a non-technical sample group proved useful in identifying distinctive characteristics in the supervision of scientists and engineers. The final portion of this chapter presents recommendations.

Recommendations

Based on the research findings and the questions which arose but could not be explored in this thesis, the following recommendations are made.

1. It is recommended, that to better understand the characteristics in the supervision of scientists and engineers within the United States Air Force, a similar study be undertaken to compare views from scientists and engineers within industry.

2. It is recommended, that organizations use the findings of this thesis in conjunction with an internal study to arrive at characteristics of supervision particular to their working environment.

3. It is recommended, that a study be directed at determining whether scientists and engineers should be classified as a homogeneous group when identifying characteristics of supervision.

These recommendations conclude the presentation and discussion of this research effort. The writers have gained many new insights into the supervision of scientists and engineers, as reported in this thesis, and many insights not reported, which were an outgrowth of the time spent in personal contact with working scientists and engineers. It is the hope of the writers that the information presented will be of use to future researchers or practitioners in the study or practical application of the supervision of scientists and engineers.

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APPENDIX A
MAIL CORRESPONDENCE

Graduate schools, institutions, and researchers that were sent letters requesting information relating to the topical area. An asterisk identifies the agencies which replied.

Naval Post Graduate School
Research Administration
Code 0234
Monterey, California 93940

*U.S. Army Management Engineering Training Agency
Department of the Army
Rock Island, Illinois 61201

*Social Research Center
University of Missouri
Columbia, Missouri 65201

*Battelle Memorial Institute
Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201

*Dr. Mawritz Blonder
Department of Management
Hofstra University
Hempstead, New York 11550

APPENDIX B

SAMPLE OF TRANSMITTAL LETTER REQUESTING INFORMATION

AFIT/ENS
Wright-Patterson AFB, Ohio 45433

Dear Sir,

We are graduate students in Systems Management at the Air Force Institute of Technology, Wright-Patterson Air Force Base, Dayton, Ohio.

Your assistance would be appreciated in support of our thesis entitled A Study of Characteristics in the Supervision of Scientific and Engineering Personnel. We are in the preliminary stages of research and are seeking access to studies you may have sponsored in the areas of research management and/or supervision of scientists and engineers. Please send us any information (bibliographies, abstracts, titles, studies etc.) pertaining to the above topics. We will reimburse you for expenses incurred.

Our topic is of current interest to the United States Air Force and your help would significantly assist us in our research.

Thank you very much for the cooperation and help you can give us.

GEORGE DAUGAVIETIS, Capt, USAF
Graduate Systems Management
School of Engineering

RONALD S. HARRIS, Capt, USAF
Graduate Systems Management
School of Engineering

APPENDIX C

QUESTIONS USED FOR CLASSIFYING THE PERSONNEL INTERVIEWED

DATE _____

INTERVIEW CATEGORY -- Supervisor _____ Operative _____

GRADE/GS/WG _____

AFSC (Mil) _____

LENGTH OF TIME IN PRESENT POSITION _____

LENGTH OF TIME IN PRESENT CAREER FIELD _____

EDUCATION COMPLETED (Yrs/Level) -- Elementary ____ HS ____
College (yrs) _____
Tech Training _____

MAJOR FIELD OF STUDY _____

APPENDIX D

Classification of Sample Interviewed

Table I

Distribution of scientists and engineers by grade or rank

Supervisors (Total Sample = 41)

Military		Civilian	
Lt Col	1	GS 15	4
Maj	3	14	16
Capt	4	13	13

Non-Supervisors (Total Sample = 72)

Military		Civilian	
Capt	15	PL 313	1
Lt	10	GS 15	1
		14	3
		13	20
		12	11
		11	5
		9	4
		7	2

Table II

Distribution of scientists and engineers by discipline

Supervisors

Scientific		Engineering	
Chemist	5	Aeronautical	8
Physicist	5	Electrical	9
Metallurgist	1	Mechanical	10
Mathematician	1	Aero/Mech	1
		Guidance/Control	1

Non-Supervisors

Scientific		Engineering	
Chemist	6	Aeronautical	20
Physicist	10	Electrical	16
Chemical Eng.	2	Mechanical	10
Metallurgist	3	Control Systems	1
Material Science	4		

Appendix D - Continued

Table III

Distribution of scientific/engineering supervisors according to experience

Experience in Present Position		Total Experience in Career Field	
Years	Number	Years	Number
More than 15	2	More than 20	7
10-15	5	15-20	13
5-10	7	10-15	6
3-4	5	5-10	11
2-3	7	0-5	3
0-1	15		

Table IV

Distribution of scientific/engineering non-supervisors according to experience

Years	Number
More than 20	8
15-20	7
10-15	14
5-10	19
3-4	5
2-3	5
1-2	10
0-1	4

Table V

Ditribution of scientists and engineers according to education level completed

Supervisors (Total Sample = 41)

Degree	Number
PhD	8
Masters	23
Bachelors	10

Non-Supervisors (Total Sample = 72)

Degree	Number
PhD	13
Masters	28
Bachelors	31

Appendix D - Continued

Table VI

Distribution of non-technical personnel according to grade or rank

Supervisors (Total Sample = 40)

Military		Civilian	
Maj	2	GS 14	1
Capt	1	13	5
Lt	1	12	4
CMSgt	1	11	1
MSgt	5	9	2
TSgt	5	WG 13	1
SSgt	10	6	1

Non-Supervisors (Total Sample = 58)

Military		Civilian	
Capt	4	GS 13	1
Lt	2	12	6
SSgt	3	11	6
Sgt	12	9	3
Amn	3	7	2
		6	3
		5	7
		4	4
		WG 13	2

Appendix D - Continued

Table VII

Distribution of non-technical personnel by specialty

Supervisors	
Specialty	
Procurement	2
Technical Support	11
Supply	6
Accounting/Finance	3
Medical Supply	1
Military Personnel	13
Civilian Personnel	4

Non-Supervisors	
Specialty	
Procurement	13
Technical Support	15
Supply	6
Accounting/Finance	3
Medical Supply	1
Civilian Personnel	13
Military Personnel	5
Civil Engineering	1
Academic Administration	1

Table VIII

Distribution of non-technical supervisors by experience
(Total Sample = 40)

Experience in the Present Position	
Years	Number
10-15	1
5-10	5
4-5	1
3-4	3
2-3	4
1-2	14
0-1	12

Total Experience in the Career Field	
Years	Number
More than 20	11
15-20	8
10-15	5
5-10	10
0-5	6

Appendix D - Continued

TABLE IX

Distribution of non-technical operatives as to total experin the present career field (Total Sample = 58)

Years	Number
More than 20	10
15-20	4
10-15	5
5-10	10
3-4	13
Less than 3	16

Table X

Distribution of non-technical personnel by education completed

Supervisors (Total Sample = 40)

Degree	Number
High School	12
College	
1 yr.	7
2 yrs.	7
3 yrs.	3
Bachelors	6
Masters	5

Non-Supervisors (Total Sample = 58)

Degree	Number
High School	20
College	
1 yr.	4
2 yrs.	9
3 yrs.	5
Bachelors	12
Masters	7
PhD	1

APPENDIX E

INTERVIEW WORK SHEET

SUPERVISORS AND NON-SUPERVISORS
(Non-technical area)

Our thesis deals with the supervision of scientists and engineers within the United States Air Force. Your views on supervision are being solicited because we feel that the study of supervision in the non-technical fields can aid in the understanding of scientific/engineering supervision.

1. In your experience as a(n) _____, what have been examples of good supervision?

2. In your experience as a(n) _____, what have been examples of inadequate supervision?

3. What supervisory skills, techniques, or practices do you feel are most necessary in the supervision of _____ personnel?

   a. 1.
      2.
      3.
      4.
      5.
      etc.

   b. How would you rank these in order of importance?

APPENDIX F

INTERVIEW WORK SHEET

SUPERVISORS AND NON-SUPERVISORS
(Scientific/Engineering Area)

Our study of the literature has revealed a variety of techniques/practices/skills considered necessary in the supervision of scientists and engineers. Your views are being solicited in order to help us better understand these elements as they may apply to supervision of scientists and engineers within the United States Air Force.

1. In you experience as a(n) _____, what have been examples of good supervision?

2. In your experience as a(n) _____, what have been examples of inadequate supervision?

3. What supervisory skills, techniques, or practices do you feel are most necessary in the supervision of _____ personnel?

   a. 1.
      2.
      3.
      4.
      5.
      etc.

   b. How would you rank these in order of importance?

4. Do you feel that _____ as a group differ from nontechnical workers, particularly in regard to their goals, needs, and personal traits?

   a. Yes/No

   b. If you do, in what ways are they different?

APPENDIX G

SUPPLEMENTAL QUESTIONNAIRE

Part A -- Circle the response that most accurately reflects the degree to which you feel the factor is important in the supervision of scientists and engineers. Associate your response with the following numeric scale.

Utmost	Great	Considerable	Some	Little or No
5	4	3	2	1

Part B -- Circle the response that most accurately reflects the percentage of time you feel supervision in the Air Force provides for the factor.

Question 1: Communication with colleagues in the same discipline (government, industry, or education)

A. Importance

a. Utmost importance
b. Great importance
c. Considerable importance
d. Some importance
e. Little or no importance

B. Practice

a. Usually (85-100%)
b. Sometimes (40-60%)
c. Rarely (Less than 25%)
d. Never (0%)
e. No response

Question 2: Communications with supervisor(s)

A. Importance

a. Utmost importance
b. Great importance
c. Considerable importance
d. Some importance
e. Little or no importance

B. Practice

a. Usually (85-100%)
b. Sometimes (40-60%)
c. Rarely (Less than 25%)
d. Never (0%)
e. No response

APPENDIX G - Continued

Question 3: Recognition for outstanding achievement

A. Importance

a. Utmost importance
b. Great importance
c. Considerable importance
d. Some importance
e. Little or no importance

B. Practice

a. Usually (85-100%)
b. Sometimes (40-60%)
c. Rarely (Less than 25%)
d. Never (0%)
e. No response

Question 4: Freedom to develop and apply one's own ideas to solve problems

A. Importance

a. Utmost importance
b. Great importance
c. Considerable importance
d. Some importance
e. Little or no importance

B. Practice

a. Usually (85-100%)
b. Sometimes (40-60%)
c. Rarely (Less than 25%)
d. Never (0%)
e. No response

Question 5: What other factors not mentioned here do you feel are necessary for the establishment of an environment conducive to scientific/engineering pursuits?

APPENDIX H

ORGANIZATIONS PARTICIPATING IN THIS STUDY

Aeronautical Systems Division, (Air Force Systems Command)
Engineering Operations Division
Directorate of Avionics Engineering

Air Force Materials Laboratory (Air Force Wright Aeronautical Laboratories)
Metals & Ceramics Division
Nonmetallic Materials Division

Air Force Flight Dynamics Laboratory (Air Force Wright Aeronautical Laboratories)
Flight Control Division

Air Force Aero Propulsion Laboratory (Air Force Wright Aeronautical Laboratories)
Aerospace Power Division
Turbine Engine Division

Air Force Avionics Laboratory (Air Force Wright Aeronautical Laboratories)
Electronic Technology Division

Foreign Technology Division, Air Force Systems Command

Aeronautical Systems Division (Air Force Systems Command)
Directorate of R&D Procurement

2750th Air Base Wing, Air Force Logistics Command
Personnel Division
Comptroller Division
Logistics Squadron

Air Force Aero Propulsion Laboratory (Air Force Wright Aeronautical Laboratories)
Technical Services Division

Air Force Avionics Laboratory (Air Force Wright Aeronautical Laboratories)
Technical Services Division

APPENDIX H - Continued

Air Force Institute of Technology (Air University)
Consolidated Base Personnel Office
Civil Engineering
Office of Information
Academic Administration Office

USAF Medical Center Wright Patterson (Air Force Logistics Command) Central Nursing Supply Services

APPENDIX I

RESPONSES OF SCIENTISTS/ENGINEERS TO QUESTIONS 1, 2, AND 3

Table I is the result of categorizing 159 responses from 41 scientific/engineering supervisors.

Table I
Categorization of Responses to Question 1 by Scientific/Engineering Supervisors

Category	Responses Frequency	Percentage
Human Relations (23.26%)		
Listens to and exchanges ideas with subordinates	13	8.18
Concern for and interest in the needs of subordinates	8	5.03
Deals with subordinates as individuals	5	3.14
Recognizes capabilities of subordinates	5	3.14
Motivates subordinates to get the job done	5	3.14
Establishes a good working relationship (rapport) with subordinates	1	.63
Working Environment (23.90%)		
Provides freedom for job accomplishment	11	6.92
Places trust and confidence is subordinates	5	3.14
Provides authority and responsibility	5	3.14
Involves subordinates in decision process	5	3.14
Shows interest in subordinates and their work	3	1.89
Provides an environment for R&D	3	1.89
Is flexible in applying rules and regulations	3	1.89
Treats people as professionals	2	1.26
Provides a variety of jobs	1	.63
Goals and Requirements (10.06%)		
Defines goals	7	4.40
Provides guidance on what is expected	7	4.40
Sets challenging goals	2	1.26

Table I - Continued

Category	Responses Frequency	Percentage
Management Related Activities (10.70%)		
Able decision maker	3	1.89
Ability to judge importance of work	3	1.89
Ability to look at overall problem and analyze	3	1.89
Understanding of management techniques	2	1.26
Provides a communication link between subordinates and upper management	3	1.89
	3	1.89
Accomplishes technical tasks assigned	2	1.26
Is committed to technical not political decisions	1	.63
Performance Evaluation (10.07%)		
Provides recognition	12	7.55
Provides feedback on performance	4	2.52
Qualities of the Supervisor (22.01%)		
Job related		
Technical competence	18	11.32
Administrative skills	6	3.77
Leadership qualities	2	1.26
Personal		
Well-organized, sets a good example, innovative, fair, aggressive	9	5.66

Table II is the result of categorizing 118 responses from 41 scientific/engineering supervisors.

Table II
Categorization of Responses to Question 2 by Scientific/Engineering Supervisors

Category	Responses Frequency	Percentage
Human Relations (19.47%)		
Fails to communicate downwards or listen to ideas of subordinates	13	11.0
Lack of interest in needs of subordinates	6	5.08
Fails to identify or use capabilities of subordinates	4	3.39
Working Environment (25.40%)		
Too strong administrative control	13	11.0
Lack of support and interest in work of subordinates	7	5.93
Fails to delegate responsibility	4	3.39
Distrusts subordinates	3	2.54
Undermines moral of subordinates	2	1.69
Lack of funds	1	.85
Goals and Requirements (9.32%)		
Does not provide adequate guidance	11	9.32
Management Related Activities (13.55%)		
Inability to make or understand consequences of a decision	10	8.47
Lack of management skills (i.e. planning and organizing)	2	1.69
Lack of involvement in managing the organization	4	3.39

Table II - Continued

Category	Responses Frequency	Percentage
Performance Evaluation (4.24%)		
Lack of recognition	4	3.39
Unconstructive criticism	1	.85
Qualities of the Supervisor (11.86%)		
Job Related		
Lack of technical competence	8	6.78
Lack of leadership	2	1.69
Lack of administrative skills	1	.85
Personal	3	2.54
Other (16.10%)		
Opposite of question 1	15	12.71
Overprotects oneself at the expense of the organization	3	2.54
System dictates bad supervision - can only go so far as an engineer, then must become a supervisor to get promoted	1	.85

Table III is the result of categorizing 52 responses from 41 scientific/engineering supervisors.

Table III
Categorization of Items Ranked as Number One in Question 3 by Scientific/Engineering Supervisors

Category	Responses Frequency	Responses Percentage (P)	Weighting Factor (WF)	Relative Weight (P·WF)
Human Relations				
Concern for and interest in the needs of subordinates	5	9.62	3	28.86
Is flexible in dealing with subordinates	5	9.62	3	28.86
Recognizes capabilities of subordinates	4	7.69	3	23.07
Motivates subordinates to get the job done	2	3.85	3	11.55
Listens to and exchanges ideas with subordinates	2	3.85	3	11.55
Working Environment				
Places trust and confidence in subordinates	3	5.77	3	17.31
Supports subordinates in their activities	2	3.85	3	11.55
Provides authority and responsibility	2	3.85	3	11.55
Involves subordinates in decision process	1	1.92	3	5.76

Table III - Continued

Category	Responses Frequency	Percentage (P)	Weighting Factor (WF)	Relative Weight (P·WF)
Goals and Requirements				
Defines goals	5	9.62	3	28.86
Provides guidance on what is expected	2	3.85	3	11.55
Management Related Activities				
Exhibits day to day awareness	1	1.92	3	5.76
Is able to direct problems as a team effort	1	1.92	3	5.76
Performance Evaluation				
Provides Recognition	1	1.92	3	5.76
Qualities of the Supervisor				
Job Related				
Technical competence	7	13.46	3	40.38
Basic communicative skills	2	3.85	3	11.55
Leadership qualities	2	3.85	3	11.55
Other				
Is acceptable to upper management	1	1.92	3	5.76

Table IV is the result of categorizing 47 responses from 41 scientific/engineering supervisors.

Table IV
Categoriztion of Items Ranked as Number Two in Question 3 by Scientific/Engineering Supervisors

Category	Responses Frequency	Responses Percentage (P)	Weighting Factor (WF)	Relative Weight (P·WF)
Human Relations				
Motivates subordinates to get the job done	4	2.13	2	17.02
Concern for and interested in the needs of subordinates	3	6.38	2	12.76
Recognizes capabilities of subordinates	2	4.26	2	8.52
Listens to and exchanges ideas with subordinates	2	4.26	2	8.52
Understands subordinates	1	2.13	2	4.26
Deals with subordinates as individuals	1	2.13	2	4.26
Working Environment				
Shows interest in subordinates and their work	4	8.51	2	17.02
Provides freedom for job accomplishment	2	4.26	2	8.52
Provides training for subordinates	1	2.13	2	4.26
Provides authority	1	2.13	2	4.26
Supports subordinates and their activities	1	2.13	2	4.26

Table IV - Continued

Category	Responses Frequency	Percentage (P)	Weighting Factor (WF)	Relative Weight (P·WF)
Goals and Requirements				
Provides guidance on what is expected	1	2.13	2	4.26
Relates goals to a specific job	1	2.13	2	4.26
Management Related Activities				
Able decision maker	2	4.26	2	8.52
Able organizer	1	2.13	2	4.26
Understanding of management techniques	1	2.13	2	4.26
Able to judge importance of projects	1	2.13	2	4.26
Performance Evaluation				
Provides recognition	4	8.51	2	17.02
Qualities of the Supervisor				
Job Related				
Technical competence	8	17.0	2	17.02
Basic communicative skills	2	4.26	2	8.52
Personal				
Able to get along with people, tactful, initiative, performs under pressure	4	8.51	2	17.02

Table V is the result of categorizing 41 reponses from 41 scientific/engineering supervisors.

Table V
Categorization of Items Ranked as Number Three in Question 3 by Scientific/Engineering Supervisors

Category	Responses Frequency	Responses Percentage (P)	Weighting Factor (WF)	Relative Weight (P·WF)
Human Relations				
Listens to and exchanges ideas with subordinates	3	7.31	1	7.31
Deals with subordinates as individuals	3	7.31	1	7.31
Recognizes capabilities of subordinates	1	2.44	1	2.44
Concern for and interest in the needs of subordinates	1	2.44	1	2.44
Establishes a good working relationship (rapport) with subordinates	1	2.44	1	2.44
Working Environment				
Supports subordinates in their activities	3	7.31	1	7.31
Keeps subordinates informed	2	4.88	1	2.44
Involves subordinates in decision process	1	2.44	1	2.44
Places trust and confidence in subordinates	1	2.44	1	2.44
Provides an environment that does not inhibit R&D	1	2.44	1	2.44

Table V - Continued

Category	Responses Frequency	Responses Percentage (P)	Weighting Factor (WF)	Relative Weight (P·WF)
Knows accomplishments of subordinates and the organization	1	2.44	1	2.44
Provides freedom for job accomplishment	2	4.88	1	4.88
Goals and Requirements				
Provides guidance on what is expected	2	4.88	1	4.88
Communicates goals	1	2.44	1	2.44
Management Related Activities				
Keeps upper management informed	1	2.44	1	2.44
Understanding of management techniques	1	2.44	1	2.44
Performance Evaluation				
Provides recognition	3	7.31	1	7.31
Qualities of the Supervisor				
Job Related				
Technical competence	4	9.76	1	9.76
Administrative skills	4	9.76	1	9.76
Basic communicative skills	2	4.88	1	4.88
Personal				
Honest, uses common sense, positive attitude toward job, fair	4	9.76	1	9.76

Table VI is the result of categorizing 68 responses from 41 scientific/engineering supervisors.

Table VI
Categorization of Items Ranked as Numbers Four thru Ten in Question 3 by Scientific/Engineering Supervisors

Category	Responses Frequency	Percentage
Human Relations		
Concern for and interest in the needs of subordinates	7	10.29
Listens to and exchanges ideas with subordinates	6	8.82
Motivates workers to get the job done	2	2.94
Is flexible in dealing with subordinates	1	1.47
Maintains frequent contact with subordinates	1	1.47
Working Environment		
Provides freedom for job accomplishments	3	4.41
Supports subordinates in their activities	2	2.94
Provides responsibility	2	2.94
Places trust and confidence in subordinates	2	2.94
Involves subordinates in decision process	2	2.94
Relieves subordinates of outside pressures	1	1.47
Goals and Requirements		
Provides guidance on what is expected	1	1.47
Define goals	1	1.47
Managment Related Activities		
Knowledgeable of procedures and practices	2	2.94
Understanding of managment techniques	2	2.94
Bends rules as necessary to accomplish objectives	1	1.47
Communicates with upper management	1	1.47

Table VI - Continued

Category	Responses Frequency	Percentage
Performance Evaluation		
Provides recognition	5	7.35
Keeps people informed	1	1.47
Qualities of the Supervisor		
Job Related		
Technical competence	9	13.23
Administrative skills	7	10.29
Basic communicative skills	3	4.41
Personal		
Sets a good example, optimistic, tactful, works well with people	5	7.35

Table VII is the result of categorizing 262 responses from 72 scientific/engineering operatives.

Table VII
Categorization of Responses to Question 1 by Scientific/Engineering Operatives

Category	Responses Frequency	Percentage
Human Relations (22.14%)		
Concern for and interest in the needs of subordinates	19	7.25
Listens to and exchanges ideas with subordinates	13	4.96
Deals with subordinates as individuals	9	3.44
Recognizes capabilities of subordinates	8	3.05
Motivates subordinates to get the job done	6	2.29
Establishes a good working relationship (rapport) with subordinates	3	1.15
Working Environment (37.41%)		
Provides freedom in job accomplishment	34	12.98
Keeps subordinates informed	13	4.96
Provides responsibility and authority	12	4.58
Supports subordinates in their activities	12	4.58
Involves subordinates in decision process	6	2.29
Provides physical support for research activities	5	1.91
Keeps informed of what subordinates are doing	4	1.53
Maintains an open-door policy	3	1.15
Provides on the job training	2	.86
Places trust and confidence in subordinates	2	.86
Provides a smooth flowing working environment	1	.38
Provides an abundance of work	1	.38
Provides challenging and interesting work	3	1.91
Goals and Requirements (10.69%)		
Provides guidance on what is expected	22	8.40
Defines goals	6	2.29

Table VII - Continued

Category	Responses Frequency	Percentage
Goals and Requirements (10.69%)		
Provides guidance on what is expected	22	8.40
Defines goals	6	2.29
Management Related Activities (3.04%)		
Understands command and laboratory organization	1	.38
Provides an investment strategy	1	.38
Provides timely review of projects to avoid repetition	1	.38
Is aware of the "big" picture	1	.38
Is a technical manager	1	.38
Builds an organization balanced in abilities	1	.38
Understands the problems of the organization	1	.38
Uses influence to convince upper management of organizational importance	1	.38
Performance Evaluation (4.96%)		
Provides recognition	13	4.96
Qualities of the Supervisor (20.62%)		
Job Related		
Technical competence	24	9.16
Administrative skills	12	4.58
Basic communicative skills	3	1.15
Personal		
Dynamic, strong willed, diplomatic, fair, easy to get along with, wide range of interests, forceful, personal pride, objective	15	5.73

Table VII - Continued

Category	Responses Frequency	Percentage
Other (1.14%)		
Subordinate knows who he is working for	1	.38
Supervisor does not ask subordinate to do that which he would not do himself	1	.38
A supervisor who comes from the ranks	1	.38

Table VIII is the result of categorizing 192 responses from 72 scientific/engineering operatives.

Table VIII
Categorization of Responses to Question 2 by Scientific/Engineering Operatives

Category	Responses Frequency	Percentage
Human Relations (18.23%)		
Fails to communicate or consider subordinate idea	12	6.25
Lack of concern and interest in subordinate needs	12	6.25
Fails to recognize individual capabilities	7	3.65
Loses sight of personal aspects in dealing with subordinates	4	2.08
Working Environment (25.50%)		
Becomes too involved in technical matters	10	5.21
Does not pass on information to subordinates	6	3.13
Does not keep informed of what subordinates are doing	5	2.60
Lack of responsibility and authority given to subordinates	4	2.08
Lack of supervisory continuity	4	2.08
Does not provide adequate physical support	4	2.08
Does not involve subordinates in decision process	3	1.56
Lack of confidence and trust in subordinates	3	1.56
Lack of motivation	2	1.04
Lack of balance in work requirements	2	1.04
Lack of a creative environment	2	1.04
Lack of support of subordinate decisions	1	.52
Organizational structure not the same as structure in reality	1	.52
Unscheduled meetings	1	.52
Does not provide challenging work	1	.52

Table VIII - Continued

Category	Responses Frequency	Percentage
Goals and Requirements (13.55%)		
Does not provide adequate guidance	19	9.90
Poorly defines goals	7	3.65
Management Related Activities (15.62%)		
Lack of understanding of management techniques	12	6.25
Unable to make decisions	12	6.25
Makes decisions on other than a technical basis	3	1.56
Establishes unnecessary management levels	1	.52
Does not provide an intermediary between supervisor and subordinate	1	.52
Does not recognize problems	1	.52
Performance Evaluation (4.17%)		
Lack of recognition	6	3.13
Lack of feedback on performance	2	1.04
Qualities of the Supervisor (12.51%)		
Job Related		
Requires too many administrative details	11	5.73
Lacks technical competence	6	3.13
Personal		
Lack of: integrity, fairness, honesty, also vindic-dive, overbearing, abrasive	7	3.65

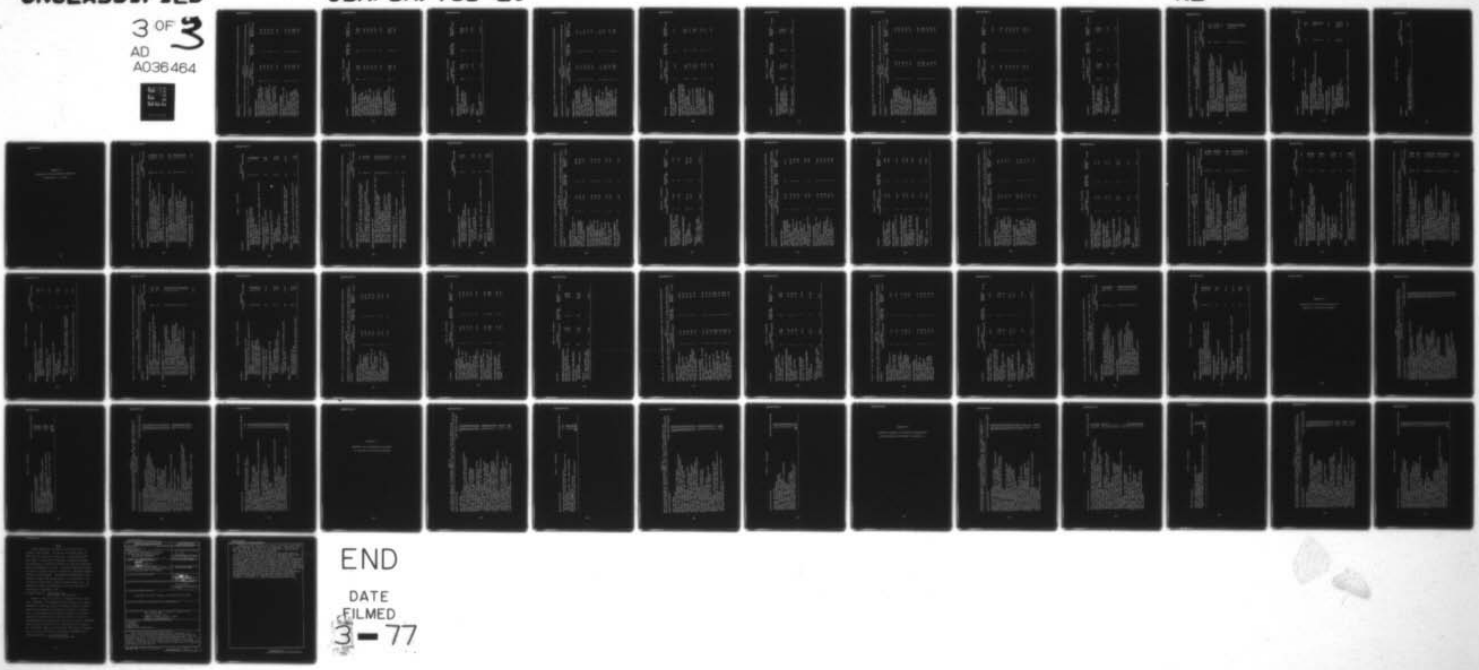
Table VIII - Continued

Category	Responses Frequency	Percentage
Other (10.41%)		
Opposite of above	12	6.25
Not consistent in what one says	4	2.08
Takes credit for subordinate work	2	1.04
One who does not work for his own boss	2	1.04

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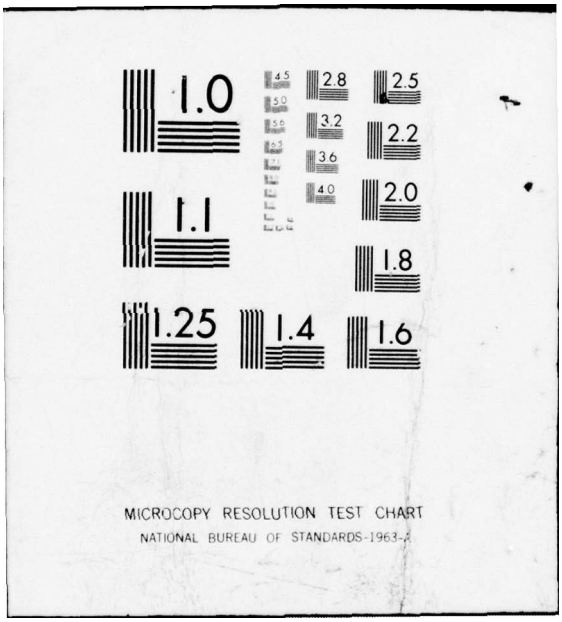

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Table IX is the result of categorizing 91 responses from 72 scientific/engineering operatives.

Table IX
Categorization of Items Ranked as Number One in Question 3 by Scientific/Engineering Operatives

Category	Responses Frequency	Responses Percentage	Weighting Factor (WF)	Relative Weight (P·WF)
Human Relations				
Deals with and relates to subordinates as individuals	22	24.18	3	72.54
Recognizes capabilities of subordinates	4	4.40	3	13.20
Concern for and interest in the needs of subordinates	4	4.40	3	13.20
Motivates subordinates to get the job done	4	4.40	3	13.20
Establishes a good working relationship (rapport) with subordinates	1	1.10	3	3.30
Working Environment				
Supports activities of sub-ordinates	2	2.20	3	3.30
Provides responsibility and authority	2	2.20	3	6.60
Keeps informed of what subordinates are doing	1	1.10	3	3.30
Provides sufficient work	1	1.10	3	3.30

Table IX - Continued

Category	Responses Frequency	Responses Percentage	Weighting Factor (WF)	Relative Weight (P·WF)
Management Related Activities				
Understands management techniques	3	3.30	3	9.90
Able decision maker	2	2.20	3	6.60
Is able to handle the military and civilian personnel systems	2	2.20	3	6.60
Gets people to agree on technical matters	1	1.10	3	3.30
Does managing rather than dollar chasing	1	1.10	3	3.30
Understands mission of the organization	1	1.10	3	3.30
Communicates accomplishments of organization to upper management	1	1.10	3	3.30
Goals and Requirements				
Provides freedom of subordinates to set own goals	11	12.09	3	36.27
Defines goals	1	1.10	3	3.30
Provides guidance on what is expected	1	1.10	3	3.30

Table IX - Continued

Category	Responses Frequency	Responses Percentage	Weighting Factor (WF)	Relative Weight (P·WF)
Qualities of the Supervisor				
Job Related				
Technical competence	19	20.88	3	62.64
Administrative skills	3	3.30	3	9.90
Basic communicative skills	1	1.10	3	3.30
Personal				
Integrity	1	1.10	3	3.30
Other				
Work for whom one is responsible	1	1.10	3	3.30

Table X is the result of categorizing 80 responses from 72 scientific/engineering operatives.

Table X
Categorization of Items Ranked as Number Two in Question 3 by Scientific/Engineering Operatives

Category	Responses Frequency	Responses Percentage	Weighting Factor (WF)	Relative Weight (P·WF)
Human Relations				
Listens to and exchanges ideas with subordinates	7	8.75	2	17.5
Deals with subordinates as individuals	6	7.5	2	15
Concern for and interest in the needs of subordinates	5	6.25	2	12.5
Motivates subordinates to get the job done	3	3.75	2	7.5
Recognizes capabilities of subordinates	3	3.75	2	7.5
Working Environment				
Provides freedom for job accomplishment	4	5.0	2	10.0
Provides authority and responsibility	2	2.5	2	5.0
Keeps subordinates informed	2	2.50		
Keeps informed of what subordinates are doing	1	1.25	2	2.5
Supports subordinates in their decisions	1	1.25	2	2.5
Provides meaningful tasks	1	1.25	2	2.5

Table X - Continued

Category	Responses Frequency	Responses Percentage	Weighting Factor (WF)	Relative Weight (P·WF)
Goals and Requirements				
Provides guidance on what is expected	3	3.75	2	7.5
Management Related Activities				
Interfaces with upper management in selling programs of the organization	4	5.0	2	10.0
Business knowledge	3	3.75	2	7.5
Able to identify overall problems	3	3.75	2	7.5
Able to prioritize information	2	2.5	2	5.0
Stays with decisions made	1	1.25	2	2.5
Has a total picture of a project (dollars and manpower necessary)	1	1.25	2	2.5
Provides answers or finds them out	1	1.25	2	2.5
Performance Evaluation				
Provides recognition	3	3.75	2	7.5

Table X - Continued

Category	Responses Frequency	Responses Percentage	Weighting Factor (WF)	Relative Weight (P·WF)
Qualities of the Supervisor				
Job Related				
Technical competence	15	18.75	2	37.5
Administrative skills	2	2.5	2	5.0
Basic communicative skills	2	2.5	2	5.0
Leadership qualities	1	1.25	2	2.5
Personal				
Fair, thorough, forceful	4	5.0	2	10.0

Table XI is the result of categorizing 68 responses from 72 scientific/engineering operatives.

Table XI
Categorization of Items Ranked as Number Three in Question 3 by Scientific/Engineering Operatives

Category	Responses Frequency	Percentage(P)	Weighting Factor (WF)	Relative Weight (P·WF)
Human Relations				
Listens to and exchanges ideas with subordinates	5	7.35	1	7.35
Concern for and interest in the needs of subordinates	2	2.94	1	2.94
Motivates subordinates to get the job done	2	2.94	1	2.94
Recognizes capabilities of subordinates	1	1.47	1	1.47
Deals with subordinates as individuals	1	1.47	1	1.47
Working Environment				
Provides freedom for job accomplishment	6	8.82	1	8.82
Supports activities of subordinates	5	7.35	1	7.35
Provides authority	3	4.41	1	4.41
Places trust in the subordinates	2	294	1	2.94
Provides physical support for research activities	2	2.94	1	2.94
Involves subordinates in decision making	1	1.47	1	1.47

Table XI - Continued

Category	Responses Frequency	Responses Percentage(P)	Weighting Factor (WF)	Relative Weight	(P·WF)
Goals and Requirements					
Provides guidance on what is expected	3	4.41	1	4.41	
Management Related Activities					
Provides effective communication outside the organizations	4	5.88	1	5.88	
Coordinates people and resources to accomplish tasks	3	4.41	1	4.41	
Assumes responsibility for group output	1	1.47	1	1.47	
Knowledgeable of the "big" picture	1	1.47	1	1.47	
Builds a balanced organization	1	1.47	1	1.47	
Performance Evaluation					
Provides recognition	4	5.88	1	5.88	
Provides feedback on performance	1	1.47	1	1.47	

Table XI - Continued

Category	Responses Frequency	Responses Percentage(P)	Weighting Factor (WF)	Relative Weight	(P·WF)
Qualities of the Supverisor					
Job Related					
Technical competence	10	14.71	1	14.71	
Administrative skills	3	4.41	1	4.41	
Basic communicative skills	3	4.41	1	4.41	
Personal					
Stable, dynamic, accepts criticism	3	4.41	1	4.41	
Other					
Supervisor has common social experiences with subordinates	1	1.47	1	1.47	

Table XII is the result of categorizing 110 responses from 72 scientists/engineering operatives.

Table XII
Categorization of Items Ranked as Number Four thru Seven in Question 3 by Scientific/Engineering Operatives

Category	Responses Frequency	Percentage
Human Relations		
Listens to and exchanges ideas with subordinates	8	7.27
Concern for and interest in the needs of subordinates	7	6.36
Establishes a good working relationship (rapport) with people	5	4.54
Motivates subordinates to get the job done	3	2.72
Recognizes capabilities of subordinates	2	1.82
Maintain a calm atmosphere when discussing technical matters with subordinates	1	.91
Working Environment		
Provides freedom for job accomplishment	6	5.45
Provides responsibility and authority	5	4.54
Supports activities of subordinates	5	4.54
Shows an interest in the work of subordinates	4	3.63
Involves subordinates in decision process	3	2.72
Maintains a high level of morale	1	.91
Places confidence in subordinates	1	.91
Provides a broad spectrum of work opportunities	1	.91
Provides a creative environment	1	.91
Provides a smooth working environment	1	.91

Table XII - Continued

Category	Responses Frequency	Percentage
Goals and Requirements		
Provides guidance on what is expected	5	4.54
Defines goals	1	.91
Management Related Activities		
Able to recognize important work	2	1.82
Provides scientific community with laboratory results	2	1.82
Mediator	1	.91
Able to see the "big" picture	1	.91
Is able to ask good questions	1	.91
Good organizer	1	.91
Performance Evaluation		
Provides recognition	4	3.63
Qualities of the Supervisor		
Job Related		
Technical competence	14	12.73
Administrative skills	12	10.91
Basic communicative skills	4	3.63
Leadership qualities	2	1.82
Personal		
Innovative, diplomatic, patient, emotionally detached	4	3.63

Table XII - Continued

Category	Responses Frequency	Percentage
Other		
Supervisor respects subordinates	1	.91
Subordinate knows who he is working for	1	.91

Appendix J

Responses of Non-technical personnel to Questions 1, 2, and 3

Table I is the result of categorizing 157 responses from 40 non-technical supervisors.

Table I
Categorization of Responses to Question 1 by Non-Technical Supervisors

Category	Responses Frequency	Percentage
Human Relations (33.11%)		
Concern for and interest in the needs of the subordinates	19	12.10
Deals with subordinates as individuals	13	8.28
Listens to and exchanges ideas with subordinates	7	4.46
Motivates subordinates to get the job done	5	3.18
Is flexible in dealing with people	4	2.55
Establishes a good working relationship (rapport) with subordinates	2	1.27
Recognizes the capabilities of subordinates	2	1.27
Working Environment (24.20%)		
Provides freedom for job accomplishment	9	5.73
Supports subordinates in their activities	7	4.46
Trains subordinates or provides them an opportunity to receive training	6	3.82
Places trust and confidence in subordinates	3	1.91
Provides authority and responsibility	3	1.91
Works with the subordinates to get the job done	3	1.91
Fosters an environment of high morale	1	.64
Provides challenging and interesting work	3	1.91
Gains respect and support of subordinates	3	1.91
Goals and Requirements (4.46%)		
Provides guidance on what is expected	7	4.46

Table I - continued

Category	Responses Frequency	Percentage
Management Related Activities (4.47%)		
Gains support from outside sources	2	1.27
Capability for long range planning	1	.64
Problem solving abilities	1	.64
Firm decision maker	1	.64
Good organizer	1	.64
Follows regulations but works to change them if incorrect	1	.64
Performance Evaluation (8.23%)		
Provides feedback on performance	7	4.46
Provides recognition	6	3.82
Qualities of the Supervisor (24.21%)		
Job Related		
Job knowledge	11	7.01
Administrative skills	2	1.27
Basic communicative skills	1	.64
Personal		
Fair, honest, adaptable, even-tempered, sets a good example, friendly, uses common sense, dedicated	24	15.29
Other (1.28%)		
Does not expect workers to do that which he could not do himself	1	.64
Does not hold the first mistake against a subordinate	1	.64

Table II is the result of categorizing 99 responses from 40 non-technical supervisors.

Table II
Categorization of Responses to Question 2 by Non-Technical Supervisors

Category	Responses Frequency	Percentage
Human Relations (21.0%)		
Does not listen to nor exchange ideas with subordinates	9	9.0
Lack of concern for and interest in the needs of subordinates	4	4.0
Does not recognize capabilities of subordinates	4	4.0
Fails to recognize individual differences in subordinates	2	2.0
Inability to work with subordinates	2	2.0
Working Environment (28.0%)		
Does not get involved in the work but still takes the credit	11	11.0
Provides little freedom in job accomplishment	4	4.0
Not informed of what subordinates are doing	3	3.0
Delegates too much authority	2	2.0
Does not support subordinates	2	2.0
Lack of trust and confidence in subordinates	2	2.0
Fails to keep subordinate informed	2	2.0
Provides inadequate training for subordinates	1	1.0
Does not provide challenging/interesting work	1	1.0
Goals and Requirements (5.0%)		
Provides no guidance of what is expected	5	5.0
Management Related Activities (10%)		
Inability to make or understand consequences of a decision	9	9.0
Does not follow chain of command	1	1.0

Table II - Continued

Category	Responses Frequency	Percentage
Performance Evaluation (4.0%)		
Provides no recognition	2	2.0
Overrated performance ratings	1	1.0
Provides no feedback on performance	1	1.0
Qualities of the Supervisor (20.0%)		
Job Related		
Lack of job knowledge	5	5.0
Too much attention to details	1	1.0
Personal		
Lazy, sets bad example, name caller, dishonest, partial	14	14.0
Other (12.0%)		
Opposite of Question #1	9	9.0
Ambitious at expense of subordinates	2	2.0
Inconsistent	1	1.0

Table III is the result of categorizing 42 responses from 40 non-technical supervisors.

Table III
Categorization of Items Ranked as Number One in Question 3 by Non-Technical Supervisors

Category	Responses Frequency	Responses Percentage(P)	Weighting Factor (WF)	Relative Weight (P·WF)
Human Relations				
Concern for and interest in the needs of the sub-ordinates	4	9.52	3	28.56
Listens to and exchanges ideas with subordinates	2	4.76	3	14.28
Deals with subordinates as individuals	1	2.38	3	7.14
Working Environment				
Involves subordinates in the decision process	1	2.38	3	7.14
Firm but flexible in job accomplishment	1	2.38	3	7.14
Provides freedom for job accomplishment	1	2.38	3	7.14
Trains subordinates or provides them an opportunity to receive training	1	2.38	3	7.14
Looks after the safety of the personnel	1	2.38	3	7.14
Goals and Requirements				
Provides guidance on what is expected	1	2.38	3	7.14

Table III - Continued

Category	Responses Frequency	Percentage(P)	Weighting Factor (WF)	Relative Weight	(P·WF)
Management Related Activities					
Decision making ability	1	2.38	3	7.14	
Knowledgeable in the role of the organization in mission accomplishment	1	2.38	3	7.14	
Qualities of the Supervisor					
Job Related					
Job knowledge	15	35.71	3	107.13	
Basic communicative skills	4	9.52	3	28.56	
Personal					
Integrity, sets a good example, accepts responsibility, fairness	8	19.05	3	57.15	

Table IV is the result of categorizing 41 responses from 40 non-technical supervisors.

Table IV
Categorization of Items Ranked as Number Two in Question 3 by Non-technical Supervisors

Category	Response Frequency	Response Percentage(P)	Weighting Factor (WF)	Relative Weight (P·WF)
Human Relations				
Listens to and exchanges ideas with subordinates	5	12.20	2	24.4
Concern for and interest in the needs of the subordinates	4	9.76	2	19.52
Motivates subordinates to get the job done	2	4.88	2	9.76
Deals with subordinates as individulas	1	2.44	2	4.88
Establishes a good working relationship (rappport) with the subordinates	1	2.44	2	4.88
Recognizes the capabilities of the subordinates	1	2.44	2	4.88
Working Environment				
Keeps informed of what subordinates are doing	3	7.32	2	14.64
Provides for a creative atmosphere	2	4.88	2	9.76
Trains subordinates to function independently	2	4.88	2	9.76
Places trust and confidence in subordinates	1	2.44	2	4.88
Supports subordinates in their activities	1	2.44	2	4.88

Table IV - Continued

Category	Responses Frequency	Percentage(P)	Weighting Factor (WF)	Relative Weight	(P*WF)
Provides authority and responsibility	1	2.44	2	4.88	
Gains the respect and support of subordinates	1	2.44	2	4.88	
Goals and Requirements					
Provides guidance on what is expected	2	4.88	2	9.76	
Management Related Activities					
Decision making ability	2	4.88	2	9.76	
Understanding of management techniques	1	2.44	2	4.88	
Knowledgeable in the role of the organization in mission accomplishment	1	2.44	2	4.88	
Qualities of the Supervisor					
Job Related					
Job knowledge	4	9.76	2	19.52	
Personal					
Honest, fair, diplomatic	6	14.63	2	29.26	

Table V is the result of categorizing 40 responses from 40 non-technical supervisors.

Table V
Categorization of Items Ranked as Number Three in Question 3 by Non-Technical Supervisors

Category	Responses Frequency	Responses Percentage(P)	Weighting Factor (WF)	Relative Weight (P·WF)
Human Relations				
Deals with subordinates as individuals	6	15.0	1	15.0
Listens to and exchanges ideas with subordinates	2	5.0	1	5.0
Recognizes the capabilities of the subordinates	2	5.0	1	5.0
Concern for and interest in the needs of subordinates	1	2.5	1	2.5
Working Environment				
Provides freedom for job accomplishment	4	10.0	1	10.0
Shows interest in subordinates and their work	4	10.0	1	10.0
Supports subordinates in their activities	1	2.5	1	2.5
Gains the respect and support of subordinates	1	2.5	1	2.5
Has the ability to bring unity and coordination into the organization	1	2.5	1	2.5

Table V - Continued

Category	Responses Frequency	Responses Percentage(P)	Weighting Factor (WF)	Relative Weight	(P·WF)
Management Related Activities					
Understanding of management techniques	3	7.5	1	7.5	
Possesses the ability to deal with upper management	1	2.5	1	2.5	
Performance Evaluation					
Provides recognition	1	2.5	1	2.5	
Provides feedback on performance	1	2.5	1	2.5	
Qualities of the Supervisor					
Job related					
Job knowledge	5	12.5	1	12.5	
Basic communicative skills	1	2.5	1	2.5	
Personal					
Flexible, honest, level-headed, set a good example, fairness	5	12.5	1	12.5	
Other					
Puts oneself in the place of the subordinates	1	2.5	1	2.5	

Table VI is the result of categorizing 64 responses from 40 non-technical supervisors.

Table VI
Categorization of Items Ranked as Numbers 4 thru 10 in Question 3 by Non-Technical Supervisors

Category	Responses Frequency	Percentage
Human Relations		
Concern for and interest in the needs of the subordinates	5	7.81
Deals with subordinates as individuals	5	7.81
Listens to and exchanges ideas with subordinates	6	9.38
Is informal with subordinates	1	1.56
Establishes a good working relationship (rapport) with subordinates	1	1.56
Motivates subordinates to get the job done	1	1.56
Recognizes the capabilities of subordinates	4	9.38
Looks after safety of subordinates	1	1.56
Working Environment		
Keeps subordinates informed	3	4.69
Provides an opportunity for continued education	2	3.13
Trains subordinates or provides them an opportunity to receive training	2	3.13
Provides freedom for job accomplishment	2	3.13
Supports subordinates in their activities	2	3.13
Provides espirit de corps	2	3.13
Provides challenging and interesting work	1	1.56
Understands the pressure environment of some jobs	1	1.56
Places trust and confidence in subordinates	1	1.56
Flexibility in responding to higher management and to employees	1	1.56

Table VI - Continued

Category	Responses Frequency	Percentage
Goals and Requirements		
Provides guidance on what is expected	1	1.56
Management Related Activities		
Understands management techniques	1	1.56
Has overall view of regulations covering subordinates	1	1.56
Strives to become an effective subordinate manager	1	1.56
Understanding of the psychology of people	1	1.56
Performance Evaluation		
Recognition	4	9.38
Provides feedback on performance	1	1.56
Rates subordinates fairly	1	1.56
Qualities of the Supervisor		
Job Related		
Administrative skills	2	3.13
Job knowledge	1	1.56
Communicative skills	1	1.56
Personal		
Fair, sincere, sets a good example, honest	5	7.81
Other		
Provides an opportunity for subordinates to compete for promotions	1	1.56
Does not hold small mistakes against the subordinate	1	1.56
Helps subordinate to correct mistakes	1	1.56

Table VII is the result of categorizing 197 responses from 58 non-technical operatives.

Table VII
Categorization of Responses to Question 1 by Non-Technical Operatives

Category	Responses Frequency	Percentage
Human Relations (28.43%)		
Concern for and interest in the needs of the subordinates	25	12.69
Listens to and exchanges ideas with subordinates	11	5.58
Deals with subordinates as individuals	9	4.57
Establishes a good working relationship (rapport) with subordinates	6	3.05
Listens to problems of subordinates	5	2.54
Working Environment (45.69%)		
Provides freedom for job accomplishment	22	11.17
Provides challenging and interesting work	9	4.57
Supports subordinates in their activities	8	4.06
Works with the subordinates to get the job done	8	4.06
Provides authority and responsibility	7	3.55
Keeps subordinates informed	7	3.55
Trains subordinates or provides them an opportunity to receive training	5	2.54
Is available to subordinates	6	3.05
Provides material support	5	2.54
Keeps informed of what subordinates are doing	5	2.54
Involves subordinates in the decision process	4	3.03
Fosters an environment of high morale	3	1.52
Places trust and confidence in subordinates	1	.51
Goals and Requirements (6.61%)		
Provides guidance on what is expected	10	5.08
Provides well-defined goals	2	1.02
Fosters goal congruence	1	.51

Table VII - Continued

Category	Responses Frequency	Percentage
Management Related Activities (2.04%)		
Good organizer	2	1.02
Problem solving abilities	1	.51
Ability to deal with people at all organizational levels	1	.51
Performance Evaluation (2.54%)		
Provides recognition	5	2.54
Qualities of the Supervisor (13.20%)		
Job Related		
Job knowledge	9	4.57
Administrative skills	1	.51
Personal		
Calm, rational, patient, compassionate, strong-willed, sets a good example, progressive thinker, dedicated	16	8.12
Other (1.52%)		
Does not demand more of subordinates than he can do himself	3	1.52

Table VIII is the result of categorizing 155 responses from 58 non-technical operatives

Table VIII
Categorization of Responses to Question 2 by Non-Technical Operatives

Category	Responses Frequency	Percentage
Human Relations (20.01%)		
Lack of concern for and interest in the needs of subordinates	18	11.61
Does not listen to nor exchange ideas with subordinates	9	5.81
Fails to recognize individual differneces in subordinates	3	1.94
Does not motivate subordinates	1	.65
Working Environment (25.21%)		
Provides little freedom in job accomplishment	7	4.52
Does not provide responsibility and authority	6	3.87
Does not get involved in the work	5	3.23
Does not support subordinates	5	3.23
Provides inadequate training for subordinates	3	1.94
Does not provide challenging/interesting work	3	1.94
Inflexible to regulations for job accomplishment	5	3.23
Fails to keep subordinates informed	2	1.29
Not available to subordinates when needed	1	.65
Lack of supervisor continuity	1	.65
Lack of trust and confidence in subordinates	1	.65
Undermines morale	1	.65
Too lenient	1	.65
Goals and Requirements (3.23%)		
Provides no guidance of what is expected	5	3.23

Table VIII - Continued

Category	Responses Frequency	Percentage
Management Related Activities (14.20%)		
Inability to make or understand consequences of a decision	11	7.10
Inadequate supervisory training	2	1.29
Inability to solve problems	3	1.94
Lack of planning and organizing	2	1.29
Lack of control over subordinates	2	1.29
Lacks leadership qualities	2	1.29
Performance Evaluation (9.03%)		
Provides no recognition	14	9.03
Qualities of the Supervisor (21.30%)		
Job Related		
Lack of job knowledge	8	5.16
Neglects administrative duties	1	.65
Assigns too many administrative duties	1	.65
Personal		
Self-centered, unstable, bad example, gossiper, dishonest, partial	23	14.84
Other (7.75%)		
Opposite of Question #1	10	6.45
Distrusts promotion system	1	.65
Allows subordinates to write own performance ratings	1	.65

Table IX is the result of categorizing 66 responses from 58 non-technical operatives.

Table IX
Categorization of Items Ranked as Number One in Question 3 by Non-Technical Operatives

Category	Responses Frequency	Percentage(P)	Weighting Factor (WF)	Relative Weight (P*WF)
Human Relations				
Motivates subordinates to get the job done	6	9.09	3	27.27
Listens to and exchanges ideas with subordinates	5	7.85	3	22.74
Deals with subordinates as individuals	3	4.55	3	13.65
Recognizes the capabilities of the subordinates	3	4.55	3	13.65
Concern for and interest in the needs of the subordinates	3	4.55	3	13.65
Has the ability to get along with people	1	1.52	3	4.54
Establishes a good working relationship (rapport) with subordinates	1	1.52	3	4.56

Table IX - Continued

Category	Responses Frequency	Responses Percentage(P)	Weighting Factor (WF)	Relative Weight (P·WF)
Working Environment				
Gains the respect and support of the subordinates	3	4.55	3	13.65
Provides a freedom for job accomplishment	2	3.03	3	9.09
Acts as a buffer to filter extraneous work	1	1.52	3	4.56
Provides authority and responsibility	1	1.52	3	4.56
Trains subordinates or provides them an opportunity to receive training	1	1.52	3	4.56
Goals and Requirements				
Provides guidance on what is expected	2	3.03	3	9.09
Makes subordinates aware of organizational goals	1	1.52	3	4.56
Maintains stated objectives	1	1.52	3	4.56
Performance Evaluation				
Provides recognition	1	1.52	3	4.56
Provides discipline when needed	1	1.52	3	4.56

Table IX - Continued

Category	Responses Frequency	Responses Percentage(P)	Weighting Factor (WF)	Relative Weight	(P·WF)
Management Related Activities					
Rational decision maker	1	1.52	3	4.56	
Possesses leadership qualities	1	1.52	3	4.56	
Good organizer	1	1.52	3	4.56	
Qualities of the Supervisor					
Job Related					
Job knowledge	15	22.73	3	68.19	
Administrative competence	1	1.52	3	4.56	
Personal					
Sets a good example, integrity, honesty, charismatic, positive attitude, fairness	11	16.67	3	50.01	

Table XI is the result of categorizing 59 responses from 58 non-technical operatives.

Table X
Categorization of Items Ranked as Number Two in Question 3 by Non-Technical Operatives

Category	Responses Frequency	Percentage(P)	Weighting Factor (WF)	Relative Weight	(P·EF)
Human Relations					
Listens to the problems of subordinates	5	8.47	2	16.94	
Deals with subordinates as individuals	5	8.47	2	16.94	
Has the ability to get along with people	3	5.08	2	10.16	
Concern for and interest in the needs of subordinates	3	5.08	2	10.16	
Recognizes the capabilities of the subordinates	1	1.69	2	3.38	
Working Environment					
Supports subordinates in their activities	4	6.78	2	13.56	
Gets subordinates to work together	2	3.39	2	6.78	
Makes subordinates feel important	1	1.69	2	3.38	
Provides challenging and interesting work	1	1.69	2	3.38	
Keeps subordinates informed	1	1.69	2	3.38	
Provides authority and responsibility	1	1.69	2	3.38	
Places trust and confidence in subordinates	1	1.69	2	3.38	
Is available when needed	1	1.69	2	3.38	
Keeps informed of what subordinates are doing	1	1.69	2	3.38	

Table X - Continued

Category	Responses Frequency	Responses Percentage(P)	Weighting Factor (WF)	Relative Weight (P·WF)
Goals and Requirements				
Provides guidance of what is expected	2	3.39	2	6.78
Fosters goal congurence	1	1.69	2	3.38
Management Related Activities				
Rational decision maker	1	1.69	2	3.38
Has adequate supervisory training	1	1.69	2	3.38
Possesses leadership qualities	1	1.69	2	3.38
Performance Evaluation				
Provides recognition	2	3.39	2	6.78
Qualities of the Supervisor				
Job Related Job knowledge	11	18.64	2	37.28
Personal Versatility, loyalty, stable, strong convictions, dedicated, fairness	10	16.95	2	33.9

Table XI is the result of categorizing 56 responses from non-technical operatives.

Table XI
Categorization of Items ranked as Number Three in Question 3 by Non-Technical Operatives

Category	Responses Frequency	Responses Percentage(P)	Weighting Factor (WF)	Relative Weight (P·WF)
Human Relations				
Deals with subordinates as individuals	4	7.14	1	7.14
Concern for and interest in the needs of the subordinates	4	7.14	1	7.14
Establishes a good working relationship (rapport) with subordinates	4	7.14	1	7.14
Listens to and exchanges ideas with subordinates	3	5.36	1	5.36
Listens to the problems of subordinates	1	1.79	1	1.79
Working Environment				
Supports subordinates in their activities	3	7.14	1	7.14
Provides authority and responsibility	2	5.36	1	5.36
Provides challenging/ interesting work	2	5.36	1	5.36
Keeps informed of what subordinates are doing	1	1.79	1	1.79
Creates a good working environment	1	1.79	1	1.79

Table XI - Continued

Category	Responses Frequency	Responses Percentage(P)	Weighting Factor (WF)	Relative Weight	(P·WF)
Goals and Requirements					
Provides what is expected	5	8.93	1	8.93	
Management Related Activities					
Minimum number of workers per supervisor	1	1.79	1	1.79	
Good organizer	1	1.79	1	1.79	
Effectively manages people (time-off, etc.)	1	1.79	1	1.79	
Performance Evaluation					
Provides recognition	6	10.71	1	10.71	
Provides feedback on performance	2	3.57	1	3.57	
Qualities of the Supervisor					
Job Related Job knowledge	3	5.36	1	5.36	
Personal Sets a good example, forceful, fair, diplomatic, compassionate	12	21.43	1	21.43	

Table XII is the result of categorizing 78 from 58 non-technical operatives.

Table XII
Categorization of Items Ranked as Numbers Four thru Eight in Question 3 by Non-Technical Operatives

Category	Responses Frequency	Percentage
Human Relations		
Deals with subordiantes as individuals	9	11.54
Recognizes the capabilities of subordinates	5	6.41
Gets involved with subordinates outside the job	1	1.28
Motivates subordinates to get the job done	1	1.28
Tempers justice with mercy	1	1.28
Listens to problems of subordinates	1	1.28
Working Environment		
Provides freedom for job accomplishment	6	7.69
Keeps subordinates in the decision process	2	2.56
Promotes esprit de corps	2	2.56
Provides authority and responsibility	2	2.56
Involves subordinates in the decision process	2	2.56
Keeps informed of what the subordinates are doing	2	2.56
Supports subordinates in their activities	2	2.56
Balances the workload among subordinates	2	2.56
Is available when needed	1	1.28
Filter extraneous work	1	1.28
Provides good working conditions	1	1.28

Table XII - Continued

Category	Responses Frequency	Percentage
Management Related Activities		
Rational decision maker	3	3.85
Requires work to be channeled through his office	1	1.28
Knowledge of management theory (training)	2	2.56
Ability to coordinate with outside organizations	1	1.28
Management by exception	1	1.28
Performance Evaluation		
Recognition	5	6.41
Provides feedback on performance	1	1.28
Qualities of the Supervisor		
Job Related		
Job knowledge	7	8.97
Personal		
Sets a good example, compassionate, fair, dedicated respected	8	10.26
Goals and Requirements		
Sets well defined goals	2	2.56
Provides guidance on what is expected	1	1.28
Other		
Puts oneself in the place of subordinates	2	2.56

Appendix K

Responses of scientists/engineers to

Question 3 by relative weights

Table I
Total Relative Weight of Items Ranked Number One, Two, or Three in Question 3 by Scientific/Engineering Supervisors (Asterisk * denotes items common to supervisors and operatives)

Subclassifications	Total Relative Weight
*Technical competence	84.14
*Concern for and interest in the needs of subordinates	44.06
*Recognizes capabilities of subordinates	34.03
*Defines/communicates goals	31.30
*Provides recognition	30.09
Is flexible in dealing with subordinates	28.86
*Motivates subordinates to get the job done	28.57
*Listens to and exchanges ideas with subordinates	27.38
*Personal qualities of supervisor	26.78
*Basic communicative skills	24.95
*Support subordinates in their activities	23.12
*Provides freedom for job accomplishment	22.51
*Provides guidance on what is expected	20.69
*Places trust and confidence in subordinates	19.75
*Shows interest in subordinates and their work	17.02
*Keeps subordinates informed	16.43
*Provides authority and responsibility	15.81
*Deals with subordinates as individuals	11.57
*Leadership qualities	11.55
*Administrative skills	9.76
*Able decision maker	8.52
*Involves subordinates in decision process	8.20
*Understanding of management techniques	6.70
Exhibits day to day awareness	5.76
Is able to direct problems as a team effort	5.76
Is acceptable to upper management	5.76
Understands subordinates	4.26

Table I - Continued

Subclassifications	Total Relative Weight
Provides training for subordinates	4.26
Relates goals to a specific job	4.26
Able organizer	4.26
Able to judge importance of projects	4.26
*Establishes a good working relationship (rapport) with subordinates	2.44
*Knows accomplishments of subordinates and organization	2.44
Keeps upper management informed	2.44
*Provides an environment that does not inhibit research and development	2.44
	600.13

Table II
Total Relative Weight of Items Ranked as Number One, Two, or Three in Question 3 by Scientific/Engineering Operatives (Asterisk * denotes items common to supervisors and operatives)

Subclassifications	Total Relative Weight
*Technical competence	114.85
*Deals with subordinates as individuals	89.01
Provides freedom for subordinates to set own goals	36.27
*Concern for and interest in the needs of subordinates	28.64
*Listens to and exchanges ideas with subordinates	24.85
*Motivates subordinates to get the job done	23.64
*Recognizes capabilities of subordinates	22.17
*Administrative skills	19.31
*Provides freedom for job accomplishment	18.82
*Personal qualities of supervisor	17.71
*Provides authority and responsibility	16.01
*Provides guidance on what is expected	15.21
*Supports subordinates in their activities	13.95
*Provides recognition	13.38
*Basic communicative skills	12.71
Interfaces with upper management in selling programs of the organization	10.00
*Understanding of management techniques	9.90
Business knowledge	7.50
Able to identify overall problems	7.50
*Able decision maker	6.60
Is able to handle the military and civilian personnel systems	6.60
Provides effective communication outside the organization	5.88
Keeps informed of what subordinates are doing	5.80
Keeps subordinates informed	5.50
Able to prioritize information	5.00
Coordinates people and resources to accomplish tasks	4.41

Table II - Continued

Subclassifications	Total Relative Weight
*Shows interest in subordinates and their work	3.30
*Establishes a good working relationship (rapport) with subordinates	3.30
Provides sufficient work	3.30
Gets people to agree on technical matters	3.30
Does managing rather than dollar chasing	3.30
Understands mission of organization	3.30
Communicates accomplishments of organization to upper management	3.30
*Defines goals	3.30
Work for whom one is responsible for	3.30
*Places trust and confidence in subordinates	2.94
*Provides physical support for research activities	2.94
Support subordinates in their decisions	2.50
Provides meaningful tasks	2.50
Stays with decisions made	2.50
*Leadership abilities	2.50
Has a total picture of a project (dollars and manpower necessary)	3.97
Provides answers or finds them out	2.50
*Involves subordinates in decision process	1.47
Assumes responsibility for group output	1.47
Builds a balanced organization	1.47
Provides feedback on performance	1.47
Supervisor has common social experiences with subordinates	1.47
	600.62

Appendix L

Responses of non-technical personnel to Question 3 by Relative Weights

Table I

Total Relative Weight of Items Ranked Number One, Two, or Three in Question 3 by Non-Technical Supervisors (* Asterisk denotes items common to supervisors and operatives)

Subclassifications	Total Relative Weight
*Job knowledge	139.15
*Personal qualities	98.91
*Concern for and interest in the needs of subordinates	50.58
*Listens to and exchanges ideas with subordinates	43.68
Basic communicative skills	31.06
*Deals with subordinates as individuals	27.02
*Provides freedom for job accomplishment	17.14
*Provides guidance on what is expected	16.90
*Decision making ability	16.90
*Keeps informed of what subordinates are doing	14.64
Understanding of management techniques	12.38
Knowledgeable in the role of the organization in mission accomplishment	12.02
Shows interest in subordinates and their work	10.00
*Recognizes the capabilities of subordinates	9.88
*Motivates subordinates to get the job done	9.76
Provides for a creative atmosphere	9.76
Trains subordinates to function independently	9.76
*Gains the respect and support of subordinates	7.38
*Supports subordinates in their activities	7.38
*Trains subordinates or provides them an opportunity to receive training	7.14
Looks after the safety of subordinates	7.14
Involves subordinates in the decision process	7.14
Firm but flexible in job accomplishment	7.14
*Establishes a good working relationship (rapport) with the subordinates	4.88
*Places trust and confidence in subordinates	4.88

Table I - Continued

Subclassifications	Total Relative Weight
*Provides authority and responsibility	4.88
Has the ability to bring unity and coordination into the organization	2.50
Possesses ability to deal with upper management	2.50
*Provides recognition	2.50
*Provides feedback on performance	2.50
Puts oneself in the place of the subordinates	2.50
	600.00

Table II

Total Relative Weight of Items Ranked Number One, Two, or Three in Question 3 by Non-technical Operatives (Asterisk * denotes items common to supervisors and operatives)

Subclassifications	Total Relative Weight
*Job knowledge	110.83
*Personal qualities	105.34
*Deals with subordinates as individuals	37.73
*Concern for and interest in the needs of subordinates	30.95
*Listens to and exchanges ideas with subordinates	28.10
*Motivates subordinates to get the job done	27.27
*Provides guidance on what is expected	24.80
*Provides recognition	22.05
*Supports subordinates in their activities	18.92
Listens to problems of subordinates	18.73
*Recognizes the capabilities of subordinates	17.03
Has the ability to get along with people	14.72
*Gains the respect and support of subordinates	13.65
*Establishes a good working relationship (rapport) with the subordinates	11.70
*Provides authority and responsibility	11.51
*Provides freedom for job accomplishment	9.09
*Rational decision maker	7.94
Possesses leadership qualities	7.94
Provides challenging and interesting work	6.95
Gets subordinates to work together	6.78
Good organizer	6.35
*Keeps informed of what subordinates are doing	5.17
Acts as a buffer to filter extraneous work	4.56
*Trains subordinates or provides them an opportunity to receive training	4.56
Makes subordinates aware of organizational goals	4.56
Maintains stated objectives	4.56

Table II - Continued

Subclassifications	Total Relative Weight
Provides discipline	4.56
Administrative competence	4.56
*Provides feedback on performance	3.57
Makes subordinates feel important	3.38
Keeps subordinates informed	3.38
*Places trust and confidence in subordinates	3.38
Is available when needed	3.38
Fosters goal congruence	3.38
Has adequate supervisory training	3.38
Creates a good working environment	1.79
Effectively manages people (time-off, etc.)	1.79
Minimum number of workers per supervisor	1.79
	600.13

Appendix M

Combined responses of Scientific/Engineering and Non-technical Personnel to Question 3

Table I
Total Relative Weight of Items Ranked as Number One, Two, or Three in Question 3 by Scientific/Engineering Personnel (* Asterisk denotes items common to scientific/engineering and non-technical personnel)

Subclassifications	Total Relative Weight
*Technical competence	103.60
*Deals with subordinates as individuals	60.83
*Concern for and interest in the needs of subordinates	34.22
*Recognizes capabilities of subordinates	26.48
*Listens to and exchanges ideas with subordinates	25.72
Provides freedom for subordinates to set own goals	23.07
*Provides recognition	19.54
*Personal qualities	21.12
*Motivates subordinates to get the job done	25.45
*Provides freedom for job accomplishment	20.06
*Supports subordinates in their activities	17.32
*Provides guidance on what is expected	17.19
*Provides authority and responsibility	15.87
*Basic communicative skills	17.19
*Administrative skills	15.86
Defines and communicates goals	13.52
Is flexible in dealing with subordinates	10.5
*Keeps subordinates informed	9.17
*Places trust and confidence in subordinates	9.05
*Understanding of management techniques	8.8
*Shows interest in subordinates and their work	8.4
*Able decision maker	7.34
Interfaces with upper management in selling programs of the organization	6.3
*Leadership qualities	5.78
Business knowledge	4.72
Able to identify overall problems	4.72

Table I - Continued

Subclassifications	Total Relative Weight
*Keeps informed of what subordinates are doing	4.60
Is able to handle the military and civilian personnel systems	4.2
Has a total picture of a project (dollars and manpower necessary)	3.97
*Involves subordinates in decision process	3.93
Provides effective communication outside the organization	3.67
*Establishes a good working relationship (rapport) with subordinates	3.02
Able to prioritize information	3.14
Coordinates people and resources to accomplish tasks	2.75
Provides physical support for research activities	2.75
Provides sufficient work	2.1
Exhibits day to day awareness	2.1
Is able to direct problems as a team effort	2.1
Gets people to agree on technical matters	2.1
Does managing rather than dollar chasing	2.1
Understands mission of the organization	2.1
Communicates accomplishments of organization to upper management	2.1
Is acceptable to upper management	2.1
Work for whom one is responsible	2.1
Understands subordinates	1.58
Supports subordinates in their decisions	1.58
*Provides meaningful tasks	1.58
*Provides training for subordinates	1.58
Relates goals to a specific job	1.58
Stays with decision made	1.58
Provides answers or finds them out	1.58
Able to judge importance of projects	1.58
Good organizer	1.58

Table I - Continued

Subclassifications	Total Relative Weight
Assumes responsibility for group output	.92
Builds a balanced organization	.92
Keeps upper management informed	.92
*Provides feedback on performance	.92
Supervisor has common social experiences with subordinates	.92
	600.10

Table II
Total Relative Weight of Items Ranked as Number One, Two, or Three in Question 3 by Non-technical Personnel (*Asterisk denotes items common to scientific/engineering and and non-technical personnel)

Subclassifications	Total Relative Weight
*Job knowledge	121.67
*Personal qualities	102.48
*Listens to and exchanges ideas with subordinates	44.65
*Concern for and interest in needs of subordinates	38.65
*Deals with subordinates as individuals	33.52
*Provides guidance on what is expected	21.55
*Motivates subordinates to get the job done	20.68
*Recognizes the capabilities of subordinates	14.42
*Supports subordinates in their activities	14.17
*Provides recognition	14.08
*Provides freedom for job accomplishment	12.51
*Basic communicative skills	12.14
*Decision making ability	11.55
Gains the respect and support of subordinates	11.38
*Keeps informed of what subordinates are doing	9.04
*Establishes a good working relationship (rapport) with subordinates	8.96
*Provides authority and responsibility	8.87
Has the ability to get along with people	8.79
*Trains subordinates or provides them an opportunity to receive training	5.55
*Understanding of management techniques	5.13
*Possesses leadership qualities	4.79
Knowledgeable in the role of the organization in mission accomplishment	4.79
*Shows interest in subordinates and their work	4.17
*Provides challenging and interesting work	4.08

Table II - Continued

Subclassifications	Total Relative Weight
Provides for a creative atmosphere	4.00
Trains subordinates to function independently	4.00
*Places trust and confidence in subordinates	4.00
Gets subordinates to work together	4.00
Good organizer	3.83
*Provides feedback on performance	3.13
Looks after the safety of subordinates	2.79
Acts as a buffer to filter extraneous work	2.79
*Involves subordinates in decision process	2.79
Firm but flexible in job accomplishment	2.79
Makes subordinates aware of organizational goals	2.79
Maintains stated objectives	2.79
Provides discipline	2.79
*Administrative competence	2.79
Makes subordinates feel important	2.00
*Keeps subordinates informed	2.00
Is available when needed	2.00
Fosters goal congruence	2.00
Has adequate supervisory training	2.00
Listens to problems of subordinates	1.04
Creates a good working environment	1.04
Has the ability to bring unity and coordination into organization	1.04
Possesses ability to deal with upper management	1.04
Minimum number of workersper supervisor	1.04
Effectively manages people (time-off, etc.)	1.04
Puts oneself in the place of subordinates	1.04
	600.18

Vitae

George Daugavietis was born on 15 February 1948 in Nürnberg, West Germany. He came to the United States in 1949 under the Displaced Persons Act. He graduated from high school in Grand Haven, Michigan in 1966 and attended the University of Michigan from which he received a bachelors degree in mathematics in 1970. He entered the United States Air Force in January 1971 and received his commission through Officers Training School. He completed Undergraduate Pilot Training in June 1972 and served as a T-37 Instructor Pilot at Moody Air Force Base, Georgia, through August 1975. He entered the School of Engineering, Air Force Institute of Technology, in September 1975.

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SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER GSM/SM/76D-29	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* A STUDY OF CHARACTERISTICS IN THE SUPERVISION OF SCIENTIFIC AND ENGINEERING PERSONNEL.		5. TYPE OF REPORT & PERIOD COVERED MS Thesis 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) George Daugavietis Captain Ronald S. Harris Captain		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		12. REPORT DATE December 1976 13. NUMBER OF PAGES 247
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)*

Scientists
Engineers
Supervision
Research and Development

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This thesis examined the supervision of scientists and engineers in order to better understand the particular nature in the supervision of scientific and engineering personnel. The face-to-face interview of 113 scientists and engineers and 98 non-technical personnel was the primary data collection instrument. The comparison and contrast of a non-technical group was a distinguishing feature of this thesis.

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Characteristics dealing with "Human Relations" were noted as most important by scientists and engineers. Characteristics dealing with the "Qualities of the Supervisor" were noted as most important by non-technical personnel.

Nine characteristics distinctive to the supervision of scientists and engineers were identified ~~through a comparison~~ by comparing of the views of scientists/engineers and non-technical personnel toward supervision. The major differences between the views of supervisors were in the greater significance attached to characteristics dealing with 'Human Relations' by scientific/engineering supervisors, and the greater significance attached to characteristics dealing with the 'Qualities of the Supervisor' by non-technical supervisors. The major differences in the views of operatives were in the greater significance attached to characteristics dealing with the 'Qualities of the Supervisor' by non-technical operatives, and the greater significance attached to treatment of subordinates as individuals and freedom to set goals by scientific/engineering operatives.

