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ABSTRACT

Critical factors in the phenomenon of scientist's and engineer's transition from working as specialists to working as supervisors or managers were studied among 489 employees of the National Aeronautics and Space Administration and the National Institutes of Health to discover ways of avoiding or overcoming transition problems. Bench scientists and engineers, scientists and engineers at first and second levels of supervision and management, and senior scientist-engineer managers were selected into the sample population. Management was analyzed in three dimensions: the functions or tasks to be performed, the skills and abilities used in performing tasks, and motivation which provided positive and negative meaning in transition. An interview questionnaire was developed to test respondent reaction to categories used in management dimensions and to explore their views about transition problems. Data resulting from 610 interviews showed that the sample population accepted such functions in management as reporting, supervising, planning, and programs assessment. However, personal skills were considered as a source of tension. Three types of scientists and engineers were found in motivation analyses, and their identification might be used as criteria for candidate selection. Major training needs were determined to fall in the areas of personal skills and of organization processes and structures. (CC)

NASA SP-291

Transformation of Scientists and Engineers into Managers

Bayton and Chapman

NATIONAL AERONAUTICS
AND SPACE ADMINISTRATION

NASA SP-291

Transformation of Scientists and Engineers into Managers

JAMES A. BAYTON AND RICHARD L. CHAPMAN

Prepared under contract for NASA by the National Academy of Public Administration, Washington, D.C.

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Editor's Note

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FOREWORD

This report is the result of research conducted under NASA Contract NSR 09-046-001. The research was conducted and the report was developed with the advice and recommendations of an *ad hoc* group, denoted in this book the "Advisory Panel", comprised of a distinguished membership from the National Academy of Public Administration.

The results of the study have been of interest to top-level NASA administrators and managers, and have already attracted the attention of and elicited inquiries from other major Federal agencies. Because the report deals with a subject that has considerable impact on good management of public institutions, especially those in the research and development environment, NASA management is issuing it as a Special Publication to achieve wide distribution and availability.

—DeMarquis D. Wyatt
Assistant Administrator for Policy
and University Affairs

PREFACE

A function of the National Academy of Public Administration is to focus the expert judgment of its members and associates upon critical problems in public administration.

The research described in the following report, and the report itself, benefitted from the continuing general guidance of the Advisory Panel. In periodic meetings the panel critically reviewed the research plan, the development and test results of the interview instruments, the study progress, and the draft report. Following extensive discussion of the findings and their implications, the panel concluded its work by making specific recommendations.

The Academy is indebted to the panel members for their very substantial contributions to this research: Douglas W. Bray, Director of Personnel Research, American Telephone and Telegraph Company; William D. Carey, Senior Staff Consultant, Arthur D. Little, Inc.; Harold B. Finger, Assistant Secretary for Research and Technology, Department of Housing and Urban Development; Franklin P. Kilpatrick, Dean, College of Social and Behavioral Sciences, Ohio State University; and John F. Sherman, Deputy Director, National Institutes of Health.

—George A. Graham
Executive Director
National Academy of
Public Administration

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SUMMARY OF FINDINGS

A critical problem facing every organization is how to make managers from people who are specialists. The vast majority of college-trained people joining organizations enter as specialists, or become specialists before taking positions of supervisory or managerial responsibility—attorneys, accountants, economists, scientists, engineers, doctors, budget and personnel experts, and so on.

The purposes of this research were (1) to determine the principal problems and obstacles faced by specialists during the transition period when they are becoming managers, and (2) to discover ways by which their difficulties might be avoided or overcome.

It was found that senior management officials are unaware—or tend to ignore the importance—of the transition process and its problems, that little attention has been given to developing management training to overcome transition problems, and that much of the training which *is* offered is largely irrelevant to these problems.

The study was supported by, and conducted in, the National Institutes of Health and the National Aeronautics and Space Administration. Six hundred ten interviews were conducted with scientists and engineers, ranging from those still working as specialists through senior managers who had carried predominantly managerial responsibility for ten years or more.

In this study of the transition phenomenon, management was perceived as involving three dimensions: (1) the component functions or tasks to be performed; (2) the skills and abilities used in performing the tasks; and (3) the motives which give positive or negative meaning to participation in the managerial role.

It also was assumed, and the study subsequently demonstrated, that the transformation from specialist to manager is a continuing process, not a sudden change which occurs when a person moves into his first management position.

What Changes Occur?

What principal changes occur along the three dimensions of management—functions, skills, and motivation—in the transition process?

There are two fundamental changes with respect to management functions. First, more of the functions are performed, and with greater frequency, as the specialist moves into management than when he operated solely as a specialist. (He performs some management functions even as a specialist.) Second, the functions take on a broader scope in the management role than they had in the specialist role. For example, the specialist, when dealing with the budgeting function, rarely goes beyond cost estimation and cost control. In the management role, however, he is more likely to be responsible for budget development encompassing broader program areas, negotiation and liaison with related groups or organizations, and program justification which goes beyond technical program elements. This greater breadth carries with it the need to deal with a larger number of people at higher levels of responsibility and with a wider range of occupations.

The most striking change in the dimension of management skills is the shift in focus from task-centered skills to those skills needed to master the organizational system. These skills fall into two categories. First, the specialist must become more and more skilled in coping with the organizational system itself—its goals, procedures, and policies. Second, the specialist must become skilled in working with people who differ substantially in background and interests from those with whom he associated as a specialist.

Our respondents associated a certain pattern of motivations with scientists and engineers (that is, specialists). They associated a distinctly different pattern of motivations with managers. To simplify the text of this book, we shall refer to these patterns informally as "motivational patterns of a specialist", "managers' motivations", and so forth.

(This verbal shorthand should not be misconstrued. We do not mean to imply any wider known validity of the data than for those persons actually interviewed. Nor did we try to determine clinically the basic motivational patterns of our respondents.)

The study revealed a sharp division of opinion among the participants as to the relative ease or difficulty of satisfying "specialists' motivations" when one becomes a manager. A small number of specialists turned managers, who initially were neutral or somewhat negative about management, indicated that they grew to enjoy the changed role. Two-thirds of those interviewed said that they responded positively when first approached about the possibility of becoming managers. However, the transition can be a difficult problem for a specialist who tends to reject managers' motivations, or who perceives great difficulty in satisfying specialists' motivations in a managerial position.

What are the Impact and Implications of the Changes?

The study revealed that the greatest problem in the transition process relates to the organizational system. Specialists consistently have difficulty acquiring the skills and understanding to cope with the system. This was viewed as a major problem by all specialists, ranging from those who had yet to assume management responsibilities, through those in the transition process at the time of the interviews, to individuals holding senior management positions.

The extent of this problem was further revealed by interviews with the immediate superiors of those interviewed in the first and second levels of supervision or management. These superiors consistently underestimated the importance which their subordinates assigned to being able to cope with the organizational system. Thus the specialist in transition faces a changed work environment where he has inadequate skill, and where he finds minimal help in either diagnosing his need or acquiring pertinent skills.

Much, if not most, of the management training offered to specialists in transition discusses the organizational system inadequately, treating rather abstractly such topics as interpersonal relationships, decision-making, and problem-solving. All of these topics have value, but none of them directly addresses the principal and specific needs of the man in transition.

The management functions presented no particular difficulty, except as they related to skills necessary for their performance. Generally, specialists at all stages of transition held similar views as to the relative importance and difficulty of performing management functions, either as specialists or managers. There were two important exceptions. First, those specialists who had not yet entered management considered management functions important when performed in the specialist role, but were skeptical of their importance in a management setting. This suggests a view commonly held by specialists as to the general value of management *per se*. Second, the superiors consistently failed to understand (1) their subordinates' views—namely, that the subordinates disliked certain management functions, and found certain functions difficult to perform—and (2) the intensity of those views.

The distinct difference in the patterns of motivation for specialists (here scientists and engineers) and managers suggests that there may be three categories or types of specialists. First is the specialist whose motivational pattern is essentially that of a manager, although he is working at the moment in his specialty. He does not hold a specialist's typical motivational pattern deeply, though the pattern must be operative to some degree. One could expect this type of specialist to welcome a move into management.

Second is the specialist whose motivational pattern is strongly that of a specialist, and who is somewhat reluctant to move into management. Once he has made the transition, however, he discovers that the motivational pattern and reward system of a manager can have meaning for him, furnishing satisfactions which had not been anticipated.

Third is the specialist for whom the motivational patterns of a manager have definite negative appeal. If one of these men were to go into management for financial advancement, or because he was "drafted" into management, he probably would find the experience frustrating—and possibly conducive to failure. The study results suggest that, to the extent possible, specialists of this third type should be identified when management candidates are screened. This would help to determine those for whom the risk of failure is relatively high; those identified as high risks might then be provided temporary or training assignments, through which management potential could be determined more clearly.

PANEL RECOMMENDATIONS

The Advisory Panel commends this report to the attention of senior executives in both government and industry. The study reveals that the problem of transition is receiving inadequate attention and that, where the problem *is* addressed, too frequently the programs leave critical needs untouched. Based upon the report findings and their implications, the panel makes the following recommendations.

Management

1. The first and most important need is for agency leadership to realize the importance and difficulty of the transition process—and to deal effectively with this process. Top management should take an active part in selection procedures and training programs, to enhance the potential success of specialists moving into management. Such active participation can help assure realistic training, and will emphasize to transition employees the importance of this training.

2. The civil service system, as practiced in agency central personnel offices and within the Civil Service Commission, inhibits agencies' general capacity to meet the problems of transition. This study shows that from 32 to 55 percent of the scientists and engineers at the bench and the first two levels of supervision or management believe that the only path to salary advancement is through seeking managerial functions.

Both NASA and NIH nominally follow a "dual ladder" system, which permits grade and salary promotions to scientists and engineers of high technical ability without their having to enter management. However, such opportunities appear to be severely limited above grade GS-15. Personnel staffs—at either the agency central personnel office or the Civil Service Commission—insist on managerial duties as requirements for higher grade classification. This often results in promoting capable scientists and engineers into managerial positions for which they are poorly prepared, and toward which they are not positively motivated.

The relative rigidity of the personnel system, as practiced, also tends to discourage agencies from using new selection processes which have proved useful for predicting success in management.

Selection

1. This study confirmed what has already been shown elsewhere—that the salient motivations of most scientists and engineers working as specialists are substantially different from those of most managers. It also indicated that those individuals who reject the managerial value system are likely to be poor risks in managerial posts.

Therefore, agency procedures for selecting management candidates should provide systematic, discriminating evaluation of motivations, as well as other elements of management potential. Such an evaluation system not only would improve the selection process, but also would provide more specific direction to management development programs by revealing individual training needs. Supervisors should be kept informed of the most recent techniques for selecting management candidates, and should be offered training in these techniques.

2. Greater emphasis should be given to criteria other than technical competence or prominence, in selecting candidates for managerial posts. This study confirmed the commonly accepted belief that technical competence is the most frequent and most important consideration in the selection of scientists and engineers for management. The importance of special or outstanding technical competence as a factor should be weighted relative to other factors in *each job* within management, and not accepted uncritically as the foremost criterion in every in stance.

3. Selection of potential managers should be considered a continuing process. This selection process can be facilitated by assigning potential manager candidates to *ad hoc* tasks which involve a heavy engagement in the management functions. Such assignments might be tours of limited duration on a task force, or assignment to a committee or similar activity. In such an assignment the individual must work with a wide variety of people, in a context

which demands his participation as something more than a technical specialist.

Training

1. One of the greatest unmet needs is for more effective orientation of new employees to the organization environment and agency procedures. This could be accomplished by a longer, more detailed orientation process, involving both (a) the central training or employee-development organization and (b) the senior- and middle-line management of the division to which the employee is assigned.

The general orientation should be aimed at familiarizing the new employee with the formal organization, its goals and procedures.

A second- or third-level supervisor who is knowledgeable should introduce the new employee to those organizational and operational subtleties which can make him a more effective manager. This senior supervisor should serve also as an informal advisor to whom the new manager can turn. Not every supervisor can fill this demanding role, but those who are capable should be identified and used in the orientation process.

2. Supervisory training programs should be revised to reflect: (a) greater attention to skills related to the organizational system; (b) stronger emphasis upon the development of subordinates' management capability, (c) improved sensitivity of supervisors to subordinates' views and problems (as revealed by this study); and (d) wider use of information generated in the process of systematic management evaluation, to assess individual training needs.

3. Agencies should examine the need for special programs—and if a need is found should sponsor such programs—to improve employee performance in the management functions found to be most difficult. Likely problem areas are budgeting, staffing (and other personnel operations), planning, program evaluation, and management reporting. Two categories of training should be distinguished—that which all new managers should receive, and that which specific individuals should receive to meet specific, individualized needs.

4. Agencies should explore the wider use of limited intern-type assignments for new or potential managers. These posts should include some rotating work assignments, to put the new manager or candidate into contact with a variety of management functions and experiences. If special assignments are used to select as well as to train specialists for management positions, the individual participating in these assignments should be permitted to do so at no jeopardy to himself—should he find that, upon exposure, he dislikes management.

I. INTRODUCTION

This study had its roots in the early attempts of the National Academy of Public Administration to help public officials grapple with important problems of administration. In a series of more than 100 interviews during 1967 with officials at all levels of government—local, state, and national—the executive director of the Academy, George Graham, found that the "problem" mentioned most frequently was how to make managers of specialists. Senior government officials said that developing managers from their professional employees (such as attorneys, scientists, engineers, accountants and economists) was a constant challenge, and one for which they knew of no satisfactory solution.

The vast majority of those who now hold senior managerial and executive positions in the Federal Government begin their careers as specialists.[1] Therefore, it is not surprising to find that conversion, or transition, from specialist to manager is widespread. Given the often striking differences between the role of the professional (specialist) and the organizational role of the manager, the transition can be a difficult process.[2]

The goal of this research was to determine the critical factors in the phenomenon of transition from working as a specialist to working as a manager. We decided to limit the study to the transition of scientists and engineers because the substance of science and technology differs greatly from that of management, making it easier to identify change, and because the literature on the sociology of science is as rich as—or richer than—that of any other occupational group.[3]

The study was supported by and conducted in two major Federal research agencies: the National Institutes of Health (NIH) and the National Aeronautics and Space Administration (NASA).[4] In order to cover the transition process thoroughly, it was studied from the perspectives of four groups: (1) bench scientists and engineers, (2) scientists and engineers at first or second levels of supervision (generally section and branch chiefs), (3) scientists and engineers at first and second levels of management, and (4) scientists and engineers who were senior managers (supergrade or equivalent).

Supervisors and managers were kept distinct because of the different contexts in which they operate. "Supervisors" we define as those directly supervising other professionals in technical work (for example, in a laboratory); and "managers" we define as those having program responsibility but not directly supervising other professionals in the conduct of laboratory or shop work. The former has a closer, personal contact with technical work; he may be involved with technical details more than his colleague manager, who has a contract or grant program responsibility.

Much of the data collected in this research is applicable to a variety of questions about scientists and engineers in government or other large organizations. However, we attempted to analyze the data for only one purpose—to seek the principal problems involved in the specialist-to-manager transition process, their probable causes, and possible solutions.

We are indebted to the hundreds of NIH and NASA officials who participated in the study. Special thanks are due to those in the personnel and management offices who helped define the agency populations for sampling, and who made many of the arrangements for the interviews: Mel Bolster and Dorothy Burns of NIH; William Williams at NASA's Langley Research Center; Richard Stephens, Charles Bingman, Grove Webster, Owen Gallagher, John Duggan, and Ray Metcalfe of NASA Headquarters; William Henderson at NASA's Manned Spacecraft Center; Helen Davies and John Boyd at NASA's Ames Research Center; Gervaise Wyss, William Hagen, and Robert Smith III of NASA's Marshall Space Flight Center; Ernest Spivey and John Larowe of NASA's Kennedy Space Center; and Daniel Pilistine, James Dennison, and Robert O'Neill of NASA's Electronic Research Center.

National Analysts, Incorporated, was especially responsive in drawing the sample, conducting the interviews, and coding and tabulating the data.

II. THE PROBLEM OF TRANSITION

Many studies have described the value system of the scientist or engineer and its differences from those of other occupational groups.[5] The transition from specialist to manager is a problem because of the fundamental conflict between science or engineering and management as fields of professional endeavor.

For example, the scientist seeks further knowledge through experimentation, attempting to control operational factors within specified limits. He measures and observes according to recognized, objective procedures. He refrains from conclusions until he is comfortable with the amount and quality of accumulated data. On the other hand, the administrator frequently must seek knowledge, primarily as a means to action, through empirical evidence whose objectivity is clouded because the administrator is part of the system and not just an observer. The administrator finds little opportunity to control the factors relevant to his action or decision. And he must make important decisions with only fragmentary data as an operational way of life.

Few scientists or engineers, particularly if they remain in technically-oriented organizations, seek to identify themselves as either administrators or managers. Lewis Mainzer summarized this viewpoint:

> Federal research administrators generally hesitate to call themselves "administrator", do not become involved in public administration as a discipline or a conscious profession, and do not have great confidence in formal management training or theory.[6]

These differences stem from the value systems and ways of thinking that are developed during educational preparation for a career, and they are reinforced by the system of reward and punishment legitimate to each community.

One factor which undoubtedly affects the transition is "self-selection". Scientists and engineers who view the value system of the manager with repugnance probably tend to reject opportunities to enter management, leaving those who believe management to be potentially satisfying or who have few, if any, strong negative feelings about it as principal candidates.

During the transition process the scientist or engineer must add a new combination of skills and knowledge to those he already possesses. He must modify and broaden his perspective, so that he becomes capable of interweaving technical and managerial criteria within an appropriate context.

Transition as an Evolutionary Process

The transition from scientist or engineer to manager is, usually, not a single step but an evolutionary process.

Transition probably begins before the scientist or engineer enters his first position as a supervisor or manager. In most instances, he directs the efforts of others such as laboratory assistants, technicians, or small temporary groups of his colleagues in a particular task. He takes some part in the screening and selection of non-professional assistants, in planning or scheduling work layout and in developing cost estimates. Frequently, a scientist or engineer in his bench role serves upon committees to review research proposals or provide leadership for some professional activity. Such activities present opportunities for brief participation in management-oriented tasks and the exercise of skills related to them.

By the time a scientist or engineer steps into the position of a section chief (the first permanent supervisory role in both NASA and NIH), he has had at least a fleeting acquaintance with a variety of management tasks; he probably has shown enough interest or competence in them to mark him for consideration for a supervisory position.

This phenomenon of working into management gradually, and moving into the first supervisory role at least partly upon the basis of interest and success in smaller management tasks, may be less typical in a basic research laboratory. In such settings the principal consideration almost surely is the individual's success and standing as a research scientist. Technical competence usually is the first consideration, in the filling of any supervisory or managerial position in a technical agency.

There is a more drastic exception to this view of the transition process as a more-or-less gradual rather than a sharp change. This exception is the case of a scientist or engineer who moves from a position in which he spends the bulk of his time in conducting research to one of program management. A striking example of this is the selection of a scientist from the world of teaching and research, in a university, to lead a research grant program at NIH. Here the transition can be traumatic, when the individual moves from the less structured environment of the university classroom and laboratory into the semi-bureaucratic government grant operation. NIH has initiated special intern-type training, the Grants Associates Program, specifically to soften this shock and to facilitate successful transition.

Research Related to the Transition

Little research has been conducted which focuses specifically upon the transition process. In 1965, Robert Bailey and Barry Jensen reported the results of a survey made in two industrial organizations.[7] Their interviews of scientists and engineers (predominantly engineers) suggest that the full impact of transition from specialist to manager is not felt or apparent until a man moves to the second level of supervision or management. They ascribe this to the fact that the scientist or engineer in the first level of supervision is still heavily, if not predominantly, involved in technical detail. They believe that the move to the second level of supervision removes the supervisor from first-hand involvement in technical detail.[8]

Bailey and Jensen conclude that there are six reasons why the transition is difficult: (1) the specialist must switch his prime loyalty from a professional (and technical) orientation to a company (that is, management) orientation; (2) the specialist wants to be a "nice guy", but he tends to associate management with hurting rather than helping people; (3) the specialist loses *direct* control over work and now must work through others (neither can he be more proficient than each of his subordinates in their respective tasks); (4) he spends less time on things that are fun (that is, technical) and must adjust to a scale of values oriented toward management; (5) the specialist feels trapped at having opted for management to obtain more money, having deserted his "technical birthright"; and (6) in contrast to engineering and physical science, there are few rules in management to fall back upon.[9]

More recently, John Crockett completed a study of the management development needs of NASA engineers at the Manned Spacecraft Center.[10] This was a study of the perceptions of NASA R&D engineers as to their own relative competence in certain management skills—specifically, skills related to the NASA environment. The study also sought to determine what training programs the engineers believed would be most helpful. Crockett found that the engineers believed they were deficient in decision-making, planning and goal setting, human behavior in organizations, communications, and principles of organization.

A more extensive study of NIH extramural scientist-administrators—probing their characteristics, past experience, perceived roles, and attitudes about management—was completed recently by Mel Bolster.[11] (Bolster has also written an excellent review of literature on the transition of scientists to managers in a research and development agency. This unpublished paper is titled "Extending Managerial Competence: Planning the Transition from Scientist to Manager in the Federal Government", dated January 1968.) Bolster's work is a detailed study of the scientist as administrator in the NIH grant and contract programs. He was able to identify role categories of the NIH "scientist-administrators", which should prove helpful in planning training and other development programs for individuals moving toward these specific NIH roles. He concluded that one of the most difficult adjustments in the transition is associated with "having to accept the relatively sluggish responses of bureaucracy", and "accepting responsibility for the work of other people."[12]

Harold Leich and Nicholas Oganovic of the Civil Service Commission have discussed the development of human resources for science administration.[13] Their work was directed at such questions as:

> Where does the manager in a scientific and engineering organization come from?
>
> How does he differ from the individual contributor?
>
> What does he typically do?
>
> How can he be developed to a high degree of effectiveness?

Leich and Oganovic report the comments, experience, and observations of a wide variety of people in both industry and government on these questions. The authors also cite several surveys on the working environment and motivations in a Federal science agency, the background of Federal science administrators, and a survey of the kinds of tasks or responsibilities (taken from official position descriptions) that senior Federal technical managers are expected to handle. In addition the authors recommend nine ways in which the quality of science administration can be enhanced. These range from (1) encouraging undergraduate and graduate students of science and engineering to take courses in management and behavioral sciences to (2) developing a stimulating environment for creative work in technical organization. However, Leich and Oganovic do not offer new or supplementary research findings on the transition process itself.

Attempts to Smooth the Transition

Both government and industry have recognized for some time that the transition is difficult and chancy, and that organizations should provide some assistance to individuals going through the process. Aside from discussing the problem, most attention is devoted to providing some type of training for new managers or supervisors.

Beginning with the era of "scientific management", it was recognized that the role of supervision was distinct enough to call for some type of training or educational effort. Usually, it is the modern offspring of such training that is offered to specialists in their first managerial or supervisory positions.[14] These efforts will be described more thoroughly in chapter IX, Training Needs, but three closely related to this study deserve mention here:

(1) The U. S. Civil Service Commission conducts a half dozen interagency training programs directed toward the scientist or engineer in government. These programs include a three-day introduction for scientists or engineers new to government service; five-day supervisory programs; and planning, policy-making, and issue-oriented programs of five days or more. For some of these longer programs, the commission provides away-from-home residential arrangements.

(2) NASA has collaborated with Leadership Resources, Incorporated, in developing a series of one-week programs in supervision and management. These programs concentrate upon small-group behavior, organization, planning, and problem-solving; and also on laws, regulations, policies and practices relevant to first- and second-level supervisors.

(3) The principal NIH program directed toward the transition process is the "Grants Associates Program", which is analogous to the Federal management-intern program. It is a year-long program of "rotating" work assignments, each lasting from three to six weeks, and a program of lectures, seminars, visits, and discussions dealing with management skills, other Federal science agencies, Federal Government operations, science and public policy issues, and the role of NIH.

These training programs and their industrial counterparts have been developed largely on the basis of management intuition and personal experience—particularly the experience of those senior officials who have a continuing interest in the problem of transition.

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III. DIMENSIONS OF MANAGEMENT

This research is based upon the thesis that management involves three dimensions—the *functions* or tasks to be performed, the *skills* and other abilities used in performing the tasks, and the *motivations* which give positive or negative meaning to participation in the managerial role. The particular form this concept takes in this research evolved from a variety of sources such as Floyd Mann, L. F. Urwick and Rensis Likert, and from discussions with members of the DuPont Corporation in the Employee Relations Department.[15]

We recognize that there is some overlap of the functions performed by managers and specialists. There is also some overlap of skills required. For example, when an individual is working as a scientist or engineer, he has to perform many management functions. He could very well have to prepare budgets; he could have to staff and to supervise; he could have to participate in policy-making. Similarly, the skills and abilities used in performing as a manager are those which must be drawn upon when working in other fields, such as being a scientist or engineer. The scientist or engineer is a problem-solver and decision-maker; he might have to demonstrate skill in coordinating group effort; he might have to develop skill in operating within the organizational system.

The third dimension of management—motivation—is intimately involved in a person's reactions to a given vocation. An individual with high need for autonomy or independence might find working as a scientist very fulfilling but might feel that he could not obtain that type of satisfaction working as a manager. In contrast, a person with high leadership needs might find operating in a management role to be more satisfying than working as a scientist or engineer.

The general view in this research is that, when one makes the transition from being a scientist or engineer to being a manager, changes occur in these three dimensions. These changes can produce positive or negative reactions in managerial performance, or can be neutral. It is the task of this research to identify the changes which occur in each of these three dimensions, and to determine how they facilitate or inhibit the transformation of scientists and engineers into managers.

For study purposes, *listings* of the pertinent functions, skills and motivations were formalized as described in the following paragraphs.

Functions

Our categories of management functions were derived from some of the same sources mentioned above, but Thomas Mahoney in *Building the Executive Team* was particularly useful—especially in describing the Ohio State studies of Stogdill and Shartle, and the University of Minnesota studies relating to functional categories of managerial responsibility.[16]

Beginning with nine functions, we combined two and added two others (consulting, and program assessment and evaluation). These changes were based upon field tests—both individual and group interviews.

The resulting ten management functions were listed on a card, with explanatory phrases. The study respondents, interviewed face-to-face, looked at this list during the part of the interview dealing with management functions. Figure 1 shows this card.

CARD 1 #1-009

a. Budgeting

-- budget preparation
-- justification of the budget
-- living within budgetary constraints

b. Reporting

-- organizationally upward and down
 - to provide information
 - to elicit information
 - to get action
-- laterally and outside the organization

c. Staffing

-- personnel selections, training and retention

d. Supervising

-- directing work of others
-- personal counseling of subordinates
-- coordinating efforts of those outside your authority

e. Planning

-- long range
-- scheduling and work layout
-- developing scheme to accomplish objective

f. Policy-Making

-- establishing policies and procedures

g. Representing the Organization

-- at higher echelons
-- professional or public meetings
-- liaison with other agencies or groups

h. Consulting

-- assisting other groups or organizations by virtue of technical or administrative knowledge

i. Program Assessment and Evaluation

-- critically reviewing projects and programs for ultimate action by a higher authority

j. "Fire-Fighting"

-- meeting unexpected day-to-day problems

FIGURE 1.–Card used in interview, enumerating management functions

CARD 2 #1-009

a. Fundamental technology
-- well founded in the fundamentals of his field.

b. Application of techniques
-- capacity to apply techniques.

c. Knowledge in related areas
-- professional knowledge in areas related to specialty.

d. Operating within organizational system
-- capacity to operate within the organization -- a knowledge of organizational goals, structure, relationships and procedures.

e. Operating within financial system
-- capacity to operate within the financial management system -- knowledge of relevant budgeting, cost estimating, and cost control techniques or procedures.

f. Operating with personnel system
-- capacity to operate within the personnel system -- the formal and informal means (and restrictions) applicable to the full range of personnel activites from recruitment through separation.

g. Recognizing, coping with environmental factors
-- capacity to recognize and to cope with environmental factors -- e.g., constituent-professional-group interests, inter-agency problems or relations, interested officials in other component organizations within your agency, organizational politics.

h. Communication of ideas
-- ability to communicate ideas.

i. Working with diverse people
-- capacity to work with people of diverse ability, style, and temperament.

j. Coordinating, etc., group effort
-- ability to coordinate; facilitating group efforts, negotiating.

k. Leadership style
-- possessing a leadership style that draws positive responses from subordinates.

l. Generation of confidence of superior
-- capacity to generate the confidence of his superior in him.

m. Integrative ability
-- integrative ability, to perceive and assess relationships.

n. Problem-solving
-- capacity to identify and to define critical issues, to develop potential solutions.

o. Decision-making
-- possesses decision-making capacity.

p. Creative thinking
-- capable of creative thinking.

NOT PARTICULARLY IMPORTANT ________ OF CRITICAL IMPORTANCE
1 2 3 4 5 6 7 8 9

FIGURE 2.–Card used in interview, enumerating management skills

CARD 3 #1-003

a. Leadership

-- being the leader - directing others - being the one who establishes policies.

b. Detailed planning

-- developing detailed plans - being neat and orderly in one's work.

c. Doing new, different things.

d. Direct attack on problems

-- engaging in direct attack on problems and obstacles.

e. Contributing to organization's goals

-- contributing to the advancement of the organization's goals.

f. Achieving through overcoming difficult obstacles.

g. Help to one's colleagues - assisting others.

h. Being independent

-- making own decisions - doing as one wishes.

i. Seeking the support of others

-- seeking assistance from others.

j. Being recognized

-- for one's accomplishments.

k. Being able to exercise authority.

l. Risk-taking in decisions

-- liking to be in a job where one's decisions involve taking risks.

m. Associating with very congenial co-workers.

n. Associating with intellectually competent co-workers.

o. Using technical knowledge, skills.

LOW SATISFACTION 1 2 3 4 5 6 7 8 9 HIGH SATISFACTION

FIGURE 3.–Card used in interview, enumerating motivations

These management functions were studied both as they relate to scientific or engineering work and as they relate to managerial work. The aspects of these functions which we studied were: frequency of performance, enjoyment or dislike, difficulty, time consumption, and importance. Also studied were qualitative changes in the character of each function as one shifts, in performing it, from being a scientist or engineer to being a manager.

Skills

The skill categories had their roots in Robert Katz's seminal article depicting three basic skills: technical, human and conceptual.[17]

We separated Katz's category of "technical" into:

> *professional or specialist* skills (here including those related to science and engineering—"well founded in fundamentals", "capacity to apply techniques", and "knowledge in related areas"); and
>
> skills more specifically related to *management or administration* ("capacity to operate within the organization", "capacity to operate within the financial management system", "capacity to operate within the personnel system", and "capacity to recognize and to cope with environmental factors").

The human and conceptual categories were similarly subdivided to provide more specific meaning.

The four general category descriptions were deleted from the list, leaving 16 skills. This was done to avoid prejudicing respondent selection on the basis of the broad categories rather than the more specific skills.

As in the case of the management functions, the 16 listed skills were field-tested and adjusted.

The 16 skills or abilities listed on a card for the respondents appeared as shown in figure 2.

The 16 skills or abilities were studied as to their importance, both in scientific or engineering work and in managerial work. We also studied them as to the likelihood of their being sources of difficulty for a scientist or engineer moving into management.

Motivations

Fifteen motivational categories were identified. The categories of motivations were adapted from Murray's identification of basic psychological motivations—with several additions based upon field trials (e.g., "risk-taking in decisions", "using one's technical knowledge and skills", and "associating with congenial co-workers").[18]

The card with the 15 categories appeared as in figure 3.

Each category was assessed in terms of the degree of satisfaction one could obtain when working as a scientist or engineer and when working as a manager. Each was evaluated, also, on the basis of its relative difficulty or ease of satisfaction, when one moves from science or engineering to management. Finally, the respondents were asked to select those motivational categories, of the set of 15, which best describe a scientist or engineer and those which best describe a manager.

IV. RESEARCH DESIGN

This study was designed around the assumption that the period of greatest difficulty for a scientist or engineer in transition occurs during his first two jobs as a manager or supervisor.

The two principal problems we faced in pursuing this research were (1) how to obtain relevant information about the transition process, and (2) how to define and identify the "first two levels of management or supervision". Since no objective standards were available, the best source of information about the transition was judged to be those people who were in the process or had apparently completed it successfully.

Given the detailed nature of the information sought (see chapter III, Dimensions of Management), we concluded that the most satisfactory means of collecting the data would be through a structured personal interview.

Development of the Interview Instruments

On the basis of past experience in science-oriented organizations, a search of the literature bearing on the transition process, and preliminary development of the dimensions of management, we conducted a series of exploratory interviews in both NIH and NASA. These interviews were conducted to test respondent reaction to the categories used in the dimensions of management, and to explore with respondents their views about the problems of the transition process. Both group interviews and individual interviews were included.

Using this information and experience, we developed a structured interview questionnaire, and field tested it using the principal categories of respondents described below. (See Appendix for the principal questionnaire used in the interviews.)

Somewhat amended versions of this questionnaire were used for certain secondary groups of respondents (described in chapter V).

Sampling

Not all of the principal components of the National Institutes of Health nor the National Aeronautics and Space Administration were included in the study.

Although NIH has most of its activities in Bethesda, Maryland, there were a few small field activities which were excluded because they were located outside the Washington, D. C. area, and represented only a small portion of the target respondents. Those included at NIH were: the Office of the Director, Division of Research Grants, Bureau of Health Professions Education and Manpower Training, the Division of Biologics Standards, the National Cancer Institute, the National Heart Institute, the National Institute of Allergy and Infectious Diseases, the National Institute of Arthritis and Metabolic Diseases, and National Institute of Neurological Diseases and Stroke, the National Institute of General Medical Sciences, the National Institute of Dental Research, and the National Institute of Child Health and Human Development.

The NASA elements included within the study were NASA Headquarters, Ames Research Center, Electronics Research Center, Langley Research Center, Kennedy Space Center, Manned Spacecraft Center, and the Marshall Space Flight Center. Five field installations were not included because two were too small and isolated for effective conduct of the study, two were not interested in participating, and one was a contractor-operated center outside of the civil service personnel system.

In developing the sampling strategy, four considerations were considered paramount. First, the sample should be drawn to permit analysis on the basis of differences between the two principal organizations—NIH and NASA.

Second, since literature on the sociology of science and engineering consistently ascribes noticeably different motivations and interests to scientists and engineers, these two categories of respondents should be kept separate.

Third, since the focus of the study was upon the transition process, heaviest emphasis in sampling should be given to those in their first or second hierarchical positions in the transistion from specialist to manager. However, within this general group two rather different types of "management" were identified: (1) the manager who directly supervises other professionals (scientists or engineers) in research, development, or similar activities; and (2) the manager who does not directly supervise other professionals in the performance of research or related tasks, but who has program responsibility for a contract or grant program, or the like. These two categories of "managers" were kept separate and were designated respectively "supervisors" and "managers".

Finally, it was recognized that those who had completed the transition process and those who had not yet entered it (in the formal sense of having taken a management position) could offer differing perspectives, contributing to a fuller understanding of the process. Therefore, we decided to include (1) a smaller sample of scientists and engineers still working as specialists—and designated "bench" scientists or engineers—and (2) a group of third- and fourth-level or above (hierarchically) managers, to describe how they viewed the transition in retrospect. This latter group were termed "senior managers".

The numbers of respondents in all these categories are given in table 1.

In addition, the immediate superiors of a sub-sample of 40 percent of the "supervisors" and the "managers" was taken both as (1) a check against the information provided by the primary respondents in these two categories and as (2) a further set of perspectives on the transition process. The number of subordinates in the various agency groups in this sub-sample—and hence the number of their immediate-superior respondents—are given in table 2.

A total of 610 interviews was obtained—201 in NIH and 409 in NASA. Table 3 gives the number of NASA respondents in the *principal* sample groups by NASA locations.

Once the categories had been determined, it was necessary to develop the population lists from which the samples would be drawn in each agency, and to define those categories in terms applicable to each of the two agencies.

The NIH population (978 scientists) was developed by obtaining from the NIH central personnel office a listing of all employees classified as "scientist". NIH bench scientists were defined as all of those in the participating organizations at grades GS-13 and GS-14 or equivalent who were in direct research, clinical research, or collaborative activities. Discussions with NIH officials had demonstrated that there were few bench scientists below grade GS-13.

First- and second-level supervisors in NIH were defined as those scientists who were section, branch or laboratory chiefs in direct research, clinical research or collaborative research activities. Although laboratory chiefs hierarchically constitute the third level of supervision, we decided to include them because (1) NIH laboratory chiefs appear to be more

TABLE 1.—Number of respondents by agency group and current function

Current function of respondent	Number of respondents			
	NIH scientists	NASA engineers	NASA scientists	Total
Bench	30	31	35	96
Supervisor	51	49	49	149
Manager	50	51	50	151
Senior manager	30	30	33	93
Total	161	161	167	489

TABLE 2.—Number of subordinates in sub-sample (whose superiors were also interviewed), by subordinate's agency group and current function

Current function of respondent subordinate	NIH scientists	NASA engineers	NASA scientists	Total
Supervisor	20	20	22	62
Manager	20	18	21	59
Total	40	38	43	121

directly involved in research details than is the case generally in NASA, and (2) we could not mechanically exclude all of them from the population lists (given the programming circumstances and available assistance). This resulted in the NIH supervisor category having 28 percent third-level supervisors (lab chiefs)—a heavier proportion of senior supervisory scientists than was included among either NIH or NASA managers or NASA supervisors.

First- and second-level managers at NIH were defined as those scientists who were in grades GS-13 through GS-15 or equivalent and were not engaged in direct, clinical or collaborative research except for the artificial heart, artificial kidney, perinatal, and tissue transplant programs. This category was limited primarily to grant and contract program managers, heads of study sections, and assistant or deputy division chiefs. Senior managers were defined as (1) those scientists at grade GS-16 (or equivalent) and above, who were *not* branch or laboratory chiefs; and (2) Public Health Service commissioned officers who held positions at the Institute or Division Program Director level or above.

The development of the population lists for NASA proved somewhat simpler since the Personnel Management Information System (PMIS) was capable of indicating whether an individual was in a supervisory or non-supervisory position. Discussions with NASA personnel officers and field center officials revealed that NASA bench scientists or engineers rarely held grades above GS-13. With this as the division point, the bench population was defined as NASA scientists and engineers in the non-supervisory category at GS-13 or below.

Supervisors were GS-14 and GS-15 (first and second levels) in the supervisory category. Managers were defined as non-supervisory NASA scientists and engineers at grades GS-14 and GS-15. The manager category was refined at each field center by knowledgeable people who reviewed the lists, excluding individuals who performed essentially technical rather than managerial functions. Senior managers were defined as all NASA scientists and engineers at the grade GS-16 or equivalent and above.

An expanded random sample of approximately 15 percent more than the target number of respondents in each category was drawn by the subcontractor, National Analysts, Incorporated, using the population lists described above. Sampling was by category across the two agencies and not by location or major component organization.

The sample of immediate superiors was actually developed from lists of superiors of those respondents drawn in the main sample.

TABLE 3.—Number of NASA respondents by location and sample group (excluding immediate-superior sub-sample)

NASA location	Number of NASA respondents										Total
	Engineers					Scientists					
	Bench	Spvr.	Mgr.	Senior mgr.	Sub-total	Bench	Spvr.	Mgr.	Senior mgr.	Sub-total	
Headquarters (Washington, D. C.)	–	4	21	7	32	–	2	26	7	35	67
Ames Research Center	5	4	1	3	13	[illegible]	5	1	4	15	28
Electronic Research Center*	–	1	1	–	2	3	3	1	2	9	11
Kennedy Space Center	4	6	16	2	28	1	5	10	2	18	46
Langley Research Center	10	9	2	9	30	7	5	–	2	14	44
Manned Spacecraft Center	7	9	5	3	24	9	14	10	7	40	64
Marshall Space Flight Center	5	16	5	6	32	10	15	2	9	36	68
Totals	31	49	51	30	161	35	49	50	33	167	328

*Transferred from NASA to the Department of Transportation, July 1, 1970.

Conduct of the Interviewing

One week to ten days before interviews were to commence at any given location. interviewers received a full-day's training conducted jointly by the project directors and National Analysts' field supervisor. The training consisted of discussing the objectives of the study, the questionnaire, and the general environment of the agency involved. Each major category of questions in the questionnaire was demonstrated, and expected problem areas were discussed. Each interviewer then conducted a full-scale interview with a test subject from the agency, following which the interviewers convened for a debriefing and discussion of the interview.

A letter jointly signed by the executive director of the National Academy of Public Administration and a senior agency official was sent to each respondent. before an interviewer contacted that respondent for an appointment. The letter described the study and its purpose, and solicited the respondent's cooperation.

The interviews ranged in duration from an hour and a half to two and a half hours. The bulk of the interviews was conducted in September, October and November 1969.

V. DESCRIPTION OF THE SAMPLES

About 90 percent of the respondents at NIH were in fields that represented the life sciences; approximately 10 percent were in the physical sciences. As would be expected, 95 percent of the sample of NASA engineers had a background in engineering, with the remainder in the physical sciences. Among the respondents in the sample of NASA scientists, about one-half had backgrounds in the physical sciences and approximately 40 percent were in engineering, with a few in the life sciences.

Education

In the NIH sample, nearly all of the respondents had doctoral degrees—either an academic degree, the Ph. D., or a medical-practice degree such as M.D. or D.D.S. For the "bench" and manager samples at NIH, Ph. D.'s greatly outnumbered M.D.'s and other medical-practice degrees. For the supervisory and senior manager levels, however, medical-practice degrees outnumbered Ph. D.'s.

In the NASA-engineers sample, approximately 70 percent had only the B.A. or B.S. degree, with most of the remainder having either an M.A. or an M.S. and a few holding the Ph. D. Among NASA scientists, about 60 percent had only the B.A. or B.S.; the rest had the M.A., M.S. or Ph. D.

Publications

Professional activity as reflected by the production of professional papers or publications was much greater at NIH than at NASA. Within NASA, papers or publications were somewhat more frequently reported by the scientists than by the engineers (table 4).

Experience

In each of the samples at NIH and NASA, the respondents had acquired most of their professional or managerial experience while working for government agencies. This is seen in the medians for job tenure in various situations (tables 5 through 7).

TABLE 4.—Number of professional papers or publications authored or co-authored

Group	Median number of publications		
	NIH scientists	NASA engineers	NASA scientists
Bench	12	2	3
(number of persons in sample)	(30)	(31)	(35)
Supervisors	60	2	7
(number of persons in sample)	(51)	(49)	(49)
Managers	11	0	4
(number of persons in sample)	(50)	(51)	(50)
Senior managers	28	6	10
(number of persons in sample)	(30)	(30)	(33)

TABLE 5.–Length of experience, by type (NIH)

Type of experience	Length of experience (median months)			
	Bench scientists	Supervisors	Managers	Senior managers
Teaching or research in college or university	6	12	46	60
Working in scientific or professional field in business, industry, or non-profit organization	0	0	0	0
Working in scientific or professional field in government	73	156	84	48
Primarily managerial position in business, industry, or non-profit organizations	0	0	0	0
Primarily managerial positions in government	0	48	71	84
(number of persons in sample)	(30)	(51)	(50)	(30)

TABLE 6.–Length of experience, by type (NASA scientists)

Type of experience	Length of experience (median months)			
	Bench scientists	Supervisors	Managers	Senior managers
Teaching or research in college or university	0	0	0	20
Working in scientific or professional field in business, industry, or non-profit organization	0	18	45	30
Working in scientific or professional field in government	90	71	71	72
Primarily managerial position in business, industry, or non-profit organizations	0	0	0	12
Primarily managerial positions in government	0	57	81	96
(number of persons in sample)	(35)	(49)	(50)	(33)

Generally, in the NIH sample, respondents had spent most of their time working in their respective scientific or professional fields in government. An exception to this was found among NIH senior managers—in their case, they had spent most of their time primarily in *managerial* positions in government. When there had been experience outside of government, it usually had been in teaching or research at a college or university—i.e., academic work. This was particularly true for managers and senior managers, in NIH. In terms of median reported tenure, generally less than half of the NIH samples had done scientific, professional or managerial work in business, industry or non-profit organizations—i.e., in the private sector.

In NASA, also, experience fell rather heavily in governmental activity, much of the time having been spent in scientific or professional fields. There had been considerable experience, however, working in managerial positions in government. As was true at NIH, senior managers reported more experience in management than in scientific or professional activities. In contrast to the proportions at NIH, generally less than half of the NASA personnel had done academic work. The NASA respondents, however, were more likely than the NIH respondents to have had extended experience in their scientific or professional fields in the private sector. Very few of the NASA personnel had occupied managerial positions in the private sector.

Number of Subordinates

Each respondent was asked to state the largest number of employees which he had "ever had direct

TABLE 7.–Length of experience, by type (NASA engineers)

Type of experience	Length of experience (median months)			
	Bench scientists	Supervisors	Managers	Senior managers
Teaching or research in college or university	0	0	0	0
Working in scientific or professional field in business, industry, or non-profit organization	9	28	35	0
Working in scientific or professional field in government	95	60	53	84
Primarily managerial position in business, industry, or non-profit organizations	0	0	0	0
Primarily managerial positions in government	0	48	72	120
(number of persons in sample)	(31)	(49)	(51)	(30)

responsibility for supervising." Senior managers at both NIH and NASA reported the highest numbers of subordinates. The median reported by NASA senior managers was 105; for NIH senior managers, 172. In each agency, managers reported direct responsibility for supervising fewer employees (median about 10) than supervisors reported (median approximately 18). "Bench" respondents had supervised a median of about two employees (table 8).

Civil Service Grade Levels

For supervisors and managers at NIH and NASA, the grade levels of the respondents' first administrative positions tended to be GS-13 or GS-14. For senior managers, the first administrative position tended to be GS-15. (The respondents in all samples averaged 30 to 34 years of age when they entered their first managerial positions.)

Current levels (at the time of the interviews) for supervisors and managers, at NIH and NASA, tended to be grades GS-14 and GS-15. For senior managers, the current grade level tended to be grade GS-16. At NIH, "bench" respondents tended to be in grades GS-13 or GS-14; at NASA they tended to be in grade GS-13, with quite a few in grade GS-12.

When the interviews were conducted, the respondents held a variety of positions–including laboratory chief, section chief, branch chief, program manager, grant administrator (NIH), staff specialist, and bureau director (senior managers).

Tenure in Current Agency

In terms of median months reported, the respondents had worked in their respective agencies for periods ranging from 60 months, for NIH "bench" respondents, through 144 months for senior managers among NASA engineers, to 168 months for NIH supervisors (table 9).

TABLE 8.–Largest number of employees ever directly supervised

Group	Median number of people supervised		
	NIH scientists	NASA engineers	NASA scientists
Bench	2	2	2
(number of persons in sample)	(30)	(31)	(35)
Supervisors	22	16	18
(number of persons in sample)	(51)	(49)	(49)
Managers	10	12	10
(number of persons in sample)	(50)	(51)	(50)
Senior managers	172	150	105
(number of persons in sample)	(30)	(30)	(33)

TABLE 9.–Tenure in respective agencies

Group	Tenure in agency (median months)		
	NIH scientists	NASA engineers	NASA scientists
Bench	60	76	81
(number of persons in sample)	(30)	(31)	(35)
Supervisors	168	89	90
(number of persons in sample)	(51)	(49)	(49)
Managers	82	84	85
(number of persons in sample)	(50)	(51)	(50)
Senior managers	84	144	103
(number of persons in sample)	(30)	(30)	(33)

Reversal of Transition

Only about 25 percent of the management respondents at NIH or NASA said that they had occupied a non-managerial, solely scientific or professional position after their first administrative position. When this had happened, it was associated usually with a change of job or employer, or a move into a new or different field.

Fraction of Time Spent Managing

Most of the scientists and engineers in the sample, working as managers, said they did not spend all of their time in management or supervision. Most, however, did say that they spent at least 50 percent of their time in management or supervision. Apparently, most of these respondents still are able to and do spend some of their time in the technical details of their professional specialties.

Extracurricular Leadership Activities

The average respondent at NIH and NASA has not been very active in holding office in organizations outside of his work. In general, the median number of offices reported held for activities outside of work, across the various groups of respondents, was between zero and one. For the great majority of these respondents, managerial experience has been confined to their governmental work.

Correlations

The sizes of the samples, by agency and by level of position, were too small to permit analysis of the data by the characteristics discussed in this chapter.

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VI. MANAGEMENT FUNCTIONS

Management functions are those tasks—including budgeting, reporting, policy-making and program assessment—which are performed in the administrative *role*. This role can be assumed when one is working as a scientist or engineer. The scientist or engineer, in addition to performing the tasks which are specific to his specialty, can still be called upon to do budgeting, reporting, policy-making and program assessment.

Thus the transition from being a scientist or engineer can involve not only *doing* or *not doing* a given function, *per se*, but changes of the following six kinds:

1. changes in the *frequency* with which one performs given management functions
2. changes in *enjoyment or dislike* of the management functions (Certain management tasks might have been disliked when the respondent did them as a scientist or an engineer, but became enjoyable when he did them as a manager—and vice versa.)
3. changes in *difficulty* of performance (A particular management function might become more—or less—difficult to perform when one does it as a manager than when one did it as a scientist or engineer.)
4. changes in *time consumption* (Management functions can be perceived as taking more—or less—time when one performs them as a manager than when one did them as a scientist or engineer.)
5. changes in *importance* (Given management functions can be perceived as being more—or less—important when one performs them as a manager than when one did them as a scientist or engineer.)
6. qualitative changes in *character* (The nature of given management functions can change when one performs them as a manager, relative to their nature when one performed them as a scientist or engineer.)

The various management functions were studied to determine how transition from scientist or engineer to manager was reflected in changes of the above six kinds.

Frequency of Performance

In terms of management functions, managerial work brings into play a more comprehensive set of operations than science or engineering work. This is demonstrated in the respondents' reports of doing the respective management functions "frequently":

Functions generally said to be performed frequently

As a scientist or engineer	*As a manager*
Reporting	Reporting
	Supervising
Planning	Planning
	Representing the organization
	Program assessment
"Fire-fighting"	"Fire-fighting"

There were two principal exceptions to this pattern. At least half of the NIH respondents said that they did supervising frequently when working as scientists, but not "fire-fighting". Among NASA scientists, the majority did not say that they did reporting or planning frequently when working as scientists. NASA engineers, when considering their work as engineers, reflected the general pattern cited above (tables 10 through 12).

TABLE 10.–Percentages of NIH scientist-managers frequently engaged in various management functions

Management function	Percentage reporting frequent performance of each function					
	Supervisors		Managers		Senior managers	
	as a scientist (N=49*)	as a manager (N=51*)	as a scientist (N=49*)	as a manager (N=50*)	as a scientist (N=30*)	as a manager (N=30*)
Budgeting	6%	28%†	24%	30%	27%	74%†
Reporting	76	82	61	74	67	87†
Staffing	35	61†	25	24	40	69†
Supervising	67	86	78	70	63	93†
Planning	80	86	79	80	67	97†
Policy-making	18	49†	18	26	30	83†
Representing the organization	43	71†	43	62	50	80†
Consulting	29	61†	39	54	50	43
Program assessment	22	58†	37	60†	33	90†
"Fire-fighting"	39	69†	37	48	53	90†

TABLE 11.–Percentages of NASA scientist-managers frequently engaged in various management functions

Management function	Percentage reporting frequent performance of each function					
	Supervisors		Managers		Senior managers	
	as a scientist (N=49*)	as a manager (N=49*)	as a scientist (N=50*)	as a manager (N=50*)	as a scientist (N=33*)	as a manager (N=32*)
Budgeting	15%	53%†	14%	54%†	12%	72%†
Reporting	81	86	70	88	61	97†
Staffing	2	23†	12	12	15	47†
Supervising	38	98†	34	54†	43	81†
Planning	51	88†	42	88†	67	84
Policy-making	4	29†	8	35†	6	63†
Representing the organization	41	57	28	68†	19	84†
Consulting	55	49	28	44	24	53†
Program assessment	32	51	18	64†	18	66†
"Fire-fighting"	64	65	60	70	61	78

*N=number of individuals in sample NOTE: Percentages add to more than 100 because of multiple answers.

†This entry is significantly different from the adjacent entry in the column immediately to the *left*. Level of significance chosen as P=0.05 or less.

Each of the management functions was reported as done frequently, when the respondent was working as a scientist or engineer, by *some* proportion of the respondents—with one exception. The exception occurred among NASA engineers now working as managers: none of them reported having done policy-making frequently when they worked as engineers.

Certain of the management functions were said not to have been done at all, when the respondent was working as a scientist or engineer, by rather substantial proportions (generally over 30 percent) of the respondents. In NIH, these functions were budgeting and policy-making. In NASA, the range of functions not done at all, as a scientist or engineer, was greater than at NIH: generally over 30 percent said they had never done budgeting, staffing, policy-making or program assessment.

Respondents were asked to identify the management functions which they performed frequently, when working as managers and when working as specialists. Consistently higher percentages were reported for managerial positions, for six tasks:

Budgeting
Staffing
Supervising
Policy-making
Representing the organization
Program assessment

Definite increase in doing frequent planning was found at NASA (scientists and engineers). By contrast, increase in doing frequent "fire-fighting" occurred at NIH but not at NASA ("fire-fighting" as a scientist or engineer was reported by relatively high proportions at NASA). Increase in doing frequent reporting was declared by NIH senior managers and NASA scientist-senior managers. Increase in doing frequent consulting was reported for NIH supervisors, NASA scientist-senior managers and NASA engineer-supervisors.

TABLE 12.—Percentages of NASA engineer-managers frequently engaged in various management functions

Management function	Percentage reporting frequent performance of each function					
	Supervisors		Managers		Senior managers	
	as an engineer (N=49*)	as a manager (N=49*)	as an engineer (N=50*)	as a manager (N=51*)	as an engineer (N=30*)	as a manager (N=30*)
Budgeting	16%	31%	8%	47%†	13%	74%
Reporting	82	80	82	82	70	80
Staffing	8	22	4	10	7	33†
Supervising	29	92†	32	59†	43	77†
Planning	50	88†	50	80†	60	87†
Policy-making	6	25	–	26†	10	50†
Representing the organization	27	59†	22	65†	40	70†
Consulting	43	63†	34	4?	[illegible]	47
Program assessment	18	59†	10	59†	27	87†
"Fire-fighting"	53	53	70	78	63	60

*N=number of individuals in sample

†This entry is significantly different from the adjacent entry in the column immediately to the *left*. Level of significance chosen as P=0.05 or less.

NOTE: Percentages add to more than 100 because of multiple answers.

Enjoyment

There was a pattern of particularly enjoyable management functions, so reported by relatively high proportions of all respondents. This pattern was found when discussing science or engineering work and when discussing management work (tables 13 through 15).

Functions most often said to be particularly enjoyable

- Planning
- Reporting
- Supervising
- Representing the organization
- Consulting
- Program assessment

Another general pattern was that relatively few of the respondents selected budgeting and staffing as enjoyable management functions.

At NIH, relatively few respondents said they particularly enjoyed "fire-fighting" when working as scientists. Somewhat higher proportions among NASA scientists and engineers reported particular enjoyment of "fire-fighting" in their work as specialists.

The pattern of management functions cited as particularly enjoyable in specialist work was generally similar to the pattern of enjoyable functions in management work.

For some functions there were exceptions—that is, shifts in the number of respondents reporting particu-

TABLE 13.—Percentages of NIH scientist-managers particularly enjoying various management functions

Management function	Percentage reporting particular enjoyment of each function					
	Supervisors		Managers		Senior managers	
	as a scientist (N=51*)	as a manager (N=51*)	as a scientist (N=50*)	as a manager (N=50*)	as a scientist (N=30*)	as a manager (N=30*)
Budgeting	–	2%	4%	6%	3%	13%
Reporting	35%	24	34	20	23	7
Staffing	8	10	10	6	7	10
Supervising	31	28	28	20	23	23
Planning	49	57	66	50	63	73
Policy-making	12	14	12	16	27	57†
Representing the organization	24	20	28	28	23	10
Consulting	33	33	28	34	43	3†
Program assessment	10	22	26	36	30	33
"Fire-fighting"	6	12	2	8	20	10
Like all of these	–	–	4	6	–	3
Like none of these	4	4	2	2	7	3

*N=number of individuals in sample

†This entry is significantly different from the adjacent entry in the column immediately to the *left*. Level of significance chosen as P=0.05 or less.

NOTE: Percentages add to more than 100 because of multiple answers.

·lar enjoyability, correlated with the transition from specialist to manager. These were as follows: (1) for consulting, a decrease among NIH senior managers. NASA scientist-supervisors and -managers, and NASA engineer-supervisors; (2) for supervising, an increase among NASA supervisors (scientists and engineers): (3) for "fire-fighting", a decrease among NASA scientists and engineers, at all levels. This last probably reflects the change in the substance of the function from technical to managerial.

TABLE 14.–Percentages of NASA scientist-managers particularly enjoying various management functions

Management function	Percentage reporting particular enjoyment of each function					
	Supervisors		Managers		Senior managers	
	as a scientist (N=49*)	as a manager (N=49*)	as a scientist (N=50*)	as a manager (N=50*)	as a scientist (N=33*)	as a manager (N=33*)
Budgeting	2%	4%	8%	10%	–	-
Reporting	18	8	20	10	27%	15%
Staffing	4	2	6	–	3	9
Supervising	26	53†	42	36	36	46
Planning	43	51	44	52	30	54†
Policy-making	4	14	16	22	6	18
Representing the organization	31	31	30	26	24	30
Consulting	49	29†	40	24	36	27
Program assessment	24	24	20	34	9	27
"Fire-fighting"	29	18	30	18	24	6
Like all of these	–	2	–	6	3	–
Like none of these	6	8	8	2	12	–

*N=number of individuals in sample

†This entry is significantly different from the adjacent entry in the column immediately to the *left*. Level of significance chosen as P=0.05 or less.

NOTE: Percentages add to more than 100 because of multiple answers.

Dislike

When asked which of the management functions were particularly disliked, from 30 percent (NASA engineer-senior managers) to 67 percent (NIH senior managers) of the respective groups of respondents replied that *none* were particularly disliked (tables 16 through 18).

The one management function most consistently *disliked* was budgeting. A higher proportion of NASA engineers than of either other group reported particular dislike of this function. Reporting and "fire-fighting" followed budgeting in unpopularity. Only small proportions of the respondents said they particularly disliked any of the other management functions.

In comparing the selections made for management functions particularly liked and disliked, we found that budgeting was much more frequently cited as disliked. Seven functions–reporting, supervising, planning, policy-making, representing the organization, consulting and program assessment–were more often said to be liked than disliked. Staffing tended to receive about the same proportions of both judgments. In NIH, "fire-fighting" tended to be more disliked than liked, but in NASA this tendency was reversed.

TABLE 15.–Percentages of NASA engineer-managers particularly enjoying various management functions

Management function	Percentage reporting particular enjoyment of each function: Supervisors		Managers		Senior managers	
	as an engineer (N=49*)	as a manager (N=49*)	as an engineer (N=51*)	as a manager (N=51*)	as an engineer (N=30*)	as a manager (N=30*)
Budgeting	6%	–	2%	6%	–	3%
Reporting	24	26%	22	18	30%	17
Staffing	6	4	8	2	13	17
Supervising	20	51†	28	28	40	40
Planning	47	53	53	59	33	53
Policy-making	8	18	4	16	10	17
Representing the organization	26	26	35	31	23	20
Consulting	53	33†	35	33	33	20
Program assessment	18	24	12	43†	13	23
"Fire-fighting"	26	20	39	18†	37	17
Like all of these	–	–	–	–	3	3
Like none of these	6	2	4	–	–	10

*N=number of individuals in sample

†This entry is significantly different from the adjacent entry in the column immediately to the *left*. Level of significance chosen as P=0.05 or less.

NOTE: Percentages add to more than 100 because of multiple answers.

TABLE 16.–Percentages of NIH scientist-managers particularly disliking various management functions

Management function	Percentage reporting particular dislike of each function					
	Supervisors		Managers		Senior managers	
	as a scientist (N=51*)	as a manager (N=51*)	as a scientist (N=50*)	as a manager (N=50*)	as a scientist (N=30*)	as a manager (N=30*)
Budgeting	29%	26%	24%	14%	10%	13%
Reporting	20	6	12	12	17	7
Staffing	8	14	4	8	–	3
Supervising	4	4	8	6	–	–
Planning	–	–	–	–	–	–
Policy-making	2	6	2	2	–	–
Representing the organization	4	4	–	–	–	3
Consulting	–	–	–	–	–	–
Program assessment	2	4	–	4	3	–
"Fire-fighting"	20	18	14	20	17	10
Dislike none of these	39	45	48	44	57	67

*N=number of individuals in sample

NOTE: Percentages add to more than 100 because of multiple answers.

TABLE 17.–Percentages of NASA scientist-managers particularly disliking various management functions

Management function	Percentage reporting particular dislike of each function					
	Supervisors		Managers		Senior managers	
	as a scientist (N=49*)	as a manager (N=49*)	as a scientist (N=50*)	as a manager (N=50*)	as a scientist (N=33*)	as a manager (N=33*)
Budgeting	37%	29%	16%	22%	27%	33%
Reporting	18	12	20	8	12	15
Staffing	6	10	10	6	6	9
Supervising	2	4	2	2	3	–
Planning	–	2	4	8	–	6
Policy-making	4	–	2	4	3	–
Representing the organization	4	2	4	–	3	–
Consulting	2	2	2	–	–	–
Program assessment	–	–	–	6	1	3
"Fire-fighting"	10	18	8	16	9	15
Dislike none of these	31	37	48	44	48	39

*N=number of individuals in sample

NOTE: Percentages add to more than 100 because of multiple answers.

TABLE 18.–Percentages of NASA engineer-managers particularly disliking various management functions

Management function	Supervisors as an engineer (N=49*)	Supervisors as a manager (N=49*)	Managers as an engineer (N=51*)	Managers as a manager (N=51*)	Senior managers as an engineer (N=30*)	Senior managers as a manager (N=33*)
	Percentage reporting particular dislike of each function					
Budgeting	41%	41%	22%	29%	43%	40%
Reporting	8	6	22	14	17	20
Staffing	–	4	10	12	13	7
Supervising	4	6	–	2	–	–
Planning	–	6	4	2	3	7
Policy-making	–	–	8	6	–	–
Representing the organization	6	–	4	–	–	–
Consulting	–	2	6	2	–	–
Program assessment	–	2	2	–	7	–
"Fire-fighting"	10	12	8	8	13	13
Dislike none of these	39	39	37	45	40	30

*N=number of individuals in sample

NOTE: Percentages add to more than 100 because of multiple answers.

Difficulty

Most of the respondents said that they had not found any of the management functions particularly difficult to perform, either when working as a scientist or engineer or when working as a manager. The specific management functions most frequently cited (but by relatively small proportions) as particularly difficult were budgeting, reporting, and staffing (tables 19 through 21).

Senior managers at NASA in relatively high proportions (30 percent) said that budgeting was particularly difficult to perform in their work as managers. This was probably a reflection of the scope of the budgeting activity involved at the senior levels of NASA.

TABLE 19.–Percentages of NIH scientist-managers considering various management functions to be particularly difficult

Management function	Percentage reporting particular difficulty in each function					
	Supervisors		Managers		Senior managers	
	as a scientist (N=51*)	as a manager (N=51*)	as a scientist (N=50*)	as a manager (N=50*)	as a scientist (N=30*)	as a manager (N=30*)
Budgeting	6%	7%	18%	18%	20%	23%
Reporting	20	6	8	10	10	3
Staffing	6	26†	6	12	7	17
Supervising	8	8	4	8	7	7
Planning	4	10	6	4	–	–
Policy-making	2	4	4	14	–	–
Representing the organization	2	2	–	2	–	3
Consulting	–	–	–	–	–	–
Program assessment	2	6	8	12	7	10
"Fire-fighting"	2	8	4	2	–	–
None particularly difficult	47	41	52	34	57	40

*N=number of individuals in sample

†This entry is significantly different from the adjacent entry in the column immediately to the *left*. Level of significance chosen as P=0.05 or less.

NOTE: Percentages add to more than 100 because of multiple answers.

TABLE 20.–Percentages of NASA scientist-managers considering various management functions to be particularly difficult

Management function	Percentage reporting particular difficulty in each function					
	Supervisors		Managers		Senior managers	
	as a scientist (N=49*)	as a manager (N=49*)	as a scientist (N=50*)	as a manager (N=50*)	as a scientist (N=33*)	as a manager (N=33*)
Budgeting	10%	12%	10%	8%	6%	30%†
Reporting	14	6	16	10	18	9
Staffing	2	20	6	6	12	9
Supervising	8	12	6	10	3	–
Planning	8	10	6	8	9	6
Policy-making	8	14	8	10	3	9
Representing the organization	–	2	2	4	–	–
Consulting	–	2	–	2	–	–
Program assessment	4	2	6	4	6	3
"Fire-fighting"	6	4	4	4	9	3
None particularly difficult	47	35	46	50	42	36

*N=number of individuals in sample

†This entry is significantly different from the adjacent entry in the column immediately to the *left*. Level of significance chosen as P=0.05 or less.

NOTE: Percentages add to more than 100 because of multiple answers.

TABLE 21.–Percentages of NASA engineer-managers considering various management functions to be particularly difficult

Management function	Percentage reporting particular difficulty in each function					
	Supervisors		Managers		Senior managers	
	as an engineer (N=49*)	as a manager (N=49*)	as an engineer (N=51*)	as a manager (N=51*)	as an engineer (N=30*)	as a manager (N=30*)
Budgeting	14%	24%	8%	4%	30%	30%
Reporting	6	8	10	14	10	7
Staffing	2	10	2	10	10	3
Supervising	10	14	6	14	3	7
Planning	10	4	10	6	3	17
Policy-making	8	2	8	14	10	10
Representing the organization	6	2	4	–	3	3
Consulting	–	2	4	4	–	–
Program assessment	–	2	6	6	10	7
"Fire-fighting"	4	–	8	10	3	3
None particularly difficult	47	49	41	35	40	30

*N=number of individuals in sample

NOTE: Percentages add to more than 100 because of multiple answers.

Time Consumption

Reporting was consistently said to be the most time-consuming management function. Supervising, planning, and "fire-fighting" were also selected frequently as being time-consuming.

In general, there were no striking differences in the proportions saying that given functions were time-consuming for persons working as scientists or engineers and those saying this for persons working as managers (tables 22 through 24).

TABLE 22.–Percentages of NIH scientist-managers considering various management functions particularly time-consuming

Management function	Percentage reporting each function particularly time-consuming					
	Supervisors		Managers		Senior managers	
	as a scientist (N=48*)	as a manager (N=49*)	as a scientist (N=48*)	as a manager (N=50*)	as a scientist (N=30*)	as a manager (N=30*)
Budgeting	6%	8%	12%	8%	17%	17%
Reporting	29	31	44	30	23	20
Staffing	6	6	6	2	–	13
Supervising	19	31	19	18	33	23
Planning	21	20	17	12	17	13
Policy-making	4	–	4	–	3	7
Representing the organization	2	8	–	4	10	13
Consulting	6	4	2	18	10	7
Program assessment	6	14	12	10	7	13
"Fire-fighting"	10	16	6	24	13	37
None particularly time-consuming	25	12	17	16	20	7

*N=number of individuals in sample

NOTE: Percentages add to more than 100 because of multiple answers.

TABLE 23.–Percentages of NASA scientist-managers considering various management functions to be particularly time-consuming

Management function	Percentage reporting each function particularly time-consuming					
	Supervisors		Managers		Senior managers	
	as a scientist (N=48*)	as a manager (N=48*)	as a scientist (N=50*)	as a manager (N=49*)	as a scientist (N=33*)	as a manager (N=32*)
Budgeting	10%	19%	10%	16%	6%	19%
Reporting	46	40	44	39	30	34
Staffing	–	2	2	2	–	6
Supervising	10	25	12	12	9	19
Planning	10	15	20	29	6	16
Policy-making	–	8	4	4	3	3
Representing the organization	8	8	6	2	–	3
Consulting	2	6	6	4	6	3
Program assessment	4	15	10	12	3	16
"Fire-fighting"	19	23	18	16	18	16
None particularly time-consuming	19	19	22	26	36	22

*N=number of individuals in sample

NOTE: Percentages add to more than 100 because of multiple answers.

TABLE 24.–Percentages of NASA engineer-managers considering various management functions to be particularly time-consuming

Management function	Percentage reporting each function particularly time-consuming					
	Supervisors		Managers		Senior managers	
	as an engineer (N=49*)	as a manager (N=49*)	as an engineer (N=51*)	as a manager (N=51*)	as an engineer (N=29*)	as a manager (N=30*)
Budgeting	16%	8%	22%	16%	14%	30%
Reporting	43	47	43	45	34	27
Staffing	4	–	4	–	3	3
Supervising	8	26	10	12	7	33†
Planning	10	16	24	20	24	23
Policy-making	2	–	2	8	–	–
Representing the organization	6	4	6	12	3	–
Consulting	6	2	2	6	14	–
Program assessment	–	10	16	20	21	21
"Fire-fighting"	22	16	18	26	17	10
None particularly time-consuming	22	16	14	6	14	10

*N=number of individuals in sample

†This entry is significantly different from the adjacent entry in the column immediately to the *left.* Level of significance chosen as P=0.05 or less.

NOTE: Percentages add to more than 100 because of multiple answers.

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Importance

Planning was the management function most consistently selected as being particularly important. This was true in reference to both work as a scientist or engineer and work as a manager. Reporting and supervising were chosen fairly often as being particularly important management functions (tables 25 through 27).

There were some instances of a sharp change in perception of a management function's importance, at transition. Many more NIH supervisors and senior managers among NASA engineers regarded staffing as particularly important to a person working as a manager than so regarded it to a person working as a scientist or engineer. Thirty percent of NASA engineer-senior managers said that budgeting was particularly important in one's work as a manager, whereas only three percent of them said that budgeting was particularly important in one's work as a scientist or engineer. NASA engineers (supervisors and senior managers) and NASA scientist-supervisors more often judged that supervising was particularly important for managers than so judged it for specialists.

TABLE 25.–Percentages of NIH scientist-managers considering various management functions to be particularly important

Management function	Percentage reporting each function particularly time-consuming					
	Supervisors		Managers		Senior managers	
	as a scientist (N=51*)	as a manager (N=51*)	as a scientist (N=50*)	as a manager (N=50*)	as a scientist (N=30*)	as a manager (N=30*)
Budgeting	–	10%	4%	8%	7%	20%
Reporting	37%	20	28	26	17	7
Staffing	12	35†	8	14	13	20
Supervising	33	41	26	36	40	33
Planning	55	49	66	44†	63	60
Policy-making	2	14	2	16	13	50†
Representing the organization	4	4	6	6	10	10
Consulting	8	4	22	10	13	3
Program assessment	18	20	20	32	23	33
"Fire-fighting"	–	14	2	8	7	7
All particularly important	–	–	4	6	–	7
None particularly important	6	2	2	2	7	–

*N=number of individuals in sample

†This entry is significantly different from the adjacent entry in the column immediately to the *left*. Level of significance chosen as P=0.05 or less.

NOTE: Percentages add to more than 100 because of multiple answers.

TABLE 26.–Percentages of NASA scientist-managers considering various management functions to be particularly important

Management function	Percentage reporting each function particularly important					
	Supervisors		Managers		Senior managers	
	as a scientist (N=49*)	as a manager (N=49*)	as a scientist (N=50*)	as a manager (N=50*)	as a scientist (N=33*)	as a manager (N=33*)
Budgeting	4%	12%	4%	18%	9%	15%
Reporting	35	24	34	28	21	12
Staffing	6	14	2	4	9	24
Supervising	16	59†	16	30	24	30
Planning	37	55	54	54	42	46
Policy-making	8	14	4	12	3	18
Representing the organization	8	12	8	16	3	12
Consulting	22	10	12	4	18	6
Program assessment	12	18	16	28	12	12
"Fire-fighting"	10	8	20	6	18	12
All particularly important	2	6	4	6	3	6
None particularly important	10	4	6	–	9	–

*N=number of individuals in sample

†This entry is significantly different from the adjacent entry in the column immediately to the *left.* Level of significance chosen as P=0.05 or less.

NOTE: Percentages add to more than 100 because of multiple answers.

TABLE 27.–Percentages of NASA engineer-managers considering various management functions to be particularly important

Management function	Percentage reporting each function particularly important					
	Supervisors		Managers		Senior managers	
	as an engineer (N=49*)	as a manager (N=49*)	as an engineer (N=51*)	as a manager (N=51*)	as an engineer (N=30*)	as a manager (N=30*)
Budgeting	12%	4%	8%	16%	3%	30%†
Reporting	43	33	39	31	37	27
Staffing	–	16	2	10	3	30†
Supervising	14	69†	22	39	20	47†
Planning	45	59	53	61	47	50
Policy-making	–	8	2	12	–	13
Representing the organization	12	8	10	12	3	7
Consulting	22	22	16	14	27	–†
Program assessment	10	14	14	31	17	37
"Fire-fighting"	25	2†	14	18	23	3
All particularly important	2	4	4	2	9	7
None particularly important	–	–	2	2	3	7

*N=number of individuals in sample

†This entry is significantly different from the adjacent entry in the column immediately to the *left*. Level of significance chosen as P=0.05 or less.

NOTE: Percentages add to more than 100 because of multiple answers.

Reasons for Opinions

The primary reasons given for particularly enjoying given management functions and for thinking them to be particularly important were quite similar. The reasons were also quite similar for groupings of the management functions. The primary reasons given were also similar for work as a specialist and work as a manager.

Management functions	*Primary reasons for particular enjoyment and particular importance*
Budgeting Planning Policy-making Program assessment	Provides opportunity to establish goals and methods of achieving them; gives opportunity to provide resources and facilities; can relate self and one's unit to the organizational effort; can use one's technical skills; gives one control and leadership; these are fundamental, basic operations.
Reporting Representing the organization Consulting	Gives a sense of achievement and contribution; can use your technical skills; relates your work to that of the scientific and organizational community; provides interchange of ideas; can meet a challenge; helps you influence others.
Staffing Supervision	Opportunity to work with people; opportunity to develop an efficient staff; helps others to be more productive; helps achieve organizational goals; can use your technical skills.
"Fire-fighting"	You face a challenge; it is an exciting intellectual exercise; can use your technical skills.

Certain values or concepts run through these primary reasons for particularly enjoying the various management functions and for thinking them to be particularly important: having an opportunity to establish goals and to design methods for achieving them; having opportunities to use one's technical skills; being able to help others to become more productive; interchanging ideas and relating to the scientific and organizational communities.

The primary reasons given for particularly disliking certain management functions and for considering them particularly difficult were similar (both for work as a scientist or engineer and for work as a manager). Again, sets of reasons applied to groupings of the functions:

Management functions	*Primary reasons for particular dislike and particular difficulty*
Budgeting Reporting	No aptitu le for the function; no training for the function; not related to field of specialty; forces action within set limits; a source of anxiety and conflict; tedious, dull, routine and time-consuming; an exercise in futility.
Staffing Supervision	Restrictive; forces action within set limits; interpersonal relations involved; bureaucratic procedures involved; subjective judgments necessary; uncertainty of outcomes.
Planning Policy-making Program assessment	Uncertainty of outcome; lack of information needed; unknown factors are involved; subjective judgments necessary; beyond limits of authority set for my position; requires great effort; an exercise in futility.
Representing the organization	Not related to my technical field; source of anxiety; disruptive of work; waste of time; interpersonal relations involved.
Consulting	Time-consuming; requires great effort; uncertainty of outcome.
"Fire-fighting"	Time-consuming; disruptive; preempts time from more worthwhile activities; necessitates action without benefit of preparation; indicates poor planning or poor program assessment.

Values or concepts running through the reasons for particular dislike of management functions, and for finding them particularly difficult, are: absence of necessary aptitude or training; irrelevance of the functions to one's field of specialization; generation of anxiety by the functions; the need to make subjective judgments; interpersonal relations; disruption of one's regular work; and uncertainty as to outcome.

Qualitative Changes in the Character of Management Functions

The respondents were asked how each management function was different "in nature" when performed by a scientist or engineer in a purely professional context and when performed in an essentially managerial context.

TABLE 28.–Percentages of bench scientists and engineers considering various management functions to be frequently performed: comparison of specialists' experience with their perceptions of managerial work

Management function	Percentage reporting each function frequently performed					
	NIH bench scientists		NASA bench scientist		NASA bench engineers	
	Perform frequently as a scientist (N=30*)	Perceive frequent performance as a manager (N=30*)	Perform frequently as a scientist (N=35*)	Perceive frequent performance as a manager (N=35*)	Perform frequently as a scientist (N=31*)	Perceive frequent performance as a manager (N=31*)
Budgeting	–	61%†	29%	54%†	10%	58%†
Reporting	60%	89†	71	89	77	78
Staffing	10	61†	8	34†	3	42†
Supervising	60	86†	40	80†	23	87†
Planning	84	83	54	80†	65	84
Policy-making	7	64†	9	51†	10	45†
Representing the organization	17	64†	31	63†	16	74†
Consulting	16	47†	52	34	36	48
Program assessment	10	82†	29	63+	29	74†
"Fire-fighting"	55	63	63	46	74	52

*N=number of individuals in sample

†This entry is significantly different from the adjacent entry in the column immediately to the *left*. Level of significance chosen as P=0.05 or less.

NOTE: Percentages add to more than 100 because of multiple answers.

Certain perceptions of qualitative change emerged, regardless of the specific management function being discussed. The scope of the functions is much broader when they are done as a manager. The manager is responsible for broad-based projects and policies. A longer-range perspective is brought to bear on these functions when they are performed as a manager. More information is available to the manager and there is better coordination with the goals of the organization. There are more diversified contacts with personnel, in general. There are more contacts with higher-level personnel in the organization. There is a greater degree of personal involvement in performing these management functions.

A few respondents mentioned negative concepts. In a management position there is a greater demand for subjective judgments. Political expediency is more significant when one performs management functions as a manager. Performance of management functions in a managerial position entails greater degrees of constraint and restriction.

Management Functions
as Viewed by Specialists at the Bench

One set of respondents in each of the three categories (NIH, NASA scientists, and NASA engineers) consisted of individuals working as scientists or engineers at the time the research was being conducted. They were "bench" scientists, at civil service grade levels just below management. They represent the pool of specialists from which administrators may be drawn.

The opinions and evaluations of these bench professionals were studied as to three characteristics of management functions—frequency, difficulty and importance. For each characteristic, these respondents were asked to assess each management function in terms of their current work as scientists or engineers. They were then asked to evaluate each function as they thought it operated for a scientist or engineer with management responsibility, such as a branch or laboratory chief.

Most of the bench scientists and engineers thought that all ten of the management functions would be performed frequently by managers. In contrast, only reporting and planning were consistently cited as done frequently by scientists and engineers. Relatively large proportions saying that a function would be performed frequently as a manager, in comparison to the proportions reporting frequent performance in their work as scientists or engineers, occurred for budgeting, staffing, supervising, policy-making, representing the organization, and program assessment (tables 28 through 30).

Some views as to what happens in management were specific to particular sets of respondents. Substantially more bench scientists at NIH said managers did frequent reporting than said they themselves did it frequently as scientists. A substantially greater proportion of NASA scientists working at the bench said that managers did frequent planning than said that they themselves did that particular function frequently as scientists at the bench. In shifting from consideration of their own work at the bench to speculation about managers, definitely more NIH bench scientists said that consulting was done frequently.

The primary result of the analysis of the data on difficulty of management functions is seen in the pattern of replies that "none is especially difficult." Higher proportions selected this response when the discussion was about managers, than selected it in regard to specialists. This difference was especially sharp for the respondents who were bench scientists in NIH (response proportions respectively were 60 and 17 percent). In other words, there was a sense that management functions were generally more difficult to perform when being done as part of a manager's duties.

An opposite pattern was found when the discussion turned to the importance of management functions. In this case, the proportions saying that none is particularly important were greater when describing managers than when talking about work as a bench scientist or engineer. Less than 10 percent of bench respondents said that none of the functions was particularly important when working at the bench; approximately 40 percent said none was particularly important in the work of a manager. The bench respondents may have been comparing the role of the scientist to that of the manager, rather than the importance of management functions *per se* in the two contexts. This result probably reflects a "jaundiced-eye" view of the managerial role, as held by bench scientists and engineers.

Such a view has been described by Harvey Sherman, past president of the American Society for Public Administration,[19] in these words:

> By and large, the scientist sees the manager as a bureaucrat, paper shuffler, a parasite; an uncreative and unoriginal hack who serves as an obstacle in the way of creative people trying to do a job, and a person more interested in dollars and power than in knowledge and innovation.

There were increases in the proportions saying some management functions were particularly important, when the discussion shifted from work at the bench to work as a manager; there were decreases in this regard for other managerial functions. General increases in proportions occurred for staffing and supervising. Decreases in proportions were found for consulting (NASA), program assessment, "fire-fighting" (NASA engineers), and reporting (NIH).

These data strongly suggest that one of the problems in the transition of scientists and engineers to managers rests in prejudiced opinions and negative attitudes, as to the role of management functions, in the pool of individuals from which the managers will be drawn.

Management Functions
as Seen by Respondents' Superiors

From the supervisor and manager primary sample populations in this project, random sub-samplings of 20 were drawn in each category—NIH and NASA scientists and NASA engineers. The immediate superiors of these particular respondents were then interviewed. These interviews were intended to obtain from the superiors their assessments of their subordinates' jobs—in terms of questions similar to those which the subordinates had answered about themselves.

The judgments of the superiors on the frequency with which their subordinates performed management functions tended to support the responses given by the subordinates. For example, in one set of 20 respondents 15 had said that they did reporting frequently; in speaking of these 15 respondents, 12 of their superiors independently agreed that reporting was done frequently and only three said that reporting was done occasionally. In another instance, 17 of

TABLE 29.—Percentages of bench scientists and engineers considering various management functions to be particularly difficult: comparison of specialists' experience with their perceptions of managerial work

Management function	Percentage reporting each function to be particularly difficult					
	NIH bench scientists		NASA bench scientists		NASA bench engineers	
	Find particularly important as a scientist (N=30*)	Perceive particularly important for a manager (N=30*)	Find particularly important as a scientist (N=35*)	Perceive particularly important for a manager (N=35*)	Find particularly important as a scientist (N=31*)	Perceive particularly important for a manager (N=31*)
Budgeting	7%	30%†	9%	26%	16%	13%
Reporting	10	3	17	11	19	6
Staffing	10	27	3	26†	3	16
Supervising	3	20	11	14	6	10
Planning	3	20	17	11	13	3
Policy-making	3	20	9	11	16	16
Representing the organization	3	3	3	–	10	3
Consulting	–	–	–	3	3	6
Program assessment	7	3	9	11	–	23
"Fire-fighting"	3	20	3	11	–	13
None particularly difficult	60	17†	37	17†	39	19†

*N=number of individuals in sample

†This entry is significantly different from the adjacent entry in the column immediately to the *left*. Level of significance chosen as P=0.05 or less.

NOTE: Percentages add to more than 100 because of multiple answers.

the 20 respondents had said they did supervising frequently; 16 of the superiors agreed that these respondents did supervising frequently. There were few cases where a respondent said he did something frequently and his superior said that he did not do it at all. There were, however, some instances in which the subordinate had said he did not do a particular function but his superior said he did it frequently.

The superiors generally agreed with the statements made by the subordinates as to the management functions the subordinates particularly liked. This is seen in the three functions most often chosen by the respondents as being liked and those selected by the superiors in talking about the subordinates. For example, among the 20 subordinates who were NIH supervisors the three functions most often selected were planning, supervising, and consulting. The three most often chosen by their superiors were also planning, supervising, and consulting. Among the 20 subordinates who were NASA engineer-supervisors, the functions most frequently selected as particularly enjoyable were supervising, consulting, and planning; their superiors also most frequently picked supervising, consulting, and planning. When there was a difference, it generally was a matter of just one item. An example here is the 20 subordinates who were NASA engineer-managers. They most frequently chose *supervising*, planning, and representing the

TABLE 30.–Percentages of bench scientists and engineers considering various management functions to be particularly important: comparison of specialists' experience with their perceptions of managerial work

Management function	Percentage reporting each function to be particularly important					
	NIH bench scientists		NASA bench scientists		NASA bench engineers	
	Consider particularly important as a scientist (N=30*)	Perceive particularly important for a manager (N=30*)	Consider particularly important as a scientist (N=35*)	Perceive particularly important for a manager (N=35*)	Consider particularly important as a scientist (N=31*)	Perceive particularly important for a manager (N=31*)
Budgeting	10%	17%	6%	26%†	–	23%
Reporting	57	27†	37	31	32%	26
Staffing	7	50†	3	31†	–	26†
Supervising	10	47†	17	66†	19	71†
Planning	60	50	46	51	39	55
Policy-making	7	23	9	31†	3	23
Representing the organization	10	13	14	26†	13	13
Consulting	20	3	26	6†	29	6†
Program assessment	17	–	23	–†	16	–
"Fire-fighting"	23	7	14	11	26	6
All particularly important	–	7	–	3	–	3
None particularly important	7	37†	6	46†	–	39†

*N=number of individuals in sample

†This entry is significantly different from the adjacent entry in the column immediately to the *left*. Level of significance chosen as P=0.05 or less.

NOTE: Percentages add to more than 100 because of multiple answers.

organization; their superiors selected *consulting*, planning, and representing the organization.

The agreement between subordinates and their superiors generally was not as close when the discussion had to do with management functions particularly disliked. The main source of the difference is found in the relatively large number of subordinates saying that *none* of the functions was particularly disliked. In no instance did a superior say that his subordinate particularly disliked none of the management functions.

When particular functions were mentioned, both groups most often said that budgeting and "fire-fighting" were especially disliked.

In discussing the management functions which were particularly difficult for the subordinates to perform, the superiors were in agreement with the subordinates in saying, most often, that none of them was particularly difficult. When specific management functions were cited, there tended to be disagreement. The specific functions mentioned most frequently by the 20 NIH supervisors were staffing and planning; the superiors gave "fire-fighting", budgeting and reporting (tied). For NASA scientist-supervisors, the respondents gave staffing and supervising; their superiors cited reporting and program assessment as particularly difficult for the subordinates.

There was a general tendency for the superiors and the subordinates to agree on which of the management functions were particularly time-consuming (to the subordinates). Generally, these were supervising, reporting, and "fire-fighting".

Finally, the superiors and the subordinates tended to be in agreement when discussing the management functions which were particularly important in doing the supervisors' and managers' jobs. In general, planning and supervising were most often selected as particularly important. The reasons given by the superiors for the particular importance of planning were similar to those given by their subordinates:

> It provides an opportunity to design goals and methods for achieving them.
>
> It gives an opportunity to provide resources and facilities.
>
> It can relate the self to the organizational effort.

The reasons given by the superiors and their subordinates for the particular importance of supervising were also similar:

> It helps others become more productive.
>
> It helps achieve the organization's goals.
>
> It gives an opportunity to work with people.
>
> It gives an opportunity to develop an efficient staff.

Chapter Summary

The various management functions or tasks are performed to some extent when one works as either a scientist or engineer. When a scientist or an engineer moves into management, primarily two kinds of changes occur—changes in frequency of performance of the functions, and qualitative changes in their nature.

Of the ten management functions, seven showed rather consistent increases in the proportions of respondents saying that they were performed frequently by managers, in contrast to the proportions saying they were performed frequently by scientists or engineers. These seven functions were: budgeting, staffing, supervision, policy-making, planning, program assessment, and representing the organization. Such consistent changes were not found for reporting, consulting, and "fire-fighting". As should be expected, then, management involves a much more comprehensive use of most management functions than work as a scientist or an engineer.

The kind of change which was consistently demonstrated, accompanying the move from science or engineering into management, was in the qualitative character of the management functions. Performing the management functions as a manager involves increased scope of operation—one's concerns are broader, there are longer-range perspectives, there are more diversified contacts with personnel, and there are more contacts with higher-level personnel. There is, in addition, a greater degree of personal involvement in performing the management tasks.

Scientists and engineers at NIH and NASA accept the importance of management functions. There is little explicit expression of disliking performance of management functions or finding them difficult. Budgeting was the management function most often discussed in negative terms.

Certain of the management functions are particularly enjoyable—planning, reporting, supervising, representing the organization, consulting, and program assessment. The enjoyment of reporting tends to decrease as personnel move from science or engineering into management. At NASA, there is a consistent decrease in enjoyment of "fire-fighting" as this transition is made. The decreased acceptance of these two functions probably is related to their qualitative change from *technical* to *management* reporting or problem-solving.

Superiors of supervisors and managers tend to support the assessments made by those supervisors and managers with respect to the frequency, enjoyment and importance of management functions. There is less agreement as to dislike, difficulty, and time-consumption of the various functions.

VII. MANAGEMENT SKILLS

Management *functions* are the tasks which are performed in the managerial role. Management *skills* are the abilities and knowledge which can be involved in performing the management functions.

These abilities—including communication of ideas, problem-solving, and decision-making—obviously have wider applicability than to the performance of management functions. We refer to them in this research as "management skills" to distinguish them from "specialty skills"—science and engineering skills.

Sixteen management skills were defined in this project. Most of these were skills useful in performing many, if not all, of the management functions. This applies, for example, to the ability to communicate ideas, skill in operating within the organizational system, skill in working with diverse people, and skill in problem-solving.

Just as the management *functions* can be *performed* by scientists and engineers, the management *skills* can be *used* by scientists and engineers. The specialist may have to draw upon these skills in the "management" of his work as a specialist. The same question, therefore, can be raised with regard to management skills as was put to the set of management functions: What is the nature of the changes involved when one makes the transition from being a scientist or engineer to being a manager?

For the management skills, two characteristics were studied—(1) the perceived relative *importance* of given skills in performing as a specialist and as a manager, (2) and the identification of specific skills as sources of *difficulty* when this transition is made.

Importance

The respondents rated 16 management skills as to their importance "in a person performing your professional specialty" (that is, as a scientist or engineer). The skills were then rated as to their importance "in performing as a manager". A nine-point scale was used in making these ratings. 1 representing "not particularly important" and 9 representing "of critical importance". Just before a respondent gave his rating for a given skill as performed by a manager, he was reminded of the rating he had earlier given that skill as performed by a specialist.

In general, a rather restricted set of the management skills received the highest importance ratings (7.33 or above), with respect to work as a scientist or engineer. These were:

- Fundamental technology
- Application of techniques
- Communication of ideas
- Problem-solving
- Creative thinking.

A wide range of management skills received the highest importance ratings (7.00 or above) when the frame of reference was work as a manager:

- Operating within the organizational system
- Operating within the financial system
- Operating within the personnel system
- Recognizing and coping with environmental factors
- Communication of ideas
- Working with diverse people
- Coordinating group effort
- Leadership style
- Generating confidence of superior
- Integrative ability
- Problem-solving
- Decision-making
- Creative thinking.

In fact, only three of the management skills failed to receive relatively high importance ratings for work as a manager—namely, fundamental technology, application of techniques, and knowledge of related areas. This suggests a shifted emphasis in the managerial role.

The research design employed in the study permits us to answer the following questions, on the basis of

TABLE 31.–Importance of skills, as rated by NIH supervisors (1=not particularly important; 9=of critical importance)

Skill	Importance of skill in science (arbitrary units, mean)	Importance of skill in management (arbitrary units, mean)
Fundamental technology	8.51	7.51*
(number of persons in sample)	(49)	(49)
Application of techniques	8.20	6.04*
(number of persons in sample)	(50)	(50)
Knowledge in related areas	7.46	7.68
(number of persons in sample)	(50)	(50)
Operating within organizational system	4.84	7.57*
(number of persons in sample)	(50)	(51)
Operating within financial system	4.20	7.14*
(number of persons in sample)	(50)	(50)
Operating within personnel system	4.92	7.63*
(number of persons in sample)	(49)	(51)
Recognizing, coping with environmental factors	4.35	6.69*
(number of persons in sample)	(49)	(51)
Communication of ideas	8.04	8.20
(number of persons in sample)	(50)	(51)
Working with diverse people	6.26	7.98*
(number of persons in sample)	(50)	(51)
Coordinating, etc., group effort	5.46	7.73*
(number of persons in sample)	(50)	(51)
Leadership style	6.02	7.73*
(number of persons in sample)	(49)	(51)
Generation of confidence of superior	7.14	7.75
(number of persons in sample)	(50)	(51)
Integrative ability	7.68	8.10*
(number of persons in sample)	(50)	(51)
Problem-solving	8.47	8.42
(number of persons in sample)	(49)	(50)
Decision-making	7.16	8.33*
(number of persons in sample)	(50)	(51)
Creative thinking	8.60	8.24*
(number of persons in sample)	(50)	(50)

*The two mean ratings given for this skill differ significantly. The level of significance is chosen as P=0.05 or less.

our data on the perceived importance of the management skills (tables 31 through 39).*

1. Do the basic agency groups studied–NIH, NASA scientists, NASA engineers–differ in their assessments of the importance of the management skills?

2. Do the respondents at different levels–bench, supervisor, manager, senior manager–differ in their assessments of the importance of the management skills?

3. Are the assessments of the importance of the management skills related to the particular *combinations* (interactions) of agency groupings and levels?

4. Do any of the above patterns of differences vary when the frame of reference shifts from work as a scientist or engineer to work as a manager?

Differences Among Respondent Job Levels.– The agency groups differed in the degree of importance they attached to the management skills. The management skills were accorded greatest importance at NIH. The NIH respondents gave the highest importance to a greater number of the management skills than did either NASA scientists or NASA engineers.

In evaluating the work of a scientist or engineer, NIH respondents gave the significantly highest average importance ratings, in comparison to the other groups, for six of the 16 skills assessed:

Operating within the personnel system
Recognizing and coping with
environmental factors
Communication of ideas
Leadership style
Decision-making
Creative thinking.

NASA engineers assigned the significantly highest importance rating only for "operating within the organizational system". There were no instances in which NASA scientists accounted for the highest importance rating, for specialist work.

When the frame of reference shifted to managerial work, the NIH respondents again gave the largest number of significantly highest importance ratings (three of the 16 possibilities):

Fundamental technology
Operating within the personnel system
Integrative ability.

There were no instances for which either NASA scientists or NASA engineers assigned the significantly highest importance ratings, for managerial work.

The above data indicate that respondents in NIH were somewhat more conditioned to regard certain management skills as important than were the respondents from NASA (either scientists or engineers). This relationship, however, tends to cover a more comprehensive pattern of management skills when the frame of reference is science or engineering work than it covers with regard to managerial work. The NIH respondents seem to regard six specific management skills as particularly important for work in the role of scientist or engineer. The data do not permit us to determine whether this differential response on the part of the NIH respondents is due to institutional or personal factors.

Differences Among Respondent Job Levels.–When the hierarchical positions of the respondents are taken into consideration, for science or engineering work, the greatest number of significantly highest importance ratings was produced by bench respondents. They accounted for six of the highest importance ratings out of the 16 possibilities:

Operating within the organizational system
Operating within the personnel system
Leadership style
Integrative ability
Problem-solving
Decision-making.

Senior managers produced two skills with the significantly highest importance ratings:

Knowledge of related areas
Creative thinking.

There were no instances in which either supervisors or managers produced the significantly highest importance ratings, for science or engineering.

When the question focused upon managerial work, senior managers gave the significantly highest importance rating for "operating within the personnel system"; supervisors gave the significantly highest importance rating to "creative thinking".

Apparently, the group (in terms of level) which was generally most conditioned to regard these skills as important in science or engineering was the group of bench respondents. This was so only for science or engineering. This could reflect the fact that the bench respondents had had, as yet, no intensive experience in management.

*The following discussion is based upon a 3x4 analysis of variance of the importance ratings. The three agency groups were NIH scientists, NASA scientists, and NASA engineers; the four job levels were bench, supervisor, manager, and senior manager. The analysis of variance was applied separately to each management skill; it was also applied separately to the data for work as a scientist or engineer and to that for work as a manager. The relationships cited are based upon the F-tests, with level of significance chosen at P=0.05 or less.

TABLE 32.–Importance of skills, as rated by NIH managers (1=not particularly important; 9=of critical importance)

Skill	Importance of skill in science (arbitrary units, mean)	Importance of skill in management (arbitrary units, mean)
Fundamental technology	8.76	6.90*
(number of persons in sample)	(49)	(49)
Application of techniques	8.35	5.84*
(number of persons in sample)	(49)	(49)
Knowledge in related areas	7.43	7.16
(number of persons in sample)	(49)	(49)
Operating within organizational system	5.29	8.52*
(number of persons in sample)	(49)	(50)
Operating within financial system	5.22	7.67*
(number of persons in sample)	(49)	(49)
Operating within personnel system	5.04	7.60*
(number of persons in sample)	(49)	(50)
Recognizing, coping with environmental factors	5.31	8.18*
(number of persons in sample)	(49)	(50)
Communication of ideas	8.18	8.50
(number of persons in sample)	(49)	(50)
Working with diverse people	6.31	8.50*
(number of persons in sample)	(49)	(50)
Coordinating, etc., group effort	5.90	8.36*
(number of persons in sample)	(49)	(50)
Leadership style	6.57	8.16*
(number of persons in sample)	(49)	(50)
Generation of confidence of superior	7.14	8.32*
(number of persons in sample)	(49)	(50)
Integrative ability	7.63	8.34*
(number of persons in sample)	(48)	(50)
Problem-solving	8.49	8.08*
(number of persons in sample)	(49)	(50)
Decision-making	7.47	8.36*
(number of persons in sample)	(49)	(50)
Creative thinking	8.67	7.74*
(number of persons in sample)	(49)	(50)

*The two mean ratings given for this skill differ significantly. The level of significance is chosen as P=0.05 or less.

TABLE 33.–Importance of skills, as rated by NIH senior managers (1=not particularly important; 9=of critical importance)

Skill	Importance of skill in science (arbitrary units, mean)	Importance of skill in management (arbitrary units, mean)
Fundamental technology	8.83	6.17*
(number of persons in sample)	(30)	(30)
Application of techniques	8.60	5.97*
(number of persons in sample)	(30)	(30)
Knowledge in related areas	7.77	7.37
(number of persons in sample)	(30)	(30)
Operating within organizational system	4.50	8.53*
(number of persons in sample)	(30)	(30)
Operating within financial system	4.13	8.53*
(number of persons in sample)	(30)	(30)
Operating within personnel system	4.67	8.53*
(number of persons in sample)	(30)	(30)
Recognizing, coping with environmental factors	4.83	8.20*
(number of persons in sample)	(30)	(30)
Communication of ideas	7.87	8.67*
(number of persons in sample)	(30)	(30)
Working with diverse people	6.10	8.63*
(number of persons in sample)	(30)	(30)
Coordinating, etc., group effort	5.47	8.60*
(number of persons in sample)	(30)	(30)
Leadership style	5.53	8.60*
(number of persons in sample)	(30)	(30)
Generation of confidence of superior	6.97	8.43*
(number of persons in sample)	(30)	(30)
Integrative ability	7.40	8.50*
(number of persons in sample)	(30)	(30)
Problem-solving	8.73	8.47
(number of persons in sample)	(30)	(30)
Decision-making	6.63	8.80*
(number of persons in sample)	(30)	(30)
Creative thinking	8.70	8.00*
(number of persons in sample)	(30)	(30)

*The two mean ratings given for this skill differ significantly. The level of significance is chosen as P=0.05 or less.

TABLE 34.–Importance of skills, as rated by NASA scientist-supervisors (1=not particularly important: 9=of critical importance)

Skill	Importance of skill in science (arbitrary units, mean)	Importance of skill in management (arbitrary units, mean)
Fundamental technology	8.59	6.67
(number of persons in sample)	(49)	(49)
Application of techniques	8.00	6.86*
(number of persons in sample)	(49)	(49)
Knowledge in related areas	6.69	7.45*
(number of persons in sample)	(49)	(49)
Operating within organizational system	5.37	8.00*
(number of persons in sample)	(49)	(49)
Operating within financial system	4.35	7.49*
(number of persons in sample)	(49)	(49)
Operating within personnel system	4.04	7.27*
(number of persons in sample)	(49)	(49)
Recognizing, coping with environmental factors	4.65	7.47*
(number of persons in sample)	(49)	(49)
Communication of ideas	7.92	8.63*
(number of persons in sample)	(49)	(49)
Working with diverse people	6.12	8.29*
(number of persons in sample)	(49)	(49)
Coordinating, etc., group effort	5.47	8.43*
(number of persons in sample)	(49)	(49)
Leadership style	5.31	8.31*
(number of persons in sample)	(49)	(49)
Generation of confidence of superior	7.35	7.84*
(number of persons in sample)	(48)	(49)
Integrative ability	6.88	7.96
(number of persons in sample)	(48)	(49)
Problem-solving	8.43	8.06
(number of persons in sample)	(49)	(49)
Decision-making	6.69	8.55*
(number of persons in sample)	(49)	(49)
Creative thinking	8.02	7.31*
(number of persons in sample)	(49)	(49)

*The two mean ratings given for this skill differ significantly. The level of significance is chosen as P=0.05 or less.

TABLE 35.–Importance of skills, as rated by NASA scientist-managers (1=not particularly important: 9=of critical importance)

Skill	Importance of skill in science (arbitrary units, mean)	Importance of skill in management (arbitrary units, mean)
Fundamental technology	8.52	6.60*
(number of persons in sample)	(50)	(50)
Application of techniques	8.26	6.22*
(number of persons in sample)	(50)	(50)
Knowledge in related areas	6.78	7.16
(number of persons in sample)	(50)	(50)
Operating within organizational system	5.18	8.24*
(number of persons in sample)	(50)	(50)
Operating within financial system	4.72	7.84*
(number of persons in sample)	(50)	(50)
Operating within personnel system	4.68	7.34*
(number of persons in sample)	(50)	(50)
Recognizing, coping with environmental factors	4.92	7.96*
(number of persons in sample)	(50)	(50)
Communication of ideas	7.96	8.50*
(number of persons in sample)	(50)	(50)
Working with diverse people	6.20	8.18*
(number of persons in sample)	(50)	(50)
Coordinating, etc., group effort	5.80	8.12*
(number of persons in sample)	(49)	(49)
Leadership style	5.50	7.82*
(number of persons in sample)	(50)	(50)
Generation of confidence of superior	7.55	8.02*
(number of persons in sample)	(49)	(50)
Integrative ability	6.80	7.90*
(number of persons in sample)	(49)	(49)
Problem-solving	8.28	7.88
(number of persons in sample)	(50)	(50)
Decision-making	6.84	8.36*
(number of persons in sample)	(50)	(50)
Creative thinking	8.10	7.48*
(number of persons in sample)	(50)	(50)

*The two mean ratings given for this skill differ significantly. The level of significance is chosen as P=0.05 or less.

TABLE 36.–Importance of skills, as rated by NASA scientist-senior managers (1=not particularly important; 9=of critical importance)

Skill	Importance of skill in science (arbitrary units, mean)	Importance of skill in management (arbitrary units, mean)
Fundamental technology	8.48	6.58*
(number of persons in sample)	(33)	(33)
Application of techniques	7.79	6.27
(number of persons in sample)	(33)	(33)
Knowledge in related areas	6.79	7.27
(number of persons in sample)	(33)	(33)
Operating within organizational system	4.18	8.27*
(number of persons in sample)	(33)	(33)
Operating within financial system	4.03	8.03*
(number of persons in sample)	(33)	(33)
Operating within personnel system	3.91	7.70*
(number of persons in sample)	(33)	(33)
Recognizing, coping with environmental factors	3.97	7.45*
(number of persons in sample)	(33)	(33)
Communication of ideas	7.33	8.21*
(number of persons in sample)	(33)	(33)
Working with diverse people	5.18	8.21*
(number of persons in sample)	(33)	(33)
Coordinating, etc., group effort	4.55	8.12*
(number of persons in sample)	(33)	(33)
Leadership style	4.61	8.24*
(number of persons in sample)	(33)	(33)
Generation of confidence of superior	6.81	7.85*
(number of persons in sample)	(32)	(33)
Integrative ability	6.39	7.73*
(number of persons in sample)	(33)	(33)
Problem-solving	7.88	7.55
(number of persons in sample)	(33)	(33)
Decision-making	6.39	8.61*
(number of persons in sample)	(33)	(33)
Creative thinking	8.33	6.88*
(number of persons in sample)	(33)	(33)

*The two mean ratings given for this skill differ significantly. The level of significance is chosen as P=0.05 or less.

TABLE 37.–Importance of skills, as rated by NASA engineer-supervisors (1=not particularly important; 9=of critical importance)

Skill	Importance of skill in science (arbitrary units, mean)	Importance of skill in management (arbitrary units, mean)
Fundamental technology	8.27	6.59*
(number of persons in sample)	(49)	(49)
Application of techniques	8.16	6.35*
(number of persons in sample)	(49)	(48)
Knowledge in related areas	6.45	7.14*
(number of persons in sample)	(49)	(49)
Operating within organizational system	5.49	8.14*
(number of persons in sample)	(49)	(49)
Operating within financial system	3.76	7.55*
(number of persons in sample)	(49)	(49)
Operating within personnel system	3.94	7.39*
(number of persons in sample)	(49)	(49)
Recognizing, coping with environmental factors	4.61	7.41*
(number of persons in sample)	(49)	(49)
Communication of ideas	7.67	8.53*
(number of persons in sample)	(49)	(49)
Working with diverse people	6.12	8.31*
(number of persons in sample)	(49)	(49)
Coordinating, etc., group effort	5.57	8.39*
(number of persons in sample)	(49)	(49)
Leadership style	5.12	8.39*
(number of persons in sample)	(49)	(49)
Generation of confidence of superior	7.24	7.94*
(number of persons in sample)	(49)	(49)
Integrative ability	6.10	7.55*
(number of persons in sample)	(49)	(49)
Problem-solving	8.14	7.88
(number of persons in sample)	(49)	(49)
Decision-making	6.27	8.29*
(number of persons in sample)	(49)	(49)
Creative thinking	7.41	7.35
(number of persons in sample)	(49)	(49)

*The two mean ratings given for this skill differ significantly. The level of significance is chosen as P=0.05 or less.

TABLE 38.–Importance of skills, as rated by NASA engineer-managers (1=not particularly important; 9=of critical importance)

Skill	Importance of skill in science (arbitrary units, mean)	Importance of skill in management (arbitrary units, mean)
Fundamental technology	8.42	6.25*
(number of persons in sample)	(50)	(51)
Application of techniques	8.06	6.82*
(number of persons in sample)	(50)	(51)
Knowledge in related areas	6.38	7.35
(number of persons in sample)	(50)	(51)
Operating within organizational system	5.90	8.20*
(number of persons in sample)	(50)	(51)
Operating within financial system	4.72	7.76*
(number of persons in sample)	(50)	(51)
Operating within personnel system	4.28	7.00*
(number of persons in sample)	(50)	(51)
Recognizing, coping with environmental factors	4.86	7.75*
(number of persons in sample)	(50)	(51)
Communication of ideas	7.66	8.55*
(number of persons in sample)	(50)	(51)
Working with diverse people	6.54	8.25*
(number of persons in sample)	(50)	(51)
Coordinating, etc., group effort	5.82	8.39*
(number of persons in sample)	(50)	(51)
Leadership style	5.92	8.14*
(number of persons in sample)	(50)	(51)
Generation of confidence of superior	7.78	8.37*
(number of persons in sample)	(50)	(51)
Integrative ability	6.50	8.12*
(number of persons in sample)	(50)	(51)
Problem-solving	8.18	8.14
(number of persons in sample)	(50)	(51)
Decision-making	6.68	8.29*
(number of persons in sample)	(50)	(51)
Creative thinking	7.68	7.33
(number of persons in sample)	(50)	(51)

*The two mean ratings given for this skill differ significantly. The level of significance is chosen as P=0.05 or less.

TABLE 39.–Importance of skills, as rated by NASA engineer-senior managers (1=not particularly important; 9=of critical importance)

Skill	Importance of skill in science (arbitrary units, mean)	Importance of skill in management (arbitrary units, mean)
Fundamental technology	8.70	6.43*
(number of persons in sample)	(30)	(30)
Application of techniques	8.03	6.33*
(number of persons in sample)	(30)	(30)
Knowledge in related areas	6.50	7.23*
(number of persons in sample)	(30)	(30)
Operating within organizational system	5.30	8.33*
(number of persons in sample)	(30)	(30)
Operating within financial system	4.17	8.30*
(number of persons in sample)	(30)	(30)
Operating within personnel system	3.97	7.47*
(number of persons in sample)	(30)	(30)
Recognizing, coping with environmental factors	4.50	7.87*
(number of persons in sample)	(30)	(30)
Communication of ideas	7.50	8.37*
(number of persons in sample)	(30)	(30)
Working with diverse people	5.60	8.03*
(number of persons in sample)	(30)	(30)
Coordinating, etc., group effort	4.80	8.37*
(number of persons in sample)	(30)	(30)
Leadership style	5.50	8.43*
(number of persons in sample)	(30)	(30)
Generation of confidence of superior	7.77	8.17*
(number of persons in sample)	(30)	(30)
Integrative ability	6.33	7.97*
(number of persons in sample)	(30)	(30)
Problem-solving	8.30	7.87
(number of persons in sample)	(30)	(30)
Decision-making	6.77	8.50*
(number of persons in sample)	(30)	(30)
Creative thinking	8.40	7.27*
(number of persons in sample)	(30)	(30)

*The two mean ratings given for this skill differ significantly. The level of significance is chosen as P=0.05 or less.

In each of the above analyses, differences in the responses from different groups arose primarily in regard to work as a scientist or engineer. There was more similarity of opinion as to relative importance of skills with regard to work as a manager.

Differences Related to Combinations (Interactions) of Respondent Groupings.—There were four management skills for which the assessment of importance was correlated with particular combinations (interactions) of agency group *and* job level. Such correlations were found only with regard to managerial work.

1. Operating within the organizational system: Among NIH and NASA scientists, the managers and senior managers gave the significantly highest impor-

TABLE 40.—Percentages of NIH scientists regarding various management skills as most likely to be sources of difficulty, for a specialist moving into management

Skill	Percentage reporting each skill as a likely source of difficulty			
	Bench (N=30*)	Supervisors (N=51*)	Managers (N=50*)	Senior managers (N=30*)
Fundamental technology	–	2%	2%	3%
Application of techniques	3%	–	4	3
Knowledge in related areas	3	2	2	–
Operating within organizational system	55	46	53	73
Operating within financial system	38	40	35	73
Operating within personnel system	45	48	31	60
Recognizing, coping with environmental factors	38	26	31	53
Communication of ideas	3	2	6	7
Working with diverse people	21	16	27	30
Coordinating group effort	31	14	29	17
Leadership style	28	22	10	10
Generation of confidence of superior	7	4	6	–
Integrative ability	–	6	4	–
Problem-solving	3	12	8	–
Decision-making	3	20	6	17
Creative thinking	3	4	4	3
None a source of difficulty	7	6	8	–
Depends on man replaced or position taken	7	–	2	–

*N=number of individuals in sample

NOTE: Percentages add to more than 100 because of multiple answers.

tance ratings (in contrast to bench and supervisor repondents). Among NASA engineers, the bench respondents and senior managers gave the significantly highest importance ratings.

2. Recognizing and coping with environmental factors: At NIH, the managers and senior managers gave the significantly highest importance ratings. Among NASA scientists, the bench respondents and managers gave the significantly highest importance ratings. Among NASA engineers, the senior managers gave the significantly highest importance ratings.

3. Communication of ideas: At NIH, the highest importance ratings were given by senior managers. Among NASA scientists the highest importance ratings were given by supervisors. Among NASA engineers, the highest importance ratings were given by bench respondents.

4. Coordinating group effort: At NIH, senior managers gave the significantly highest importance ratings. Among both NASA scientists and engineers, the supervisors gave the highest importance ratings.

All instances in which the data showed these combination or interaction effects occurred when the frame of reference was "working as a manager". Apparently, a joint perspective of agency group and job level is operative when evaluating the role of the above four skills for managers. Such joint perspective is not functional in assessing the various skills when applied to science or engineering work.

Differences Related to the Specialist-Manager Transition.—Ten of the 16 management skills showed a significant increase in importance, when the study focus shifted from science or engineering to managerial work. This was generally true for the respondents in all three agency categories (NIH, NASA scientists, NASA engineers) and at all three management levels (supervisors, managers, senior managers—(tables 31 through 39). These ten management skills were:

- Operating within the organizational system
- Operating within the financial system
- Operating within the personnel system
- Recognizing, coping with environmental factors
- Working with diverse people
- Coordinating group effort
- Leadership style
- Generation of confidence of superior
- Integrative ability
- Decision-making.

Supervisors, managers, and senior managers, among both NASA scientists and NASA engineers, perceived communication of ideas as increasing in importance. In NIH, only the senior managers saw this particular skill as increasing in importance.

Knowledge of related areas was seen to increase in importance by supervisors in NASA (scientists and engineers) and by senior managers among NASA engineers.

There was general agreement, among all categories of respondents, that fundamental technology and application of techniques decreased in importance in the transition from specialist to manager. Except for supervisors and managers among NASA engineers, the respondents also saw creative thinking as decreasing in importance. Problem-solving generally was not seen to change in importance—except as reported by managers at NIH, who perceived problem-solving as decreasing in importance in the transition.

Bolster's study of NIH scientist-adminstrators in the extramural and collaborative programs supports this same general conclusion—that the skills related to the organizational environment are most important to the manager (or scientist-administrator). He found that these men and women who manage predominantly grant programs most frequently selected "knowledge of NIH and DHEW [Department of Health, Education, and Welfare] objectives, policies, organization, and procedures", and "intimate association with universities and other grantee institutions", as the most useful skills and knowledge in performing their primary tasks.[20]

The same conclusion can be reached from Crockett's data.[21] Of the management skills rated as the most important, four of five are related to the organization and its environment: working with superiors, motivating subordinates, establishing organizational structure, and knowledge of MSC organization.[22]

Difficulty

The respondents were asked, "Which of these skills are most likely to be a source of difficulty for a scientist [or engineer] who moves into management?"

The skills cited by the highest proportions of the respondents in all three agency groups were (tables 40 through 42):

- Operating within the organizational system
- Operating within the financial system
- Operating within the personnel system
- Recognizing, coping with environmental factors
- Working with diverse people
- Coordinating group effort
- Leadership style.

In general, relatively small proportions of the respondents said that these skills would be likely sources of difficulty:

Fundamental technology
Application of techniques
Knowledge in related areas
Communication of ideas
Generation of confidence of superior
Integrative ability
Problem-solving
Decision-making
Creative thinking

Few of the key sources of difficulty, as seen by the respondents, fall in the category of problem-centered aspects of management (problem-solving,

TABLE 41.–Percentages of NASA scientists regarding various management skills as most likely to be sources of difficulty, for a specialist moving into management

Skill	Percentage reporting each skill as a likely source of difficulty			
	Bench (N=35*)	Supervisors (N=49*)	Managers (N=50*)	Senior managers (N=33*)
Fundamental technology	3%	2%	2%	6%
Application of techniques	–	2	–	–
Knowledge in related areas	6	8	6	3
Operating within organizational system	34	31	36	52
Operating within financial system	43	33	26	58
Operating within personnel system	29	31	30	48
Recognizing, coping with environmental factors	29	31	34	48
Communication of ideas	6	16	16	9
Working with diverse people	17	29	34	46
Coordinating group effort	26	24	26	18
Leadership style	34	31	16	18
Generation of confidence of superior	6	2	6	6
Integrative ability	6	2	2	9
Problem-solving	3	2	–	–
Decision-making	23	12	18	6
Creative thinking	3	–	–	–
None a source of difficulty	6	2	2	–
Depends on man replaced or position taken	–	–	–	–

*N=number of individuals in sample

NOTE: Percentages add to more than 100 because of multiple answers.

decision-making, creative thinking). Most key sources of difficulty were in the category of coping with the organizational environment (the organizational-financial-personnel system, working with diverse people, etc.).

Senior managers at NIH, and NASA scientist-senior-managers, produced the highest proportions saying that operating within the organizational, financial and personnel systems were likely sources of difficulty at transition.

TABLE 42.–Percentages of NASA engineers regarding various management skills as most likely to be sources of difficulty, for a specialist moving into management

Skill	Percentage reporting each skill as a likely source of difficulty			
	Bench (N=31*)	Supervisors (N=49*)	Managers (N=51*)	Senior managers (N=30*)
Fundamental technology	–	–	1%	–
Application of techniques	–	–	4	3%
Knowledge in related areas	10%	4%	8	7
Operating within organizational system	26	29	37	37
Operating within financial system	32	24	41	37
Operating within personnel system	36	24	33	23
Recognizing, coping with environmental factors	32	26	35	50
Communication of ideas	10	12	26	17
Working with diverse people	42	39	39	50
Coordinating group effort	19	16	22	23
Leadership style	29	24	24	23
Generation of confidence of superior	–	–	6	3
Integrative ability	–	8	8	3
Problem-solving	–	4	2	–
Decision-making	13	16	14	17
Creative thinking	–	2	2	3
None a source of difficulty	–	8	–	3
Depends on man replaced or position taken	–	–	2	–

*N=number of individuals in sample

NOTE: Percentages add to more than 100 because of multiple answers.

TABLE 43.–Importance of skills, as rated by NIH bench scientists

Skill	Importance of skill to a scientist (arbitrary units, mean)	Perceived importance of skill to a manager (arbitrary units, mean)
Fundamental technology	8.62	7.14*
(number of persons in sample)	(29)	(29)
Application of techniques	8.31	6.10*
(number of persons in sample)	(29)	(29)
Knowledge in related areas	7.14	7.38
(number of persons in sample)	(29)	(29)
Operating within organizational system	5.69	8.24*
(number of persons in sample)	(29)	(29)
Operating within financial system	5.00	8.21*
(number of persons in sample)	(29)	(29)
Operating within personnel system	5.75	8.10*
(number of persons in sample)	(29)	(29)
Recognizing, coping with environmental factors	5.38	8.00*
(number of persons in sample)	(29)	(29)
Communication of ideas	8.03	7.83
(number of persons in sample)	(29)	(29)
Working with diverse people	6.66	8.10*
(number of persons in sample)	(29)	(29)
Coordinating, etc., group effort	6.17	8.38*
(number of persons in sample)	(29)	(29)
Leadership style	6.66	8.17*
(number of persons in sample)	(29)	(29)
Generation of confidence of superior	6.97	7.86*
(number of persons in sample)	(29)	(29)
Integrative ability	7.04	8.00*
(number of persons in sample)	(28)	(28)
Problem-solving	8.62	8.10
(number of persons in sample)	(29)	(29)
Decision-making	7.69	8.69*
(number of persons in sample)	(29)	(29)
Creative thinking	8.72	7.52*
(number of persons in sample)	(29)	(29)

*The two mean ratings given for this skill differ significantly. The level of significance is chosen as P=0.05 or less.

Reasons for Opinions on Skill Difficulty. A pattern of reasons was given for judging skills to be likely sources of difficulty to specialists in transition. The pattern emerged regardless of the particular skills being discussed. The components in this pattern were:

New and different types of skills are required; respondent has had no training in the skills required.

There is a need to define problems and solutions within the organizational framework.

The scope of the work is broader and more diversified: there is responsibility for coordination of programs.

New and different goals and objectives are involved; there can be a conflict of self-interest with organizational interests.

There is a change from an introspective, introverted climate to an extroverted one.

You are responsible for the production of others: you have to depend upon the skills of others; need to motivate others; need to consider employee rights and civil service rules.

There are considerations of political expediency.

The basic problems represented seem to be: increased breadth and diversity of responsibility (for programs and for people): new and different sets of goals. These are accompanied by problems of political expediency and the need to acquire new skills.

Management Skills as Viewed by Specialists at the Bench

All respondents currently working in their specialties ("at the bench") saw the following as increasing in importance at transition from specialty to management.

Operating within the organizational system
Operating within the financial system
Operating within the personnel system
Recognizing, coping with environmental factors
Working with diverse people
Coordinating group effort
Leadership style
Decision-making

Each of these had also been reported as increasing in importance by all respondents who actually were in management. Among the latter, however, two other skills were additionally reported as increasing in importance. generation of confidence of superior, and integrative ability. NASA bench respondents also judged these two skills as increasing in importance, but NIH bench respondents did not (tables 43 through 45).

The bench respondents agreed with management respondents in perceiving decreased importance of fundamental technology and applications of techniques, in the transition from specialist to manager. Bench respondents at NASA, but not at NIH, felt that problem-solving too would decrease in importance in the transition.

No group of bench respondents saw a change in importance for knowledge of related areas, or for communication of ideas.

Management Skills as Seen by Respondents' Superiors

The superiors of 20 respondent supervisors and managers were asked to rate, on the nine-point scale described earlier, the importance of each management skill "in a person performing ———'s job.... Note that you are rating the job, not the man".

The most important management skills, as perceived by the *total* group of subordinates, are: operating within the organizational system, operating within the financial system, and operating within the personnel system. For each of these skills, superiors attach less importance than do the respondents they supervise. This is true in both NIH and NASA. The following data are illustrative of this general result.

The superiors of the 20 NASA scientist-supervisors gave an importance rating of 6.82 to operating within the organizational system, but the 20 subordinates gave an importance rating of 8.23 to this skill. The superiors of the 20 NIH manager subordinates gave an importance rating of 6.30 to operating within the financial system, while the subordinates gave this skill an importance rating of 7.80. The superiors of the NASA scientist-managers gave operating within the personnel system an importance rating of only 4.24, yet their subordinates gave this skill an importance rating of 7.52.

Of the 16 management skills studied, eight tended to be given lower importance ratings by superiors than were given by the management respondents they supervised. There were no management skills for which the superiors tended consistently to give higher importance ratings than did their subordinates. The superiors do not agree, in general, with the relative importance that their subordinates in management attach to some of the most critical skills.

TABLE 44.–Importance of skills, as rated by NASA bench scientists

Skill	Importance of skill to a scientist (arbitrary units, mean)	Perceived importance of skill to a manager (arbitrary units, mean)
Fundamental technology	8.29	7.29*
(number of persons in sample)	(35)	(35)
Application of techniques	7.71	6.43*
(number of persons in sample)	(35)	(35)
Knowledge in related areas	6.80	7.14
(number of persons in sample)	(35)	(35)
Operating within organizational system	5.77	7.86*
(number of persons in sample)	(35)	(35)
Operating within financial system	5.40	8.00*
(number of persons in sample)	(35)	(35)
Operating within personnel system	5.51	7.80*
(number of persons in sample)	(35)	(35)
Recognizing, coping with environmental factors	5.66	7.97*
(number of persons in sample)	(35)	(35)
Communication of ideas	8.06	8.46
(number of persons in sample)	(35)	(35)
Working with diverse people	6.63	7.94*
(number of persons in sample)	(35)	(35)
Coordinating, etc., group effort	6.29	8.14*
(number of persons in sample)	(35)	(35)
Leadership style	6.31	7.97*
(number of persons in sample)	(35)	(35)
Generation of confidence of superior	7.34	7.71
(number of persons in sample)	(35)	(35)
Integrative ability	7.26	7.69
(number of persons in sample)	(35)	(35)
Problem-solving	8.40	7.83*
(number of persons in sample)	(35)	(35)
Decision-making	7.63	8.66*
(number of persons in sample)	(35)	(35)
Creative thinking	8.14	7.66
(number of persons in sample)	(35)	(35)

*The two mean ratings given for this skill differ significantly. The level of significance is chosen as P=0.05 or less.

TABLE 45.–Importance of skills, as rated by NASA bench engineers

Skill	Importance of skill to an engineer (arbitrary units, mean)	Perceived importance of skill to a manager (arbitrary units, mean)
Fundamental technology	8.16	6.90*
(number of persons in sample)	(31)	(31)
Application of techniques	7.71	6.10*
(number of persons in sample)	(31)	(31)
Knowledge in related areas	6.48	7.16
(number of persons in sample)	(31)	(31)
Operating within organizational system	6.19	8.32*
(number of persons in sample)	(31)	(31)
Operating within financial system	4.97	7.65*
(number of persons in sample)	(31)	(31)
Operating within personnel system	3.94	7.42*
(number of persons in sample)	(31)	(31)
Recognizing, coping with environmental factors	5.39	7.35*
(number of persons in sample)	(31)	(31)
Communication of ideas	8.29	8.61
(number of persons in sample)	(31)	(31)
Working with diverse people	7.16	8.03*
(number of persons in sample)	(31)	(31)
Coordinating, etc., group effort	6.81	8.16*
(number of persons in sample)	(31)	(31)
Leadership style	6.52	8.35*
(number of persons in sample)	(31)	(31)
Generation of confidence of superior	7.68	8.06
(number of persons in sample)	(31)	(31)
Integrative ability	6.84	7.10
(number of persons in sample)	(31)	(31)
Problem-solving	8.52	7.48*
(number of persons in sample)	(31)	(31)
Decision-making	7.26	8.29*
(number of persons in sample)	(31)	(31)
Creative thinking	7.65	7.00
(number of persons in sample)	(31)	(31)

*The two mean ratings given for this skill differ significantly. The level of significance is chosen as P=0.05 or less.

The superiors were asked, "Which of the skills do you feel has been a source of difficulty for (the subordinate)?" The subordinates said that their major sources of difficulty were operating within the organizational, financial and personnel systems, and recognizing and coping with environmental factors. The superiors generally agreed only that their subordinates had difficulty in operating within the organizational system. The superiors tended to view working with diverse people, leadership style and generation of confidence of superiors as being sources of difficulty in their subordinates more frequently than did the latter in describing themselves. These data suggest that the superiors may not understand the attitudes and opinions of their subordinates with respect to the management skills.

Chapter Summary

Management skills may be classified as those focusing upon the solution of highly specialized problems (fundamental technology, application of techniques, problem-solving, decision-making, creative thinking) and those concerned with functioning in the management environment (operating within the organizational, financial and personnel systems; working with diverse people). The management skills thought to be most important differ, depending on the kind of work under consideration—science or engineering *vs.* management. For the former, the most important skills are "problem-centered"; for the latter, the most important skills are "system-centered".

Most important management skills

As a scientist or engineer	*As a manager*
Fundamental technology	Operating within the organizational system
Application of techniques	Operating within the financial system
Problem-solving	Operating within the personnel system
Creative thinking	Communication of ideas
Communication of ideas	Working with diverse people
	Coordinating group effort
	Leadership style
	Integrative ability

The "system-centered" skills are not only seen as being most important, for performing the role of manager, they are also seen as being the main sources of difficulty. They present difficulty mainly because of the breadth and diversity of the responsibilities in management, because new goals and objectives come into play, and because new skills must be developed.

The current bench scientists and engineers, when thinking about management, anticipate that the "system-oriented" skills will increase in importance and become sources of difficulty.

Superiors of respondents now in management positions differ with them about the relative importance of those management skills most critical to the subordinates' jobs. They also tend to underestimate the degree to which their subordinates experience difficulty in some of the most important "system-oriented" management skills.

VIII. MOTIVATIONS

The third aspect of involvement in the managerial role, after management functions and skills, has to do with motivations—psychological needs which an individual seeks to satisfy, and activities which are particularly important to him.

An individual's occupation interacts, in either positive or negative ways, with his psychological needs and his feeling for what is particularly important in his life. Motivations can play a part in attracting an individual to an occupation in the first place. His continuing in an occupation can be sustained by the degree to which his experiences in it satisfy his motivations. If working in a given occupation has served this reinforcing role, entrance into any new occupation may be problematical—to the extent that the new occupation is not perceived as producing the satisfactions demanded by the individual's motivational systems. There is the possibility, of course, that a new occupation could actually do a better job of satisfying the individual's motivations.

In this research, three aspects of 15 different motivations were studied, as these motivations related to science or engineering and to managerial work. First, we sought to determine how much *satisfaction potential* the respondents would associate with each of the motivations—for scientists or engineers, and for managers. Second, the respondents were asked which of these motivations were characteristic of or typified scientists or engineers on the one hand and managers on the other. This procedure produced *stereotypes of* the motivational patterns associated, respectively, with specialists and with managers. Both of these approaches served to establish how our respondents perceived motivational patterns to vary between the two occupations. Finally, the question was raised as to how much *difficulty* would be encountered in attempting to satisfy the respective motivations, in moving from specialist to manager. This approach indicates the critical problem areas, in terms of motivations, which are encountered when the transition is made.

It must be noted that the questions nominally dealt with the associations between the motivations and the *jobs*, not with the relative strengths of the various motivations in the respondents.

Satisfaction Potential

We investigated the degree to which the respective motivations might provide satisfaction, by asking a series of questions which began as follows (the respondents were looking at a card on which the 15 motivations were identified and described).

> This is a list of psychological rewards that may or may not be involved in how much satisfaction a person obtains from his work. Take a moment to note each one of these.
>
> Let's take the perspective of a person engaged primarily in scientific [or engineering] activities. How much satisfaction does a scientist [or engineer] normally get from *leadership* while working as a scientist [or engineer]?

The respondents replied using a nine-point scale, 1 representing "low satisfaction" and 9 representing "high satisfaction". The last part of the question was asked for each item.

After going through the list of 15 motivations, the next question was:

> Now let's move to the perspective of a person in a management job. You gave *leadership* a rating of ——— for a scientist [or engineer]. How would you rate the degree of satisfaction which a manager normally gets from *leadership?*

The last part of this question was repeated for each item. The respondents were always reminded of

TABLE 46.–Degree to which occupation satisfies motivations and values, as rated by NIH scientist-supervisors (1=low satisfaction; 9=high satisfaction)

Motivation or value	Degree of satisfaction from occupation: In science (arbitrary units, mean)	Degree of satisfaction from occupation: In management (arbitrary units, mean)
Leadership	5.19	7.35
(number of persons in sample)	(48)	(49)
Detailed planning	5.73	6.00
(number of persons in sample)	(48)	(49)
Doing new, different things	8.02	6.67*
(number of persons in sample)	(48)	(49)
Direct attack on problems	8.19	7.06*
(number of persons in sample)	(48)	(49)
Contributing to organization's goals	5.04	7.67*
(number of persons in sample)	(47)	(48)
Achieving	7.92	7.61
(number of persons in sample)	(48)	(49)
Help to one's colleagues	6.27	7.65*
(number of persons in sample)	(48)	(49)
Being independent	7.98	7.18*
(number of persons in sample)	(48)	(49)
Seeking support of others	4.65	5.90*
(number of persons in sample)	(48)	(49)
Being recognized	7.98	7.37*
(number of persons in sample)	(48)	(49)
Being able to exercise authority	4.88	6.59*
(number of persons in sample)	(48)	(49)
Risk-taking in decisions	4.72	5.73*
(number of persons in sample)	(47)	(49)
Associating with very congenial co-workers	6.17	6.39
(number of persons in sample)	(48)	(49)
Associating with intellectually competent co-workers	8.17	7.80
(number of persons in sample)	(48)	(49)
Using technical knowledge, skills	7.81	6.33*
(number of persons in sample)	(48)	(49)

*The two mean ratings given for this skill differ significantly. The level of s[illegible]ificance is chosen as P=0.05 or less.

the ratings they had given with respect to science or engineering.

A set of five motivations consistently received high satisfaction ratings when associated with science or engineering work; a set of three consistently received high ratings when associated with management (tables 46 through 54):

Highest-satisfaction-rated motivations

As a scientist or engineer	*As a manager*
Making direct attack on problems	Being a leader
Achieving through overcoming difficult obstacles	Contributing to organization's goals
Being recognized	Achieving through overcoming difficult obstacles
Associating with intellectually competent co-workers	
Using technical knowledge and skills	

These respondents see that both science or engineering work and managerial work can make strong contributions to the satisfaction of one's need to *achieve*.

In science or engineering, high satisfaction potential exists for *problem-centered* motivations—liking to make direct attack on problems, and liking to use one's technical knowledge and skills. Also, working as a scientist or engineer has high potential for satisfying one's need to be recognized for accomplishments, and one's desire to be associated with intellectually competent co-workers.

In contrast, working as a manager has high potential for satisfying one's need to be a leader (to direct others; to being the one who establishes policies) and one's enjoyment of contributing to the organizations's progress.

Science or Engineering Work—Differences by Agency.—The satisfaction ratings given to the respective motivations varied with agency group (NIH, NASA scientists, NASA engineers) and with position of the respondent (bench, supervisor, manager, senior manager).*

In the satisfaction ratings given for work as a scientist, NIH gave the highest ratings on seven of the 15 motivations:

Being a leader
Liking to do detailed planning
Helping one's colleagues
Being independent
Seeking the support of others
Being recognized
Associating with intellectually competent co-workers

NASA engineers produced the highest satisfaction ratings on four of the 15 motivations:

Contributions to organization's goals
Being able to exercise authority
Risk-taking in making decisions
Associating with congenial co-workers

Note that these four motivations rated highest by NASA engineers are those usually associated with management—although it is engineering work which is under consideration.

Science or Engineering Work: Differences by Agency and Position.—The satisfaction potential which was perceived for the need to *achieve* varied by agency and position. In NIH, the highest satisfaction ratings were given by the senior managers; in NASA, the highest ratings were given by the bench respondents.

Managerial Work—Differences by Agency.—When referring to managerial work, the respondents at NASA produced the highest satisfaction ratings for six of the 15 motivations: four were produced by NASA engineers, two by NASA scientists. The motivations given the highest satisfaction ratings by NASA engineers were:

Doing new and different things
Being recognized
Being able to exercise authority
Risk-taking in decisions.

The two given highest satisfaction ratings by NASA scientists were:

Being a leader
Making direct attack on problems

Overall Differences by Occupation.—In summary, NIH respondents gave the highest satisfaction ratings to motivations when they were referring to scientific work; NASA respondents, especially the engineers, gave the highest satisfaction ratings in reference to managerial work. This suggests some predisposition by engineers, as compared with scientists, to favor management. (In each instance, the base-point is the level of ratings given by the other categories of respondents.)

The satisfaction potential which was perceived for enjoyment of detailed planning varied by agency and position of respondent. At NIH, the senior managers gave the highest satisfaction ratings; among NASA

*The following discussion is based upon a 3x4 analysis of variance comparable to t.. t conducted for the management skills (see footnote in chapter VII).

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TABLE 47.–Degree to which occupation satisfies motivations and values, as rated by NIH scientist-managers (1=low satisfaction; 9=high satisfaction)

Motivation or value	Degree of satisfaction from occupation	
	In science (arbitrary units, mean)	In management (arbitrary units, mean)
Leadership	6.10	8.00*
(number of persons in sample)	(48)	(49)
Detailed planning	7.25	7.18
(number of persons in sample)	(48)	(49)
Doing new, different things	7.73	7.14*
(number of persons in sample)	(48)	(49)
Direct attack on problems	8.35	7.86*
(number of persons in sample)	(48)	(49)
Contributing to organization's goals	4.77	8.31*
(number of persons in sample)	(48)	(49)
Achieving	8.04	7.92
(number of persons in sample)	(48)	(49)
Help to one's colleagues	6.75	7.73*
(number of persons in sample)	(48)	(49)
Being independent	8.33	6.86*
(number of persons in sample)	(48)	(49)
Seeking support of others	5.19	7.10*
(number of persons in sample)	(47)	(49)
Being recognized	8.48	7.86*
(number of persons in sample)	(48)	(49)
Being able to exercise authority	4.98	7.10*
(number of persons in sample)	(48)	(49)
Risk-taking in decisions	5.64	6.33
(number of persons in sample)	(47)	(49)
Associating with very congenial co-workers	6.60	7.35*
(number of persons in sample)	(48)	(49)
Associating with intellectually competent co-workers	8.40	7.73*
(number of persons in sample)	(48)	(49)
Using technical knowledge, skills	8.48	6.53*
(number of persons in sample)	(48)	(49)

*The two mean ratings given for this skill differ significantly. The level of significance is chosen as P=0.05 or less.

TABLE 48.–Degree to which occupation satisfies motivations and values, as rated by NIH scientist-senior managers (1=low satisfaction; 9=high satisfaction)

Motivation or value	Degree of satisfaction from occupation: In science (arbitrary units, mean)	Degree of satisfaction from occupation: In management (arbitrary units, mean)
Leadership	5.17	8.53*
(number of persons in sample)	(30)	(30)
Detailed planning	6.24	7.34*
(number of persons in sample)	(29)	(29)
Doing new, different things	7.80	7.47
(number of persons in sample)	(30)	(30)
Direct attack on problems	8.43	8.20
(number of persons in sample)	(30)	(30)
Contributing to organization's goals	4.57	8.27*
(number of persons in sample)	(30)	(30)
Achieving	8.13	8.53*
(number of persons in sample)	(30)	(30)
Help to one's colleagues	6.13	7.47
(number of persons in sample)	(30)	(30)
Being independent	8.43	6.20*
(number of persons in sample)	(30)	(30)
Seeking support of others	4.60	6.57*
(number of persons in sample)	(30)	(30)
Being recognized	8.33	7.97
(number of persons in sample)	(30)	(30)
Being able to exercise authority	5.07	7.07*
(number of persons in sample)	(30)	(30)
Risk-taking in decisions	4.77	7.07*
(number of persons in sample)	(30)	(30)
Associating with very congenial co-workers	5.67	6.87*
(number of persons in sample)	(30)	(30)
Associating with intellectually competent co-workers	8.33	7.93
(number of persons in sample)	(30)	(30)
Using technical knowledge, skills	8.47	5.83*
(number of persons in sample)	(30)	(30)

*The two mean ratings given for this skill differ significantly. The level of significance is chosen as P=0.05 or less.

TABLE 49.–Degree to which occupation satisfies motivations and values, as rated by NASA scientist-supervisors (1=low satisfaction; 9=high satisfaction)

Motivation or value	Degree of satisfaction from occupation	
	In science (arbitrary units, mean)	In management (arbitrary units, mean)
Leadership	4.65	8.06*
(number of persons in sample)	(49)	(49)
Detailed planning	5.45	7.00*
(number of persons in sample)	(49)	(49)
Doing new, different things	7.88	7.27
(number of persons in sample)	(49)	(49)
Direct attack on problems	7.98	7.37*
(number of persons in sample)	(49)	(49)
Contributing to organization's goals	5.33	8.39*
(number of persons in sample)	(49)	(49)
Achieving	8.24	8.00
(number of persons in sample)	(49)	(49)
Help to one's colleagues	5.96	7.59*
(number of persons in sample)	(49)	(49)
Being independent	7.43	6.90
(number of persons in sample)	(49)	(49)
Seeking support of others	4.39	6.20*
(number of persons in sample)	(49)	(49)
Being recognized	8.08	7.55
(number of persons in sample)	(49)	(49)
Being able to exercise authority	4.88	6.58*
(number of persons in sample)	(49)	(48)
Risk-taking in decisions	5.00	6.82*
(number of persons in sample)	(49)	(49)
Associating with very congenial co-workers	5.57	6.86*
(number of persons in sample)	(49)	(49)
Associating with intellectually competent co-workers	7.63	7.35
(number of persons in sample)	(49)	(49)
Using technical knowledge, skills	8.47	6.71*
(number of persons in sample)	(49)	(49)

*The two mean ratings given for this skill differ significantly. The level of significance is chosen as P=0.05 or less.

scientists, the highest satisfaction rating was given by the supervisors; and, among NASA engineers, the highest rating was given by the managers.

Stereotypical Patterns

The above discussions were based only upon the motivations which received the highest mean satisfaction-potential ratings. Therefore the stereotypical role of each of the 15 motivations, as seen by the respondents, was not evaluated for science or engineering work as compared with managerial work. The patterns of motivations associated with the two occupations are found in the answers to these questions:

> Now, let's go over this list of rewards in terms of those you think best describe a person who is a scientist [or engineer]. You may select as many as you wish. Which ones best describe a scientist [or engineer]?
>
> Now tell me which ones best describe a manager. Again, you may select as many as you wish.

The replies to these questions produced stereotype patterns of motivations—showing those which our respondents associated with science or engineering and with management. The following table is based upon selection of each motivation by the greater proportion of respondents as best describing a scientist or engineer or as best describing a manager.

Motivations associated with science or engineering	*Motivations associated with management*
Liking to do new and different things	Being a leader
Making direct attack on problems	Contributing to organization's goals
Being independent	Helping one's colleagues
Being recognized	Seeking the support of others
Associating with intellectually competent co-workers	Exercising authority
Using technical knowledge and skills	Risk-taking in decisions

Except for managers in NIH and managers among NASA engineers, the groups of respondents most often associated the enjoyment of detailed planning with managers. The NIH managers tended to associate enjoyment of detailed planning with scientists rather than managers. Among NASA engineer-managers, about the same proportions associated this motivation with engineers as with managers.

The perception of the need to achieve through overcoming difficult obstacles varied. All bench respondents associated this motivation with scientists or engineers. NASA scientist-supervisors agreed. Among all other categories of respondents, however, the largest proportions said that the need to achieve describes both specialists and managers.

Perception of "associating with very congenial co-workers" varied, as shown in the accompanying list.

Respondent groups linking desire for "congenial co-workers" & science or engineering	*Respondent groups linking desire for "congenial co-workers" & management*
Senior managers —NIH —NASA engineers	Senior managers —NASA scientists
Managers —NASA scientists	Managers —NIH
	Supervisors —NIH —NASA scientists
	Bench —NIH —NASA scientists —NASA engineers

Differences Related to the Specialist-Manager Transition.—When one moves from science or engineering into management, the potential for satisfying the following motivations tends to *increase* (based upon the satisfaction ratings, tables 46 through 54).

- Being a leader
- Liking to do detailed planning
- Contributing to the organization's goals
- Helping one's colleagues
- Seeking the support of others
- Exercising authority
- Risk-taking in decision-making.

In the transition to management, the potential for satisfying these motivations tends to *decrease:*

- Making direct attack on problems
- Being independent
- Being recognized for accomplishments
- Using technical knowledge and skills.

Generally, satisfaction potential for the need to achieve, and for associating with very congenial co-workers, tended to increase in the transition, but most of the differences involved were not significant. There was a general tendency toward decrease of satisfaction potential, in the transition, for enjoyment of new and different things and for association with

TABLE 50. -Degree to which occupation satisfies motivations and values, as rated by NASA scientist-managers (1=low satisfaction; 9=high satisfaction)

Motivation or value	Degree of satisfaction from occupation	
	In science (arbitrary units. mean)	In management (arbitrary units. mean)
Leadership (number of persons in sample)	5.18 (49)	8.06* (48)
Detailed planning (number of persons in sample)	6.14 (49)	6.94* (49)
Doing new, different things (number of persons in sample)	7.63 (49)	7.19 (48)
Direct attack on problems (number of persons in sample)	8.16 (49)	7.81 (48)
Contributing to organization's goals (number of persons in sample)	5.20 (49)	8.10* (49)
Achieving (number of persons in sample)	8.18 (49)	8.00 (48)
Help to one's colleagues (number of persons in sample)	6.43 (49)	6.82 (49)
Being independent (number of persons in sample)	7.71 (49)	6.27* (48)
Seeking support of others (number of persons in sample)	4.78 (49)	6.31* (49)
Being recognized (number of persons in sample)	8.22 (49)	7.59* (49)
Being able to exercise authority (number of persons in sample)	5.00 (49)	7.10* (48)
Risk-taking in decisions (number of persons in sample)	5.24 (49)	6.94* (48)
Associating with very congenial co-workers (number of persons in sample)	6.90 (49)	7.16 (49)
Associating with intellectually competent co-workers (number of persons in sample)	8.18 (49)	7.78* (49)
Using technical knowledge, skills (number of persons in sample)	8.49 (49)	6.37* (49)

*The two mean ratings given for this skill differ significantly. The level of significance is chosen as P=0.05 or less.

TABLE 51. Degree to which occupation satisfies motivations and values, as rated by NASA scientist-senior managers (1=low satisfaction; 9=high satisfaction)

Motivation or value	Degree of satisfaction from occupation	
	In science (arbitrary units, mean)	In management (arbitrary units, mean)
Leadership	4.28	7.88*
(number of persons in sample)	(32)	(33)
Detailed planning	4.48	6.45*
(number of persons in sample)	(33)	(33)
Doing new, different things	7.42	6.97
(number of persons in sample)	(33)	(33)
Direct attack on problems	7.73	7.09*
(number of persons in sample)	(33)	(33)
Contributing to organization's goals	4.64	8.15*
(number of persons in sample)	(33)	(33)
Achieving	7.52	8.09
(number of persons in sample)	(33)	(33)
Help to one's colleagues	5.73	7.36*
(number of persons in sample)	(33)	(33)
Being independent	7.82	6.19*
(number of persons in sample)	(33)	(32)
Seeking support of others	3.94	6.42*
(number of persons in sample)	(33)	(33)
Being recognized	8.06	7.36*
(number of persons in sample)	(33)	(33)
Being able to exercise authority	4.27	6.91*
(number of persons in sample)	(33)	(33)
Risk-taking in decisions	4.58	6.61*
(number of persons in sample)	(33)	(33)
Associating with very congenial co-workers	5.79	6.45
(number of persons in sample)	(33)	(33)
Associating with intellectually competent co-workers	7.97	7.39*
(number of persons in sample)	(33)	(33)
Using technical knowledge, skills	8.27	6.88*
(number of persons in sample)	(33)	(33)

*The two mean ratings given for this skill differ significantly. The level of significance is chosen as P=0.05 or less.

TABLE 52. Degree to which occupation satisfies motivations and values, as rated by NASA engineer-supervisors (1=low satisfaction; 9=high satisfaction)

Motivation or value	Degree of satisfaction from occupation	
	In science (arbitrary units, mean)	In management (arbitrary units, mean)
Leadership	4.18	7.71*
(number of persons in sample)	(49)	(49)
Detailed planning	5.49	6.39
(number of persons in sample)	(49)	(49)
Doing new, different things	7.67	7.41
(number of persons in sample)	(49)	(49)
Direct attack on problems	7.84	7.55
(number of persons in sample)	(49)	(49)
Contributing to organization's goals	5.55	7.96*
(number of persons in sample)	(49)	(49)
Achieving	7.57	7.80
(number of persons in sample)	(49)	(49)
Help to one's colleagues	5.88	7.51*
(number of persons in sample)	(49)	(49)
Being independent	5.92	6.29
(number of persons in sample)	(49)	(49)
Seeking support of others	4.48	5.92*
(number of persons in sample)	(49)	(48)
Being recognized	7.92	7.69
(number of persons in sample)	(49)	(49)
Being able to exercise authority	4.86	7.02*
(number of persons in sample)	(49)	(49)
Risk-taking in decisions	4.86	6.73*
(number of persons in sample)	(49)	(49)
Associating with very congenial co-workers	6.55	7.10*
(number of persons in sample)	(49)	(49)
Associating with intellectually competent co-workers	7.82	7.65
(number of persons in sample)	(49)	(49)
Using technical knowledge, skills	8.31	6.69*
(number of persons in sample)	(49)	(49)

*The two mean ratings given for this skill differ significantly. The level of significance is chosen as P=0.05 or less.

TABLE 53.–Degree to which occupation satisfies motivations and values, as rated by NASA engineer-managers (1=low satisfaction; 9=high satisfaction)

Motivation or value	Degree of satisfaction from occupation	
	In science (arbitrary units, mean)	In management (arbitrary units, mean)
Leadership	5.20	8.20*
(number of persons in sample)	(49)	(50)
Detailed planning	6.57	6.74
(number of persons in sample)	(49)	(50)
Doing new, different things	7.65	7.78
(number of persons in sample)	(49)	(50)
Direct attack on problems	8.02	7.52*
(number of persons in sample)	(49)	(50)
Contributing to organization's goals	5.45	8.00*
(number of persons in sample)	(49)	(50)
Achieving	7.80	8.12*
(number of persons in sample)	(49)	(50)
Help to one's colleagues	6.59	7.24*
(number of persons in sample)	(49)	(50)
Being independent	7.27	7.12
(number of persons in sample)	(49)	(50)
Seeking support of others	4.67	6.52*
(number of persons in sample)	(49)	(50)
Being recognized	8.04	7.98
(number of persons in sample)	(49)	(50)
Being able to exercise authority	5.88	7.70*
(number of persons in sample)	(49)	(50)
Risk-taking in decisions	5.65	7.36*
(number of persons in sample)	(49)	(50)
Associating with very congenial co-workers	6.78	7.06
(number of persons in sample)	(49)	(50)
Associating with intellectually competent co-workers	7.65	7.76
(number of persons in sample)	(49)	(50)
Using technical knowledge, skills	8.35	6.54*
(number of persons in sample)	(49)	(50)

*The two mean ratings given for this skill differ significantly. The level of significance is chosen as P=0.05 or less.

TABLE 54.–Degree to which occupation satisfies motivations and values, as rated by NASA engineer-senior managers (1=low satisfaction; 9=high satisfaction)

Motivation or value	Degree of satisfaction from occupation	
	In science (arbitrary units, mean)	In management (arbitrary units, mean)
Leadership (number of persons in sample)	4.33 (30)	7.87* (30)
Detailed planning (number of persons in sample)	5.10 (30)	6.03* (30)
Doing new, different things (number of persons in sample)	8.00 (30)	7.97 (30)
Direct attack on problems (number of persons in sample)	7.80 (30)	7.50 (30)
Contributing to organization's goals (number of persons in sample)	5.80 (30)	8.10* (30)
Achieving (number of persons in sample)	8.10 (30)	8.03 (30)
Help to one's colleagues (number of persons in sample)	5.80 (30)	6.70* (30)
Being independent (number of persons in sample)	6.70 (30)	6.63 (30)
Seeking support of others (number of persons in sample)	4.03 (29)	5.28* (29)
Being recognized (number of persons in sample)	7.77 (30)	7.47 (30)
Being able to exercise authority (number of persons in sample)	5.07 (30)	6.90* (30)
Risk-taking in decisions (number of persons in sample)	5.03 (30)	6.90* (30)
Associating with very congenial co-workers (number of persons in sample)	5.87 (30)	6.13 (30)
Associating with intellectually competent co-workers (number of persons in sample)	7.17 (30)	7.40 (30)
Using technical knowledge, skills (number of persons in sample)	8.10 (30)	6.23* (30)

*The two mean ratings given for this skill differ significantly. The level of significance is chosen as P=0.05 or less.

intellectually competent co-workers—but, again, most of the differences involved were not significant.

Difficulty of Satisfying Motivations, in Transition

The respondents were asked whether they thought each of the respective motivations "would be relatively difficult to satisfy, relatively easy to satisfy, or make no difference, when a person moves from being a scientist [or engineer] to being a supervisor or manager."

There were four motivations for which the replies consistently indicated relative ease of satisfaction, in the transition:

- Being a leader
- Contributing to the organization's goals
- Helping one's colleagues
- Exercising authority.

There were just two motivations for which the replies consistently indicated relative difficulty of satisfaction, at transition:

- Being independent
- Using technical knowledge and skills.

"Associating with intellectually competent co-workers" was an item with high satisfaction potential for work as a scientist or engineer. Most respondents said that there would be no difference in ability to satisy this motive, in the shift to management.

For each of the other eight motivations the data produced no consistent direction in terms of relative difficulty.

For example, "being recognized" was perceived as having high satisfaction potential for scientists or engineers, but not for managers. A scientist or engineer with a high need to be recognized would be expected to maintain that high degree of need if he became a manager. Yet the respondents were not consistent in what they thought would happen to such a person, in terms of relative difficulty of satisfying that need. In several groups, roughly equal proportions saw, respectively, relative ease and relative difficulty of satisfying this particular need. These groups were NIH supervisors, managers, and senior managers. NASA engineer-managers, NASA scientist-managers and scientist-senior managers more often said that the need for recognition would be relatively difficult to satisfy. In contrast, NASA engineer-senior managers more often said this need would be relatively easy to satisfy, under the circumstances described.

The remaining motivations for which there were no consistent judgments on relative difficulty, at transition, were:

- Liking to do detailed planning
- Liking to do new and different things
- Making direct attack on problems
- Achieving through overcoming difficult obstacles
- Seeking the support of others
- Risk-taking in decisions
- Associating with very congenial co-workers.

Six motivations had been identified as being associated with science or engineering work namely, liking to do new and different things, making direct attack on problems, being independent, being recognized, associating with intellectually competent co-workers and using technical knowledge and skills. Of these, two were consistently seen as relatively difficult to satisfy, in shifting to managerial work—namely, being independent, and using technical knowledge and skills. It was generally said that there would be no difference in ability to satisfy the need for "associating with intellectually competent co-workers". No consistent patterns were found with respect to the other three motivations—liking to do new and different things, making direct attack on problems, and being recognized.

Risk-taking in decisions was perceived as being more characteristic of managers than of scientists or engineers. Scientists and engineers, however, do engage in some degree of risk-taking in decisions. The respondents were asked how risk-taking is different for managers *vs.* scientists or engineers. Most of the replies stressed the increased scope of the problems encountered by managers, and the implications of the decisions for the outcome of the broader programs and policies. There were frequent comments that the decision consequences involved greater numbers of people and considerable financial risk.

Motivations as Viewed by Specialists at the Bench

Taking into consideration the satisfaction ratings given by the bench respondents (tables 55 through 57), and their selections of certain motivations as best describing specialists and managers, respectively, the following patterns emerged.

Motivations associated with science or engineering	*Motivations associated with management*
Liking to do new and different things	Being a leader
Making direct attack on problems	Doing detailed planning
Achieving through overcoming difficult obstacles	Contributing to organization's goals
Being independent	Helping one's colleagues

TABLE 55. - Degree to which occupation satisfies motivations and values, as rated by NIH bench scientists (1=low satisfaction: 9=high satisfaction)

Motivation or value	Degree of satisfaction from occupation: Received by scientist (arbitrary units, mean)	Degree of satisfaction from occupation: Perceived for manager (arbitrary units, mean)
Leadership	5.63	8.39*
(number of persons in sample)	(27)	(28)
Detailed planning	5.82	7.11*
(number of persons in sample)	(28)	(27)
Doing new, different things	8.00	6.14*
(number of persons in sample)	(27)	(28)
Direct attack on problems	8.19	7.11*
(number of persons in sample)	(27)	(28)
Contributing to organization's goals	5.33	8.18*
(number of persons in sample)	(27)	(28)
Achieving	7.96	7.36
(number of persons in sample)	(27)	(28)
Help to one's colleagues	6.85	7.64
(number of persons in sample)	(27)	(28)
Being independent	8.00	6.86*
(number of persons in sample)	(27)	(28)
Seeking support of others	5.11	6.46*
(number of persons in sample)	(27)	(28)
Being recognized	7.96	7.96
(number of persons in sample)	(27)	(28)
Being able to exercise authority	4.93	7.64*
(number of persons in sample)	(27)	(28)
Risk-taking in decisions	4.96	5.22
(number of persons in sample)	(26)	(27)
Associating with very congenial co-workers	6.63	7.11
(number of persons in sample)	(27)	(28)
Associating with intellectually competent co-workers	7.81	6.79*
(number of persons in sample)	(27)	(28)
Using technical knowledge, skills	8.04	6.29*
(number of persons in sample)	(27)	(28)

*The two mean ratings given for this skill differ significantly. The level of significance is chosen as P=0.05 or less.

Being recognized	Seeking the support of others
Associating with intellectually competent co-workers	Exercising authority
Using technical knowledge and skills	Risk-taking in decisions
	Associating with very congenial co-workers

These data support, in general, the results obtained from the respondents who actually were in management. There are some exceptions, however. The bench respondents associated the need to *achieve* with science or engineering work; there were differences of opinion among the various groups of management respondents as to whether this item had more satisfaction potential among specialists or managers. The bench linked enjoyment of detailed planning, and association with very congenial co-workers, with managerial work; the management respondents were not in general agreement on these items.

Motivations as Seen by Respondents' Superiors

The superiors were asked to rate the amount of satisfaction (using the nine-point scale described earlier) to be obtained from their subordinates' jobs. Here again, the focus was upon the jobs, not upon the subordinates.

The overall pattern was for the superiors to perceive less satisfaction potential in the subordinates' jobs than did the respective subordinates. We discuss below two examples of motivations receiving this pattern of responses—being a leader, and contributing to organization's goals:

1. Being a leader—Among NASA scientists the mean satisfaction rating given by the 20 superiors of managers was 5.85; the mean given by their 20 subordinates was 8.50. Among NASA engineers, the 20 superiors of managers gave a mean satisfaction rating of 5.77; their subordinates gave a mean of 8.22.

2. Contributing to organization's goals—For the 20 superiors of NIH supervisors, the mean satisfaction rating was 6.37; the mean for their subordinates was 8.11. Among NASA superiors of scientist-supervisors, the mean was 7.27; the mean for their subordinates was 8.45. Among NASA superiors of engineer-supervisors, the mean was 6.90; the mean for their subordinates was 7.90.

For 13 of the 15 motivations under study, the mean satisfaction ratings given by the superiors were significantly lower than those given by subordinates:

Being a leader
Liking to do detailed planning
Making direct attack on problems
Contributing to the organization's goals
Achieving through overcoming difficult obstacles
Helping one's colleagues
Being independent
Seeking the support of others
Being recognized
Exercising authority
Risk-taking in decisions
Associating with very congenial co-workers
Associating with intellectually competent co-workers

For each of these 13 motivations, data on the superiors' views were kept segregated by positions of the subordinates—supervisors *vs.* managers. This means that there were 26 opportunities for significant difference between opinion of supervisor and subordinate, in each agency group—NIH, NASA scientists, and NASA engineers.

It developed that NASA engineers and their superiors produced significant differences of opinion in response to 19 of the 26 opportunities: in each of these cases the superiors gave lower mean satisfaction ratings than their subordinates gave. NASA scientists similarly disagreed in 16 of the 26 cases. In contrast, at NIH significantly lower mean satisfaction ratings were given by superiors in only eight of the 26 cases.

There was a general tendency for superiors to assign lower satisfaction potential to motivations than their subordinates assigned—but this tendency was much more characteristic of NASA than of NIH.

There were three motivations for which some groups of superiors gave higher satisfaction ratings than did their subordinates:

Motivations to which superiors assigned higher satisfaction ratings than did their subordinates, by agency and position of subordinate

(1) Being recognized
 —NIH supervisors

(2) Liking to do new and different things
 —NIH supervisors
 —NIH managers

(3) Using technical knowledge and skills
 —NIH supervisors
 —NIH managers
 —NASA engineer supervisors
 —NASA scientist managers
 —NASA engineer managers

One of these was "being recognized". Superiors of NASA scientist- and engineer-managers assigned this item lower satisfaction potential than their subordinates assigned. In NIH, however, superiors of super-

TABLE 56.–Degree to which occupation satisfies motivations and values, as rated by NASA bench scientists (1=low satisfaction; 9=high satisfaction)

Motivation or value	Degree of satisfaction from occupation: Received by scientist (arbitrary units, mean)	Degree of satisfaction from occupation: Perceived for manager (arbitrary units, mean)
Leadership	5.80	8.09*
(number of persons in sample)	(35)	(35)
Detailed planning	5.86	6.66*
(number of persons in sample)	(35)	(35)
Doing new, different things	8.06	7.29*
(number of persons in sample)	(35)	(35)
Direct attack on problems	7.91	7.71
(number of persons in sample)	(35)	(35)
Contributing to organization's goals	6.37	8.20*
(number of persons in sample)	(35)	(35)
Achieving	8.31	8.09
(number of persons in sample)	(35)	(35)
Help to one's colleagues	6.57	7.26
(number of persons in sample)	(35)	(35)
Being independent	7.03	7.32
(number of persons in sample)	(34)	(34)
Seeking support of others	5.20	5.94*
(number of persons in sample)	(35)	(35)
Being recognized	7.51	7.86
(number of persons in sample)	(35)	(35)
Being able to exercise authority	5.57	7.14*
(number of persons in sample)	(35)	(35)
Risk-taking in decisions	5.71	6.69*
(number of persons in sample)	(35)	(35)
Associating with very congenial co-workers	6.51	6.74
(number of persons in sample)	(35)	(35)
Associating with intellectually competent co-workers	7.66	7.29
(number of persons in sample)	(35)	(35)
Using technical knowledge, skills	8.14	6.60*
(number of persons in sample)	(35)	(35)

*The two mean ratings given for this skill differ significantly. The level of significance is chosen as P=0.05 or less.

TABLE 57.–Degree to which occupation satisfies motivations and values, as rated by NASA bench engineers (1=low satisfaction; 9=high satisfaction)

Motivation or value	Degree of satisfaction from occupation: Received by engineer (arbitrary units, mean)	Degree of satisfaction from occupation: Perceived for manager (arbitrary units, mean)
Leadership	5.77	8.03*
(number of persons in sample)	(31)	(31)
Detailed planning	5.68	6.19
(number of persons in sample)	(31)	(31)
Doing new, different things	8.13	6.68*
(number of persons in sample)	(31)	(31)
Direct attack on problems	7.87	6.87*
(number of persons in sample)	(31)	(31)
Contributing to organization's goals	6.23	8.16*
(number of persons in sample)	(31)	(31)
Achieving	8.23	7.87
(number of persons in sample)	(31)	(31)
Help to one's colleagues	6.32	7.29*
(number of persons in sample)	(31)	(31)
Being independent	6.90	6.77
(number of persons in sample)	(31)	(31)
Seeking support of others	5.00	5.81*
(number of persons in sample)	(31)	(31)
Being recognized	8.00	8.29
(number of persons in sample)	(31)	(31)
Being able to exercise authority	5.94	7.55*
(number of persons in sample)	(31)	(31)
Risk-taking in decisions	6.0[illegible]	6.61
(number of persons in sample)	(31)	(31)
Associating with very congenial co-workers	6.13	6.42
(number of persons in sample)	(31)	(31)
Associating with intellectually competent co-workers	7.58	7.52
(number of persons in sample)	(31)	(31)
Using technical knowledge, skills	8.32	6.55*
(number of persons in sample)	(31)	(31)

*The two mean ratings given for this skill differ significantly. The level of significance is chosen as P=0.05 or less.

visors gave "being recognized" a higher satisfaction rating than their subordinates gave. For "liking to do new and different things", NIH superiors of supervisors and of managers gave higher satisfaction ratings than their subordinates gave. For the motivation "using technical knowledge and skills", superiors of NIH supervisors and NASA engineer-supervisors gave higher satisfaction ratings than their subordinates gave; the same pattern occurred with respect to managers in all three agency groups (NIH, NASA scientists and NASA engineers).

The superiors were asked whether each of the motivations would be "relatively difficult to satisfy, relatively easy to satisfy, or would make no differ-

TABLE 58.–Percentages of NIH scientists judging the system of rewards which operates for a manager to be dissimilar and similar to that which operates for a scientist

Judgment of two rewards systems	Percentage reporting each judgment			
	Bench (N=30*)	Supervisors (N=50*)	Managers (N=50*)	Senior managers (N=30*)
Quite different	77%	58%	68%	67%
Quite alike	20	38	32	33

TABLE 59.–Percentages of NASA specialists judging the system of rewards which operates for a manager to be dissimilar and similar to that which operates for a specialist

Judgment of two rewards systems	Percentage reporting each judgment							
	Engineers				Scientists			
	Bench (N=31*)	Supervisors (N=49*)	Managers (N=51*)	Senior managers (N=30*)	Bench (N=35*)	Supervisors (N=49*)	Managers (N=50*)	Senior managers (N=33*)
Quite different	58%	41%	41%	60%	57%	53%	50%	58%
Quite alike	39	59	57	40	40	45	48	39

TABLE 60.–Percentages of NIH scientists holding various views concerning "management as the only path to salary advancement"

View	Percentage holding each view			
	Bench (N=30*)	Supervisors (N=51*)	Managers (N=50*)	Senior managers (N=30*)
Management is the only path to salary advancement	33%	32%	32%	7%
Management is not the only path	47	58	44	86
Management most likely, but not the only path	10	10	10	–
Don't know	10	–	14	–
Totals	100%	100%	100%	100%

*N=number of individuals in sample

ence when a person moves from being a scientist or engineer to being a supervisor or manager." Although the numbers involved are small, there were five motivations which the data suggest that the superiors perceive differently from their subordinates, as regards difficulty of satisfaction. There were: risk-taking in making decisions, using technical knowledge and skills, making direct attack on problems, contributing to the organization's goals, and exercising authority.

1. Risk-taking in making decisions—Of the 20 superiors of NIH supervisors, 11 said this would be relatively difficult, on moving into management; of the 20 subordinates, four said this would be relatively difficult.

2. Using technical knowledge and skills—Of the 20 superiors of managers in the NASA scientist group, 14 of the superiors said this would be relatively difficult; only six of the subordinates said it would be relatively difficult. Of the 20 superiors of managers in the NASA engineer group, 12 said this would be relatively difficult; only five of the subordinates said it would be relatively difficult.

3. Making direct attack on problems—Of the 20 NIH superiors of supervisors, 11 said that this would be relatively difficult in the transition; only five of the subordinates agreed.

4. Contributing to the organization's goals—Of the 20 superiors of managers in the NASA scientist group, only two of the superiors said this would be relatively difficult in the transition; 11 of the respondents said it would be relatively difficult.

5. Exercising authority—Of the 20 superiors of managers in the NASA scientist group, only three of the superiors said this would be relatively difficult to satisfy in the transition; 11 of the subordinates said it would be difficult to satisfy.

Systems of Rewards, for Specialists and Managers

Most of the respondents thought that the system of rewards that operated for managers was quite different from that which operated for scientists or engineers. The only exceptions to this were found among NASA engineer-supervisors and -managers. In these latter cases, most said that the two systems of rewards were quite alike (tables 58 and 59).

The system of rewards which operated for a scientist or engineer was said to be:

- Achievement of goals and objectives; successful job performance
- Recognition among peers and colleagues
- Awards and other acknowledgments of outstanding job performance
- Satisfaction of solving problems; of meeting a challenge
- Status; pride in position attained
- Independence of action
- Making contributions to the advancement of science; making new discoveries
- Interchange of professional information at meetings, through papers
- Utilization of personal abilities; creative use of one's abilities
- Financial advancement

The system of rewards said to operate for a manager included:

- Financial advancement (mentioned more frequently as a reward for managers than as a reward for scientists or engineers)
- Advancement or promotion in grade or position
- Satisfaction from directing others; increased authority
- Enabling others to make a contribution
- Wider scope and involvement in policy decisions
- Status; pride in position attained
- Achievement of goals and objectives; successful job performance

Both systems of rewards were said to contain achievement satisfactions and status satisfactions. The context was different, however. The system of rewards for scientists and engineers is mainly specialty-oriented; the system for managers is primarily oriented toward scope of operation and exercise of authority. There also seemed to be more emphasis upon financial reward in the system for managers.

Management as the Only Path to Financial Advancement

In NIH, about 30 percent of the respondents currently working at the bench, and about the same proportion among supervisors and managers, said that if a scientist wanted to advance in salary, the only path open to him would be to go into management. Only seven percent of NIH senior managers said this. The largest proportions of each group of NIH respondents stated that this was not true. Approximately 10 percent, however, gave the qualified response that although it was not the only path, management was the most likely one (table 60).

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Among NASA supervisors and managers, one-half said that the only path to salary advancement was through management. About 45 percent of managers in NASA said this. In contrast, only 23 percent of senior managers said that management was the only path to salary advancement (tables 61 and 62). Among the lower-job-level respondents there was no widespread confidence that salary advancement could be attained without going into management.

Those who said that the only path to salary advancement was through management reacted unfavorably to this perceived circumstance. The view was that skill in a scientific or engineering specialty should carry with it financial reward.

Circumstances of First Managerial Position

A variety of factors was cited when the respondents were asked, "What factors or circumstances caused you to enter your first managerial or supervisory position?" Many said that their promotions had been offered or initiated by management. Others said that they had possessed the necessary qualifications. Still others said that the openings had been created by advancement of their immediate superiors.

TABLE 61.–Percentages of NASA scientists holding various views concerning "management as the only path to salary advancement"

View	Percentage holding each view			
	Bench (N=35*)	Supervisors (N=49*)	Managers (N=50*)	Senior managers (N=33*)
Management is the only path to salary advancement	54%	53%	44%	24%
Management is not the only path	29	35	52	64
Management most likely, but not the only path	11	12	2	12
Don't know	6	–	2	–
Totals	100%	100%	100%	100%

TABLE 62.–Percentages of NASA engineers holding various views concerning "management as the only path to salary advancement"

View	Percentage holding each view			
	Bench (N=31*)	Supervisors (N=49*)	Managers (N=51*)	Senior managers (N=30*)
Management is the only path to salary advancement	55%	55%	45%	23%
Management is not the only path	35	45	45	70
Management most likely, but not the only path	10	–	8	7
Don't know	–	–	2	–
Totals	100%	100%	100%	100%

*N=number of individuals in sample

Some said that openings had been created by the expansion of programs. Among respondents working as bench scientists or engineers, about 40 percent said that the acquisition of their own businesses might cause them to enter management (tables 63 through 65).

Thoughts on Approaching Management

Perceptions of the motivations and the system of rewards associated with management can influence the scientist or engineer, as he considers shifting into management. The respondents were asked:

> In the last position in which you worked, as a scientist [or engineer], what were your thoughts when you considered the possibility that you might go into a managerial position?

Approximately 65 percent of all of the respondents gave answers which indicated they had reacted favorably to the possibility of going into management; about 45 percent had reacted unfavorably. Some had reacted both favorably and unfavorably. There was no sharp variation, in this respect, by agency group (NIH, NASA scientists, NASA engineers).

Among the favorable reactions were:

> Management involves broader or wider scope of work in the organization.
>
> Management brings a change of emphasis and a change of pace.
>
> There was a desire to change roles.
>
> Management gives an opportunity to initiate or influence policies, programs, methods.

TABLE 63.–percentages of NIH scientists citing various factors or circumstances as having caused initial entry into management (ten most frequent responses)

Factor or circumstance	Percentage reporting each factor or circumstance as entry cause (ten most frequent responses)			
	Bench* (N=30†)	Supervisors (N=49†)	Managers (N=50†)	Senior managers (N=30†)
Opening created by program expansion	7%	10%	2%	3%
Acquisition of own business	40	–	–	–
Unplanned circumstance, availability at time opening was created	–	10	18	17
Promotion was offered or initiated by management	3	26	22	27
Ability–possessed necessary qualifications of knowledge or aptitude	7	22	20	7
Personal ambition	17	–	6	3
Opportunity or desire for leadership duties, direction, policy-making, or exercise of power	17	4	8	3
Opportunity or desire for advancement in position, level, or grade, or a larger potential for advancement	–	10	14	3
Opportunity or desire for personal relationships at a higher level	3	2	4	–
Opportunity or desire for more interesting, enjoyable work	3	4	18	17

*Bench respondents were asked, "What factors or circumstances *might* cause you to enter a managerial position?"

†N=number of individuals in sample

TABLE 64.–Percentages of NASA engineers citing various factors or circumstances as having caused initial entry into management (ten most frequent responses)

Factor or circumstance	Percentage reporting each factor or circumstance as entry cause (ten most frequent responses)			
	Bench* (N=31†)	Supervisors (N=49†)	Managers (N=50†)	Senior managers (N=29†)
Opening created by program expansion	10%	26%	16%	31%
Acquisition of own business	52	–	4	–
Unplanned circumstance, availability at time opening was created	10	8	12	3
Promotion was offered or initiated by management	–	33	26	38
Ability–possessed necessary qualifications of knowledge or aptitude	10	12	22	24
Personal ambition	19	6	10	3
Opportunity or desire for leadership duties, direction, policy-making, or exercise of power	3	–	10	7
Opportunity or desire for advancement in position, level, or grade, or a larger potential for advancement	–	16	22	10
Opportunity or desire for personal relationships at a higher level	19	–	–	–
Opportunity or desire for more interesting, enjoyable work	7	4	8	7

*Bench respondents were asked, "What factors or circumstances *might* cause you to enter a managerial position?"

†N=number of individuals in sample

It provides the possibility of fulfilling one's own scientific goals through management.

This is an opportunity to discharge an obligation to science; to advance the cause of science.

The work (management) is challenging and a test of one's ability.

There would be self-development in terms of acquiring new knowledge, expertise, experience.

There would be financial advancement.

There would be greater prestige.

Included in the unfavorable reactions were:

Management involves the loss of opportunity to work in one's field of specialization.

It involves the loss of opportunity to do work which is enjoyable and interesting.

One is concerned whether the change of role would produce satisfaction or happiness.

There is question whether going into management would justify moving from an established, successful work area to a new one.

Wonder (or doubt) that one has the needed aptitudes or abilities.

The possibility of going into management created reluctance and apprehension.

The favorable reactions may be characterized by perceptions of management as a broadening of opportunity and influence, as a challenge, and as a personal advancement. The themes in the unfavorable

TABLE 65.–Percentages of NASA scientists citing various factors or circumstances as having caused initial entry into management (ten most frequent responses)

Factor or circumstance	Percentage reporting each factor or circumstance as entry cause (ten most frequent responses)			
	Bench* (N=35†)	Supervisors (N=49†)	Managers (N=49†)	Senior managers (N=33†)
Opening created by program expansion	9%	26%	10%	18%
Acquisition of own business	34	–	-	–
Unplanned circumstance, availability at time opening was created	11	10	8	12
Promotion was offered or initiated by management	14	39	26	46
Ability–possessed necessary qualifications of knowledge or aptitude	11	39	22	24
Personal ambition	11	8	2	3
Opportunity or desire for leadership duties, direction, policy-making, or exercise of power	9	16	12	9
Opportunity or desire for advancement in position, level, or grade, or a larger potential for advancement	–	8	13	12
Opportunity or desire for personal relationships at a higher level	29	–	4	–
Opportunity or desire for more interesting, enjoyable work	–	4	10	3

*Bench respondents were asked, "What factors or circumstances *might* cause you to enter a managerial position?"

†N=number of individuals in sample

reactions are reluctance to leave one's specialty, and anxiety as to one's competence to perform effectively in the managerial role.

Differences between the Roles of Specialist and Administrator

Motivational potential is revealed in the answers to the question:

> Thinking back over this entire interview, what would you now say are the major differences between the scientist's [or engineer's] and the administrator's roles?

The key differences cited can be summarized as follows:

The role of scientist or engineer	*The role of administrator*
Originates projects; creates; develops research; seeks knowledge.	Has broad perspective.
Is self-oriented; utilizes own skills; evaluates own work.	Has full responsibility.
Has a narrower perspective; works on limited programs.	Sustains projects; provides organization helping scientist to achieve.
Has limited responsibilities.	People oriented; responsible for and responsive to people on every level.
Is technically oriented; specialized.	Utilizes and integrates skills of others; motivates, regulates others.
Is objective; factual.	Concerned with limitations of budgets.
Is independent in actions.	

Again we see the themes of specialization and independence associated with being a scientist or engineer, and a broad scope of operations and exercise of authority associated with being a manager.

Primary Adjustments Made by a Specialist in Transition

The respondents were asked, "What would you say are the primary adjustments that a scientist [or engineer] has to make to become a successful manager?" The most frequently given replies were:

Relinquish one's own research activity.

Participate in interpersonal relationships at all levels.

Accept loss of independence of action.

Learn to operate within the organizational restraint.

Acquire organizational skills.

Accept success of the organization rather than own success.

Delegate authority.

Utilization of skills of others.

Accept responsibility for the organization.

Relinquish concern with detailed operation; adjust to broader scope of operation.

Adopt subjective approach.

Develop qualities of leadership.

Criteria which Superiors Use to Select Managers

For each respondent group of supervisors and managers, (NIH, NASA scientists, NASA engineers). 20 superiors were asked what specific criteria they used in selecting candidates for a supervisory or managerial position. The highest proportions (about 80 percent) said they used the criterion of technical qualifications or competence. Approximately 70 percent said they used the criterion of ability to interact with others (congeniality, "personality", ability to inspire confidence). About 30 percent said they used as criteria the supervisory abilities, and leadership capacity to motivate others. Smaller proportions said their criteria included organizational ability; ability to plan, make decisions, solve problems, and communicate; and willingness to support organizational goals and policies.

Most superiors gave several criteria. They were asked to rank them in order of importance. The criterion most frequently given the first rank was technical qualifications or competence. No other criterion approached this one in being ranked first.

Superiors did not place nearly as much stress on motivational criteria as they did upon technical competence.

The degree to which the superiors have some sense of the motivations of their subordinates is seen in their answers to the question, "Why should an engineer or scientist such as ——— enter management?" The main reasons given were:

To advance in position

To work on a broader scope

To do more interesting work; technical work is too routine

To contribute to the organization's goals

For prestige and status

For achievement and recognition

To make more money

To have a greater degree of responsibility

Management is the ultimate level of advancement possible for a technical person.

Chapter Summary

Quite different patterns of motivation are associated with science or engineering work *vs.* managerial work. Of the set of motivations associated with being a scientist or engineer (that is, "specialists' motivations"), two were consistently seen as relatively difficult to satisfy in the transition to management—namely, being independent, and using one's technical knowledge and skills. As to the relative difficulty of satisfying the other specialist motivations, at transition, there was considerable difference of opinion.

There still remains the point that if an individual is highly involved with specialists' motivations, and if the motivations associated with working as a manager (that is, "managers' motivations") have little meaning or appeal for him, the transition can be a problem for that individual.

Bench scientists and engineers generally made the same distinctions about the motivational patterns of specialists and managers as did those respondents who were in management.

Superiors of supervisors and managers consistently differed with their subordinates over the degree of satisfaction to be obtained in their subordinates' jobs as managers. Superiors may tend to underrate the role of motivations in their subordinates' approach to their work as managers. For three motivations (risk-taking in decisions, using technical knowledge and skills, and making direct attack on problems), superiors perceived greater difficulty in obtaining satisfaction in transition than their subordinates perceived. They saw two motivations (contributing to the organization's goals, and being able to exercise authority) as significantly easier to satisfy than the subordinates saw them. These differences may arise from the difference in hierarchical perspectives and expectations, or they may reflect a lack of understanding by the superior about the motivational problems facing the subordinate in transition.

IX. TRAINING NEEDS

The respondents were asked, "What kind of help should be provided to the scientist [or engineer] who is moving into his first managerial position?" The most frequently given replies centered upon three themes.

The first was definition of the organization, in terms of lines of authority and duties and responsibilities. This reflects the concern shown previously with learning how to operate within the organizational system.

Fiedler and Neeley, in a review of second-level management for the U.S. Civil Service Commission, concluded that these were the principal areas within which the manager must become skilled:[23]

> The second-level manager must ... become an expert in organizational procedure. He must learn how to get what from whom, and he must maintain the pipeline of his sub-organization to other components of the organization. He must know the informal as well as the formal channels, and he must learn when it is safe and proper to use informal rather than formal methods for accomplishing his ends.

The second theme concerned the acquisition of support from the individual's supervisor. This would include advice, counseling and evaluation of performance.

The third theme related to training in basic management and management techniques. When specific training needs were mentioned, those most frequently cited were training in personnel administration and training in organization and policy. Budgeting was also mentioned. Some of the respondents said there should be internships or periods of observation before the actual duties are assumed.

When the 20 superiors of each sub-sample of supervisors and managers were asked the same question, they most often said that the help needed was support, counseling and advice by the individual's supervisor. They also frequently mentioned training in the fundamentals of management, management techniques, and definition of the organization's lines of authority and responsibility. Some of the superiors advocated internships or periods of observation before the individual assumed his managerial duties.

These findings are consistent with the results of Crockett's study of NASA engineers at the Manned Spacecraft Center. In that study the engineers selected five areas of training as most needed: decision-making (particularly in the non-technical context), planning and goal setting, human behavior in organizations, principles of organization, and communications (oral and written).[24]

In a similar vein Leich and Oganovic reported the results of a survey of 193 administrators of Federal technical programs (scientists and engineers), who were asked, "What courses at graduate level would you recommend be made available to prepare people of scientific backgrounds for more responsible positions in science administration or management policy formulation?" Nearly three-fourths suggested titles (or disciplines) related to the organization and its environment, or to management techniques.[25]

Concern for the Transition, as Shown by NIH and NASA

Respondents were asked this question:

> How does NIH [or NASA] show that it is concerned about the transition of scientists [or engineers] into managers?

As many as 46 percent of the respondents (this percentage was observed among NIH supervisors) replied that their agency did *not* show it was concerned.

More generally, about 30 percent of all respondents said their agency did not show it was concerned. The lowest proportion saying this (13 percent) was among NASA engineer-senior managers (table 66).

The four categories of answers most frequently given to this question were:

Provision of training programs, courses, etc.
There is an ordered program of evaluation to fill management positions.
Does *not* show that it is concerned.
Don't know.

Only the first category is positive. The second begs the question, the third is definitely negative, and the fourth shows a lack of awareness or uncertainty (perhaps a reluctance to flatly say "no"). If one looks only at the positive responses, at least half of the NASA engineers (all groups), NASA scientist supervisors, and NIH managers and senior managers said their respective agencies did show concern.

However, the majority of the respondents did refer to activities which may reflect the concern of their respective agencies for individuals making the transition to management. The activities most frequently mentioned were training programs, courses, and seminars. There were a few mentions of activities such as counseling, internships or special supervisory training in work situations, and integration of technical and management functions in one position.

When the sets of 20 superiors were asked the same question, the great majority cited training programs, courses and seminars. A few said that their agencies either did not show concern or did not show *enough* concern for the individuals in transition to management.

Specific Training Programs Mentioned

The respondents were asked:

> What specific training programs does your agency have that are designed to help scientists [or engineers] make the transition to management?

Approximately 50 percent said there were training programs having to do with management problems and techniques. Some respondents among NASA scientists and NASA engineers mentioned programs in supervision and leadership; very few at NIH mentioned such programs. Several NASA respondents (scientists and engineers) mentioned self-development programs taken at colleges or universities; again, few at NIH mentioned such programs. In contrast, there were numerous mentions at NIH of a Grants Associates Program. Other specific programs mentioned, but only by a few respondents in each case, were Brookings, Harbridge House—mentioned in NASA only—and the Federal Executive Institute—mentioned

TABLE 66.—Percentages of specialists holding various views concerning "how the agency shows its concern about the transition of scientists and engineers to managers" (four most frequent responses)

View on question	Percentage reporting each view											
	NIH scientists				NASA engineers				NASA scientists			
	Bench (N= 28*)	Spvrs. (N= 50*)	Mgrs. (N= 50*)	Sr. mgrs. (N= 29*)	Bench (N= 31*)	Spvrs. (N= 49*)	Mgrs. (N= 50*)	Sr. mgrs. (N= 30*)	Bench (N= 34*)	Spvrs. (N= 49*)	Mgrs. (N= 49*)	Sr. mgrs. (N= 33*)
There is an ordered evaluation program to fill management positions	11%	18%	8%	34%	–	4%	18%	20%	9%	–	4%	36%
Provision of training programs, courses, seminars, Grants Associate Program	14	8	54	55	52%	71	52	77	38	57%	39	46
Does not show that it is concerned	39	46	18	24	36	24	32	13	38	26	37	21
Don't know	25	10	18	3	6	–	4	3	9	6	16	3

*N=number of individuals in sample

only by senior managers. This last-mentioned program is for grades GS-16 through GS-18.

Most of the superiors of respondents, when asked this question, cited training programs which dealt with management problems and techniques.

The two programs most frequently mentioned were the NASA course in supervision and the NIH Grants Associates Program. The NASA course was developed by Leadership Resources, Incorporated (LRI) under the guidance of NASA's central Personnel Division and in cooperation with each field center. It is well received because it combines general concepts of supervision and management with the specific problems and environment of NASA and the field center where the course is given. This "tailoring" pays off in acceptance by scientists and engineers, who might reject more traditional programs using industrial or other settings as a background. The course includes considerable material on the organizational environment, and organizational goals and procedures.[26] Field centers also develop their own programs of supervisory training to comply with the Civil Service Commission's requirement (November 1968) of 80 hours of training for all supervisory positions.[27]

The NIH also provides a course in supervision, with a heavy content of interpersonal relations and human behavior in organizations. This is relatively new and was, therefore, unfamiliar to most of the NIH respondents. They tended to be more familiar with the Grants Associates Program, which is an analog to the Management Intern Program, but taking research scientists (mostly from universities) at levels GS-12 to GS-14. It consists of a year-long series of rotating work assignments throughout the organization, combined with more formal training covering general management, analytical management tools, science and public policy, administration and organization within the Federal Government. Each associate is assigned to a "preceptor" who is responsible for providing him general guidance and counsel.

TABLE 67.–Percentages of NIH scientist-managers reporting participation in training programs designed to assist in the transition to management

Response	Percentage giving each response		
	Supervisors (N=37*)	Managers (N=46*)	Senior managers (N=27*)
Have participated in such programs	22%	59%	48%
Have not participated	78	41	52
Totals	100%	100%	100%

Participation in Training Programs

Among supervisors, only 22 percent at NIH said they had participated in training programs designed to help scientists make the transition to management. At NASA, however, 62 percent of scientist-supervisors and 76 percent of engineer-supervisors reported participation in such programs (tables 67 and 68).

Among managers, 59 percent reported such participation at NIH, as did 52 percent of NASA scientist-managers, and 54 percent of NASA engineer-managers.

At NIH, 48 percent of the senior managers reported such participation, as did 59 percent of NASA scientist-senior managers and 82 percent of engineer-senior managers.

TABLE 68.–Percentages of NASA specialist-managers reporting participation in training programs designed to assist in the transition to management

Response	Percentage giving each response					
	NASA scientists			NASA engineers		
	Supervisors (N=47*)	Managers (N=44*)	Senior managers (N=32*)	Supervisors (N=45*)	Managers (N=46*)	Senior managers (N=28*)
Have participated in such programs	62%	52%	59%	76%	54%	82%
Have not participated	38	48	41	24	46	18
Totals	100%	100%	100%	100%	100%	100%

*N=number of individuals in sample

TABLE 69.—Percentages of NIH scientists citing various reasons for not attending training programs although aware of them (seven most frequent reasons)

Reasons for non-attendance	Percentage reporting each reason		
	Supervisors (N=26*)	Managers (N=17*)	Senior managers (N=13*)
No programs available at the time of transition	8%	35%	–
Not interested in the subject matter of those programs	15	–	15%
Not relevant to my level of management, too elementary, no value	23	12	38
No time, too busy, cannot fit into schedule	27	18	31
No need, felt capable of making transition without such a program, too late	23	6	8
Had previous experience or training of this kind	4	29	8
Request was refused or not acknowledged	–	–	–

TABLE 70.—Percentages of NASA scientists citing various reasons for not attending training programs although aware of them (seven most frequent reasons)

Reasons for non-attendance	Percentage reporting each reason		
	Supervisors (N=18*)	Managers (N=19*)	Senior managers (N=13*)
No programs available at the time of transition	6%	5%	8%
Not interested in the subject matter of those programs	–	10	–
Not relevant to my level of management, too elementary, no value	11	16	23
No time, too busy, cannot fit into schedule	56	47	31
No need, felt capable of making transition without such a program, too late	11	26	23
Had previous experience or training of this kind	6	21	8
Request was refused or not acknowledged	6	5	8

*N=number of individuals in sample

One of the main reasons given for *not* having participated in these particular programs was that the individual had been "too busy" and unable to fit them into his schedule or workload. This reason tended to be given to higher proportions of NASA supervisors and managers (both scientists and engineers) than by any of the other groups of respondents. Over 40 percent of those who had not participated said this among NASA supervisors and managers, 30 percent or less said this among the other groups—NIH respondents and NASA senior managers (tables 69 through 71).

Another key reason given was that the individuals had felt no need for such training; they had felt capable of making the transition without such a program. This was stated by 32 percent of NIH supervisors who had not participated, 33 percent of NASA engineer-supervisors, 26 percent of NASA scientist-managers, and 23 percent of NASA scientist-senior managers. Relatively low proportions of non-participant NIH managers and senior managers, NASA engineer-managers and NASA scientist-supervisors said they had felt no need for these programs.

Other reasons given by some respondents who had not participated in these programs were: they had not been interested in the subject matter of the programs, no programs had been available at the time, or the programs had not been relevant to their level of management. Some said they had not participated because they had not been invited to attend. Each of these four reasons was given by relatively small proportions of the respondents.

When those who had taken part in these particular programs were asked, "What programs did you participate in?", most said these had been programs in management techniques and management problems. There were some mentions of programs dealing with skills such as speed reading, writing, systems analysis, and program evaluation review techniques.

The programs in management problems were said to have covered a variety of topics—the management of scientific programs, direction of non-scientific programs, Federal policy making, relationship of public policy and science and relationships of government agencies. Included in programs in management techniques were: personnel management, program evaluation, budgeting and finance, general supervision, contract supervision, and project planning.

The respondents who had participated in the programs on management problems and techniques, designed to assist them in the transition, said that these programs had been most valuable.

TABLE 71.—Percentages of NASA engineers citing various reasons for not attending training programs although aware of them (seven most frequent reasons)

Reasons for non-attendance	Percentage reporting each reason		
	Supervisors (N=9*)	Managers (N=20*)	Senior managers (N=4*)
No programs available at the time of transition	11%	10%	25%
Not interested in the subject matter of those programs	–	–	–
Not relevant to my level of management, too elementary, no value	–	10	–
No time, too busy, cannot fit into schedule	44	40	25
No need, felt capable of making transition without such a program, too late	33	15	–
Had previous experience or training of this kind	–	20	–
Request was refused or not acknowledged	–	25	25

*N=number of individuals in sample

Chapter Summary

One of the key needs of scientists and engineers who are moving into management is to learn about the organizational system within which they will have to operate. This would seem to call for a system of internship or periods of observation designed to facilitate such learning.

There is need, also, for activities on the part of supervisors to assist subordinate scientists and engineers in the process of transition.

Specific training is needed, our respondents said, mainly in personnel administration and budgeting.

The level of participation in training programs designed to assist in the transition seems particularly in need of improvement among NIH supervisors.

X. MAKING MANAGERS OF SCIENTISTS AND ENGINEERS

Of the three dimensions involved in management – specific functions to be performed, personal skills needed for performance of these functions, and motivational-value patterns to be satisfied – it is the dimension of *personal skills* which has the greatest potential for creating tension and stress, when an individual moves from science or engineering into management.

Motivational-value conflicts appear to represent problems for a minority of scientists and engineers who make this transition. Least difficulty is experienced in the functions to be performed.

Management Functions

Scientists and engineers generally accept the view that management functions are necessary aspects of administration. This is especially true for the functions of reporting, supervising, planning and program assessment. The key indication that the management functions are not a major source of stress in the transition into management is evident in the extent to which most of the respondents cited management functions they "particularly liked" to perform and seldom gave functions they "particularly disliked". Another indication is the degree to which the respondents said the various functions were not particularly difficult to perform.

Management functions evoke a positive reaction because they are perceived as providing opportunities for the individual to be an influence in the organization. The individual establishes goals and devises methods of attaining them; he uses his technical knowledge on broad-scale problems; he has contact with a broader range of people; he has a chance to assist other people in their development. It is interesting to note that the respondents define the importance of the management functions in terms of what they mean to the individual rather than in terms of their role in the administration of an organization.

Performance of the management functions, *per se*, is not a completely new experience to the scientist or engineer who moves into management. The transition into management, however, brings about changes in two aspects of the functions. On the one hand, performance of these tasks becomes more comprehensive—a greater number of them have to be performed more frequently than was true when the individual was working as a scientist or engineer. The second change is the major one. The activities involved in the respective functions become much broader in scope—broader-based policies and programs; longer-range perspectives; broader spectrum of personal contacts within the organization. These latter aspects of the change in management functions have positive appeal to the scientists and engineers who make the transition.

When the management functions are perceived negatively the reasons given are: one's work in his specialty is disrupted; the person questions whether he has the aptitude or training to perform the tasks; there is dislike of the interpersonal relations involved in management; there is too great a demand for the individual to make subjective judgments; there is greater uncertainty as to the outcome of one's decisions and actions; political expediency is a factor in one's decisions; and management, in general, carries with it a greater degree of constraint and restriction.

Personal Skills

There is primary indication that personal skills can be a source of stress and tension: nearly all of the respondents identified specific skills which represented sources of difficulty in the transition to management. The specific skills most often cited as likely sources of difficulty and the skills mentioned with low frequency fall into two quite different groupings.

The personal skills cited by the highest proportion of respondents as likely sources of difficulty, in the transition, primarily were related to coping with the organizational environment. The particular skills mentioned were:

- Operating within the organizational system
- Operating within the financial system
- Operating within the personnel system
- Recognizing and coping with environmental factors
- Working with diverse people
- Coordinating group effort
- Leadership style.

This set of personal skills represents a pattern basically focused upon coping with the organizational system and the people who compose it. In contrast, relatively few of the respondents said that those personal skills essentially oriented toward task-centered issues were likely sources of difficulty in the transition. Among the task-oriented personal skills are: knowledge of fundamental technology, applications of technology, decision-making, and problem-solving.

Apparently, when the scientist or engineer is working at his specialty his attention is focused upon his immediate tasks and the problems which develop related to them. He is not forced, to any considerable extent, to be concerned with the various operational aspects of the organizational system. When he enters management, he discovers that new perspectives come into play. These new perspectives place great demands upon his ability to understand, cope with and manipulate the organizational system. These demands activate new and different kinds of skills—types of skills for which the very situation of working as a scientist or engineer creates minimal demand.

Motivations and Systems of Rewards

Quite different patterns of motivations were associated by the respondents with "being a scientist or engineer" and with "being a manager". The scientist or engineer was characterized as enjoying new and different activities, direct attack on problems, association with intellectually competent co-workers, and exercise of his technical knowledge and skills; and wanting independence and recognition. These we have informally called "specialists' motivations". In contrast, the manager was characterized as enjoying leadership, detailed planning, helping one's colleagues; association with congenial co-workers, and risk-taking in making decisions; and wanting to exercise authority and to contribute to the organization's goals. These we have called "managers' motivations". The need to achieve by overcoming difficult obstacles was associated both with being a scientist or engineer and with being a manager. The pattern of motivations forming the context for this need to achieve differed, however, between the two types of occupation.

The systems of rewards were also said to be different for scientists and engineers *vs.* managers. Among the rewards for scientists and engineers were: satisfactions derived from the successful completion of tasks, recognition by one's peers and colleagues, independence of action, the sense of making contributions, and the opportunity to make creative use of one's abilities. The system of rewards for managers consisted of: satisfactions derived from directing others, increased authority, pride in position attained, participating in a wide scope of activities, and involvement in policy decisions. Both systems of reward were said to include financial advancement. This particular reward was mentioned more frequently, however, as being a part of the system of rewards of managers.

With such distinct patterns of motivation and reward systems for specialists and managers, one would expect that, for most scientists and engineers, the transition into management would produce stress and tension arising from conflict and frustration. This would be expected if the pattern of motivations operating for the scientist or engineer were deeply established and the motivational pattern associated with being a manager had little appeal or even negative appeal.

Such was not the case for the majority of the respondents, however. Approximately 65 percent of them said they had reacted favorably when considering the possibility that they might go into management. The motivation and reward systems involved in management apparently had positive appeal for these individuals.

A minority of scientists and engineers did say they had reacted unfavorably to the idea of becoming managers. They saw this as involving loss of opportunity to work at their specialties and to do interesting and enjoyable work. They also showed anxiety as to whether they had the abilities needed to perform as a manager. There was a more generalized concern as to whether the change in role would produce "satisfaction or happiness".

The data on motivation and reward systems suggest that there may be three types of scientists and engineers, with respect to the transition to management:

Type I—These are scientists and engineers who have essentially "managers' motivations", although they are working at the moment in their specialties. The "specialists' motivation" pattern has no deep involvement for them (though the pattern must be operative to some degree). One could expect Type I scientists and engineers to be rather active in their efforts to move into management.

Type II- These are scientists and engineers quite involved with "specialists' motivations" and somewhat reluctant to move into management. Once the transition has been made, however, they discover that "managers' motivations" can have meaning for them; satisfactions are derived which had not been anticipated. (In the group interviews, some of the respondents reported this experience. As one respondent said, he had been reluctant to make the change but after he had worked as a manager, he "began to love it.")

Type III—These are scientists and engineers for whom "managers' motivations" have definite negative appeal. If a Type III scientist or engineer should go into management (for financial advancement reasons, or because he was "drafted" into it), he would most likely find the experience quite frustrating because his basic motivations were not being satisfied.

Approximately 65 percent of the respondents said they had looked favorably upon the prospect of going into management, when they were still working as scientists or engineers. Based upon this finding, one can hazard the guess that a majority of the scientists and engineers in management at NIH and NASA are of Type I, and that relatively small proportions are of Type II and Type III. These estimates have to be tempered with the likelihood that the respondents in this research, actually managers, probably reflect a self-selection process which has reduced the number of Type III individuals going into management. Those candidates who reject the motivations associated with management probably tend to avoid opportunities to enter management positions.

The preliminary interviews in this study revealed some anecdotal evidence that each agency occasionally promotes a Type III scientist or engineer to a rather senior supervisory position as a reward for excellence in research, then "protects" him from management tasks by assigning to him a managerially-oriented deputy or assistant. This phenomenon appears to be limited to research laboratories.

Bench Perceptions

The perceptions and opinions of the bench scientists and engineers (the pool from which future managers will emerge) are important.

Bench scientists and engineers anticipated that, in management, the scope or breadth of the management functions (such as budgeting and reporting) would increase. They tended to perceive the management functions as being difficult to perform when one works as a manager. On the other hand, bench scientists and engineers showed some skepticism as to the real importance of the management functions.

With respect to the personal skills required in management, the bench scientists and engineers said (as did the individuals actually in management) that the major areas of difficulty would be: coping with and manipulating the organizational system, working with diverse people and coordinating group efforts.

Finally, the bench respondents held perceptions similar to those in management about specialists' *vs.* managers' motivational patterns.

One main difference was found between the perceptions of bench personnel and the perceptions of other respondents. This difference was in the extent to which bench personnel considered management functions not particularly important in the manager context.

Perceptions by Immediate Superiors

One key factor in easing the transition of scientists and engineers into management has to be the role played by their immediate supervisors. Necessary to this role is understanding, by superiors, of how the individual perceives and reacts to the process of transition.

Perceptions by the immediate superiors studied in this research differed from their subordinates' perceptions about: (1) those management functions disliked and those found difficult to perform, and (2) the importance of ability to cope with and manipulate the organizational system.

In addition, the superiors (3) tended to view "working with diverse people" and "leadership style" as sources of difficulty for their subordinates more frequently than did the subordinates. The superiors also (4) saw problems in the subordinates' ability to earn the confidence of their superiors, to an extent not reported by the subordinates (this may be due to a lack of insight on the part of the subordinates).

Finally, the immediate superiors (5) generally tended to give lower importance ratings to motivational factors than did their subordinates. This may reflect some lesser awareness of the importance of motivations to their subordinates. The immediate superiors of scientists and engineers who have become supervisors and managers need to be alert to the various aspects of their subordinates' reactions to their new roles.

Implications of the Findings

The results of this research have general implications for the selection and training of scientists and engineers to become managers. There are implications, also, for later training programs designed to make them more effective managers.

The most critical problem involved in *selecting* scientists and engineers to become managers lies in the area of motivations. If "managers' motivations" are in direct conflict with the motivations to which an individual has become accustomed as a scientist or engineer, the transition will be a particularly difficult experience. The data suggest that this might be a problem for a minority of scientists and engineers. Even so, the selection process must attempt to identify those for whom motivational frustrations and conflicts will present a real problem. Ideally, this identification can be made at the time an individual is being assessed for a management position. Considerable progress has been achieved in developing systematic, more reliable means to assist in the selection process, as distinguished from the transition process.[28]

The key *training* need falls in the area of the personal skills required to perform the managerial role. The specific problem area is rather sharply defined. It is learning how to cope with and manipulate the organizational environment (the general, financial and personnel systems of the organizations; interaction with diverse people; coordination of group effort; leadership style). If this is the primary problem area, what kind of training would be best suited to fill the need? A program based upon intellectualized and cognitive approaches (such as lectures and readings) will not be sufficient. The experiences needed are those which tend to expose the individual directly to the organizational systems involved. These can be provided by some type of internship program. Such pre-entry or internship activities can also let the scientist or engineer discover the extent to which he can obtain motivational satisfactions from the managerial role.

There is some need for training in specific aspects of the management functions, even though most of the respondents said the functions presented no special difficulty. This is particularly true for budgeting. New developments related to the functions (for example, systems analysis for program assessment) should be brought to the attention of managers.

This research included a review of programs frequently used, in both industry and government, to ease specialists' transition to management. The review revealed few programs that adequately addressed specialists' lack of ability to cope with the organizational environment.[29] Too frequently, knowledge about the organization and principal personalities is assumed and, therefore, not covered in supervisory training programs. There also is a tendency to use case studies and laboratory materials which are not easily related to the work environment of the agency. Generally, industry does a much better job of orienting new employees (as well as potential managers) to the organization, its officers, policies, procedures, and ethos. Except for intern-type programs, most Federal agencies limit their orientation of employees to a half-day or less, and a handful of nondescript brochures.

There is a need for better understanding of the informal structure and processes of the organization. Few *formal* training efforts are likely to fill this need. Ideally, such understanding comes through a combination of experience, observation, and *assistance from one's superior*. As the study demonstrates, this last appears to be a critically weak link. If an agency's leaders are serious about helping scientists and engineers in the transition to managers, they must:

- more strongly emphasize the responsibility of supervisors for developing their subordinates;
- provide incentives for greater concern on the part of supervisors, in meeting these development needs; and
- provide the means by which supervisors can effectively exercise such concern.

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(Campbell *et al.* give the most recent comprehensive review of both selection and training for management candidates and managers. They conclude that there are four principal means, or combinations thereof, used to assess a candidate for a management position: personal interviews, performance evaluation, evaluation of experience and seniority, and assessment centers.

The first is used most extensively and the authors believe interviews generally to be ineffective, serving to fill the needs of the interviewer more than serving as a reliable selection device.

Both performance evaluation [i.e., how well the candidate is doing on his present job] and assessing experience tend to be unsystematic, though some recent computer applications to orderly storage of experience, test scores and performance evaluation are considered a step forward.

Perhaps one of the most promising aids to selection is the assessment center, where basic situations that must be faced in a management setting are presented to candidates and their reactions observed. A panel of observers, trained to evaluate candidate reaction, makes an aggregate assessment, identifying the candidate's strengths and weaknesses. The candidate, usually in the company of five or ten others, undertakes a series of tests and exercises [both group and individual] designed to elicit key forms of behavior which serve as indications of managerial success—e.g., leadership, delegation, control, motivation, organization, and operating under time stress. The assessment-center technique has been used successfully and with some enthusiasm by such organizations as the American Telephone and Telegraph Company, General Electric, J. C. Penny, International Business Machines, Standard Oil of Ohio, and the Internal Revenue Service. The general technique was developed for the selection of agents for the Office of Strategic Services in World War II.)

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APPENDIX: PRINCIPAL QUESTIONNAIRE

National Analysts, Inc.
Philadelphia, Pa.

Study #1-009
Fall, 1969

MAKING MANAGERS STUDY

Basic Questionnaire

Time Interview Began:	AM	PM
Time Interview Ended:	AM	PM

Respondent #:________________

Name of Respondent:____

Agency: NASA [1] NIH [2]

City:______________________ State:______________ Zip:__________

Place Interviewed: Home [1] Office [2]

Telephone Number:______________________

Interviewer's Name:__________________________ S.S.#__________

Date:______________________

INTRODUCTION: I am ______________ from National Analysts, Inc. We are conducting a study for the National Academy of Public Administration in Washington. I believe you recently received a letter informing you about this interview. This study has to do with people who have a science or engineering background and who have gone into management. It is being conducted in several governmental agencies. You were selected in a random sampling of your agency. All answers will be treated as confidential, and no participant will be identified.

1. First of all, is your professional field in the life sciences, the physical sciences, or in engineering?

(REFER TO RESPONDENT AS "SCIENTIST" THROUGHOUT INTERVIEW)	Life sciences	1
	Physical sciences	2
(REFER TO RESPONDENT AS "ENGINEER" THROUGHOUT INTERVIEW AND SKIP TO Q. 2)	Engineering	3

1a. (IF "LIFE SCIENCES," ASK): Which life science is that?

(IF "PHYSICAL SCIENCES," ASK): Which physical science is that?

2. What is your highest earned academic degree? (CIRCLE AS MANY AS GIVEN)

B.A., B.S.	1
M.A., M.S.	2
Ph.D.	3
M.D., D.D.S., D.V.M., O.D.	4
Other (SPECIFY):	5
None	0

3. How many years and months, if any, have you spent in teaching or research at a college or university? Do not include time spent as either a teaching or research assistant while working toward your degree.

(YEARS) (MONTHS)

None	0

4. How many years and months, if any, have you spent working in your scientific or professional field in business, industry, or a non-profit corporation? Do not include any time in which your duties were primarily administrative or managerial.

(YEARS) (MONTHS)

None	0

5. How many years and months have you worked in your scientific field in government agencies? Do not include any time in which your duties were primarily managerial.

(YEARS) (MONTHS)

None	0

6. How many years and months have you worked in primarily managerial positions in business, industry, a non-profit corporation or university?

_____ (YEARS) _____ (MONTHS)

None	0

7. How many years and months have you worked in primarily managerial positions in government agencies?

_____ (YEARS) _____ (MONTHS)

None	0

8. What is the largest number of employees that you have ever had direct responsibility for supervising?

LARGEST NUMBER SUPERVISED: __________

None	0

9. What is your estimate of the number of professional papers or publications that you have authored or co-authored?

NUMBER OF PUBLICATIONS: __________

None	0

10. Speaking only in terms of your work as a scientist/engineer, what was the last such job you held before entering a managerial position?

____

(SKIP TO Q. 12)	None	0

11. Was this job in government, in business or industry, at a college or university, or with a non-profit organization?

Government	1
Business or industry	2
College or university	3
Non-profit organization	4

12. What was your first managerial position in government? (PROBE FOR TITLE AND DUTIES)

13. What was the grade level of your first government managerial position?

GRADE: ________

14. What is your present position? (PROBE FOR TITLE AND DUTIES)

15. What is your grade level?

GRADE: ________

16. How many years and months have you worked in NIH (NACA-NASA)?

________ (YEARS) ________ (MONTHS)

17. What was your age when you first went into a position having management responsibility, whether that position was in government or elsewhere?

YEARS OF AGE: ________

18. After first entering management, did you ever occupy a non-managerial, solely scientific/engineering position?

Yes	1
No	2

18a. Why is that?

19. What, if any, offices have you held in activities outside of your work during the past five years? For example, professional societies, church, community, social or sport activities. (PROBE: Any others?)

a.____________________

b.____________________

c.____________________

d.____________________

e.____________________

f.____________________

No offices	0

20. (HAND RESPONDENT CARD 1; DO NOT TAKE BACK UNTIL AFTER Q. 49.) Here is a list of functions that are commonly found in managerial jobs, along with some examples of the kinds of activities within these functions. Take a moment to note each one, because the next questions have to do with these particular functions.

First, I'd like you to take the perspective you had as a scientist/engineer in the purely professional sense, prior to entering management. Within that perspective, would you say that you actually performed Budgeting "frequently," "occasionally," or "not at all"? (CIRCLE APPROPRIATE CODE BELOW)

How about Reporting?---"frequently," "occasionally," or "not at all"? (REPEAT FOR EACH FUNCTION, CIRCLING APPROPRIATE CODES BELOW)

	Frequently	Occasionally	Not At All
a. Budgeting	1	2	3
b. Reporting	1	2	3
c. Staffing	1	2	3
d. Supervising	1	2	3
e. Planning	1	2	3
f. Policy-Making	1	2	3
g. Representing the Organization	1	2	3
h. Consulting	1	2	3
i. Program Assessment	1	2	3
j. "Fire-Fighting"	1	2	3

21. Still thinking in terms of your work as a scientist/engineer, which of these functions did you especially like to perform? (ENTER IN COLUMN 1 BELOW) (PROBE: Any others you especially liked?)

22. (FOR EACH FUNCTION GIVEN, ASK): Why did you especially like to do (NAME OF FUNCTION)? (ENTER IN COLUMN 2 BELOW)

Col. 1		Col. 2.	
Function		Reason Liked	
None especially liked	0		

23. Which of these functions did you especially dislike to perform? (ENTER IN COLUMN 1 BELOW) (PROBE: Any others you especially disliked?)

24. (FOR EACH FUNCTION GIVEN, ASK): Why did you especially dislike to do (NAME OF FUNCTION)? (ENTER IN COLUMN 2 BELOW)

Col. 1		Col. 2	
Function		Reason Disliked	
None especially disliked	0		

25. When you were working strictly as a scientist/engineer, which of these functions did you find especially difficult to do? (ENTER IN COLUMN 1 BELOW) (PROBE: Any others?)

26. (FOR EACH FUNCTION GIVEN, ASK): Why was (NAME OF FUNCTION) especially difficult? (ENTER IN COLUMN 2 BELOW)

Col. 1		Col. 2
Function		Reason Difficult
None especially difficult	0	

27. Which of these functions did you find particularly time-consuming? (PROBE: Any others you found particularly time-consuming?)

None particularly time-consuming	0

28. Which of these functions did you find to be particularly important in doing your work as a scientist/engineer? (ENTER IN COLUMN 1 BELOW) (PROBE: Any others you found particularly important?)

29. (FOR EACH FUNCTION GIVEN, ASK): Why was (NAME OF FUNCTION) particularly important? (ENTER IN COLUMN 2 BELOW)

Col. 1		Col. 2	
Function		Reason Important	
None particularly important	0		

30. Now, let's shift your perspective from that of your work purely as a scientist/engineer to where you are now--a scientist/engineer with management responsibility. Within this context of supervision or management, do you actually perform Budgeting "frequently," "occasionally," or "not at all"? (CIRCLE APPROPRIATE CODE BELOW)

(REPEAT FOR EACH FUNCTION BELOW): How about Reporting?--"frequently," "occasionally," or "not at all"? (CIRCLE APPROPRIATE CODES BELOW)

	Frequently	Occasionally	Not At All
a. Budgeting	1	2	3
b. Reporting	1	2	3
c. Staffing	1	2	3
d. Supervising	1	2	3
e. Planning	1	2	3
f. Policy-Making	1	2	3
g. Representing the Organization	1	2	3
h. Consulting	1	2	3
i. Program Assessment	1	2	3
j. "Fire-fighting"	1	2	3

31. In terms of your work as a manager, which of these functions do you especially like to perform? (ENTER IN COLUMN 1 BELOW) (PROBE: Any others?)

32. (FOR EACH FUNCTION GIVEN, ASK): Why do you especially like to do (NAME OF FUNCTION) ? (ENTER IN COLUMN 2 BELOW)

Col. 1		Col. 2	
Function		Reason Liked	
None especially liked	0		

33. Which of these functions do you especially dislike to perform? (ENTER IN COLUMN 1 BELOW) (PROBE: Any others you especially dislike?)

34. (FOR EACH FUNCTION GIVEN, ASK): Why do you especially dislike to do (NAME OF FUNCTION) ? (ENTER IN COLUMN 2 BELOW)

Col. 1		Col. 2	
Function		Reason Disliked	
None especially disliked	0		

35. Which of these functions do you find to be especially difficult to perform, now that you are working in a management position? (ENTER IN COLUMN 1 BELOW) (PROBE: Any others?)

36. (FOR EACH FUNCTION GIVEN, ASK): Why is (NAME OF FUNCTION) especially difficult? (ENTER IN COLUMN 2 BELOW)

Col. 1		Col. 2	
Function		Reason Difficult	
None especially difficult	0		

37. Which of these functions do you find particularly time-consuming? (PROBE: Any others?)

None particularly time-consuming 0

38. Which of these functions do you find to be particularly important in doing your work as a supervisor or manager? (ENTER IN COLUMN 1 BELOW) (PROBE: Any others?)

39. (FOR EACH FUNCTION GIVEN, ASK): Why is (NAME OF FUNCTION) particularly important? (ENTER IN COLUMN 2 BELOW)

Col. 1		Col. 2
Function		Reason Important
None particularly important	0	

In the next set of questions I want you to focus upon any changes that you have perceived in the nature of these functions when performed by a scientist/engineer in a purely professional context and when they are performed in what is essentially a managerial context.

40. How is budgeting different in a management position from what it is in the strictly scientific/engineering role? (IF UNCLEAR WHETHER RESPONSE REFERS TO MANAGEMENT OR STRICTLY SCIENTIFIC POINT OF VIEW, PROBE.)

41. How is reporting different in a management position? (PROBE)

42. How is staffing different? (PROBE)

43. How is supervising different? (PROBE)

44. How is planning different? (PROBE)

45. How is establishing policies and procedures different in a management position? (PROBE)

46. How is representing the organization different? (PROBE)

47. How is consulting different? (PROBE)

48. How is program assessment and evaluation different? (PROBE)

49. How is "fire-fighting" different? (PROBE)

(TAKE BACK CARD 1)

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50. (HAND RESPONDENT CARD 2; DO NOT TAKE BACK UNTIL AFTER Q. 53.)
We have been talking about specific functions that a person has to perform, to some degree, whether working as a scientist/engineer, or as a manager. This card contains descriptions of the skills that a person may need to perform the various functions we have just been talking about. Take a moment to note each one of these.

Let's talk first in terms of the perspective you had as a scientist/engineer in the purely professional sense, prior to entering management. We want you to rate how important each one of these is in a person performing your professional specialty. Use the scale from "1" to "9" on the bottom of the card--"1" means that a given skill was not particularly important; "9" means that a given skill was of critical importance. Select a number that tells how important each skill is in a person performing your professional specialty. (READ LIST OF SKILLS AND ENTER RATINGS IN COLUMN 1 BELOW)

51. Still using this "1" through "9" scale, I'd like you to change your perspective from that of the scientist/engineer to that of the manager. You gave Fundamental Technology a rating of (RATING IN COLUMN 1) for a scientist/engineer in a non-managerial position; how important is Fundamental Technology in performing as a manager? (ENTER RATING IN COLUMN 2 BELOW)

(REPEAT FOR EACH SKILL BELOW): You gave (NAME OF SKILL) a rating of (RATING IN COLUMN 1) for a scientist/engineer; how about for a manager? (ENTER RATINGS IN COLUMN 2 BELOW)

	Col. 1 Q. 50 RATING	Col. 2 Q. 51 RATING
a. Fundamental technology		
b. Application of techniques		
c. Knowledge in related areas		
d. Operating within organizational system		
e. Operating within financial system		
f. Operating with personnel system		
g. Recognizing, coping with environmental factors		
h. Communication of ideas		
i. Working with diverse people		
j. Coordinating, etc., group effort		
k. Leadership style		
l. Generation of confidence of superior		
m. Integrative ability		
n. Problem-solving		
o. Decision-making		
p. Creative thinking		

52. Which of these skills are most likely to be a source of difficulty for a scientist/ engineer who moves into management? (ENTER IN COLUMN 1 BELOW) (PROBE: Any others?)

53. (FOR EACH SKILL GIVEN, ASK): Why is (NAME OF SKILL) likely to be a source of difficulty? (ENTER IN COLUMN 2 BELOW)

Col. 1		Col. 2
Skill		Reason Difficulty
None a source of difficulty	0	

(TAKE BACK CARD 2)

54. (HAND RESPONDENT CARD 3; DO NOT TAKE BACK UNTIL AFTER Q. 58)
This is a list of psychological rewards that may or may not be involved in how much satisfaction a person obtains from his work. Take a moment to note each one of these.

Let's take the perspective of a person engaged primarily in scientific/engineering activities. How much satisfaction does a scientist/engineer normally get from Leadership while working as a scientist/engineer? Use the scale on the bottom of the card, from "1" meaning low satisfaction to "9" meaning high satisfaction. (ENTER RATING IN COLUMN 1 BELOW)

How much satisfaction does a scientist/engineer normally get from Detailed Planning while working as a scientist/engineer? (ENTER RATING IN COLUMN 1 BELOW)

(REPEAT FOR EACH REWARD BELOW): From (NAME OF REWARD) ? (ENTER RATINGS IN COLUMN 1 BELOW)

55. Now, let's move to the perspective of a person in a management job.

(REPEAT FOR EACH REWARD BELOW): You gave (NAME OF REWARD) a rating of (RATING IN COLUMN 1) for a scientist/engineer. How would you rate the degree of satisfaction which a manager normally gets from (NAME OF REWARD) ? (ENTER RATINGS IN COLUMN 2 BELOW)

	Col. 1 Q. 54 RATING	Col. 2 Q. 55 RATING
a. Leadership		
b. Detailed planning		
c. Doing new, different things		
d. Direct attack on problems		
e. Contributing to organization's goals		
f. Achieving		
g. Help to one's colleagues		
h. Being independent		
i. Seeking support of others		
j. Being recognized		
k. Being able to exercise authority		
l. Risk-taking in decisions		
m. Associating with very congenial co-workers		
n. Associating with intellectually competent co-workers		
o. Using technical knowledge, skills		

56. After a person who has been primarily a scientist/engineer moves into supervision or management, he might find that each one of these rewards is relatively difficult to satisfy, relatively easy to satisfy, or that there is no difference in this respect.

Let's take up each of these rewards. In each one do you think it would be relatively difficult to satisfy, relatively easy to satisfy, or make no difference when a person moves from being a scientist/engineer to being a supervisor or manager?

(REPEAT FOR EACH REWARD BELOW): How about (NAME OF REWARD) ?--"relatively difficult," "relatively easy," or "no difference"? (CIRCLE APPROPRIATE CODES BELOW)

	Relatively Difficult	Relatively Easy	No Difference
a. Leadership	1	2	3
b. Detailed planning	1	2	3
c. Doing new, different things	1	2	3
d. Direct attack on problems	1	2	3
e. Contributing to organization's goals	1	2	3
f. Achieving	1	2	3
g. Help to one's colleagues	1	2	3
h. Being independent	1	2	3
i. Seeking support of others	1	2	3
j. Being recognized	1	2	3
k. Being able to exercise authority	1	2	3
l. Risk-taking in decisions	1	2	3
m. Associating with very congenial co-workers	1	2	3
n. Associating with intellectually competent co-workers	1	2	3
o. Using technical knowledge, skills	1	2	3

57. Now, let's go over this list of rewards in terms of those that you think best describe a person who is a scientist/engineer. You may select as many as you wish. Which ones best describe a scientist/engineer? (CIRCLE AS MANY AS GIVEN IN COLUMN 1 BELOW)

58. Now tell me which ones you think best describe a manager. Again, you may select as many as you wish. (CIRCLE AS MANY AS GIVEN IN COLUMN 2 BELOW)

	Col. 1	Col. 2
	Q. 57	Q. 58
	Best Describe A Scientist/Engineer	Best Describe A Manager
a. Leadership	1	2
b. Detailed planning	1	2
c. Doing new, different things	1	2
d. Direct attack on problems	1	2
e. Contributing to organization's goals	1	2
f. Achieving	1	2
g. Help to one's colleagues	1	2
h. Being independent	1	2
i. Seeking support of others	1	2
j. Being recognized	1	2
k. Being able to exercise authority	1	2
l. Risk-taking in decisions	1	2
m. Associating with very congenial co-workers	1	2
n. Associating with intellectually competent co-workers	1	2
o. Using technical knowledge, skills	1	2

(TAKE BACK CARD 3)

59. How is taking chances, or risk-taking different for a manager than it is for a scientist? (BE SURE IT IS CLEAR WHETHER THE RESPONDENT IS DESCRIBING A MANAGER OR A SCIENTIST)

No difference	0

60. What percentage of your time would you estimate is spent in management or supervision at your current position? Is it 100%, 50% or more, 25-50%, or is it less than 25%?

100%	1
50% or more	2
25-50%	3
Less than 25%	4

61. In the last position in which you worked as a scientist/engineer, what were your thoughts when you considered the possibility that you might go into a managerial position? (PROBE: Anything else?)

62. What factors or circumstances caused you to enter your first managerial or supervisory position? (PROBE: Any others?)

63. If a scientist/engineer wants to advance in salary in NIH/NASA, is the only path open to him to go into management?

Yes	1
No	2

64. What is your reaction to this? (PROBE: Anything else?)

65. How, if at all, does NIH/NASA show that it is concerned about the transition of scientists/engineers into managers? (PROBE: Anything else?)

Does not show that it is concerned	0

66. What specific training programs, if any, does your agency have that are designed to help scientists/engineers make the transition to management? (PROBE: Any others?)

(SKIP TO Q. 72)	None	0

67. Have you participated in any such training programs?

	Yes	1
(SKIP TO Q. 71)	No	2

68. (IF "YES" TO Q. 67, ASK): What programs did you participate in? (ENTER IN COLUMN 1 BELOW)

69. (FOR EACH PROGRAM, ASK): What did (NAME OF PROGRAM) cover? (ENTER IN COLUMN 2 BELOW)

70. (IF RESPONDENT LISTED MORE THAN ONE PROGRAM IN Q. 68, ASK): Which one of these programs did you find most valuable? (CIRCLE CODE IN COLUMN 3 BELOW)

Col. 1	Col. 2	Col. 3
Program	Program Covered:	Most Valuable
		1
		2
		3
		4

71. (IF PROGRAMS ARE MENTIONED IN Q. 66, BUT THE RESPONDENT HAS NOT PARTICIPATED--"NO" TO Q. 67, ASK): How does it happen that you have not participated in this/these program(s)? (PROBE: Any other reasons?)

72. Do you believe that the system of rewards that operates for a <u>manager</u> is quite different from or quite like the system of rewards that operates for a <u>scientist/engineer</u>?

Quite different	1
Quite alike	2

73. Why do you say that?

(IF "QUITE ALIKE" TO Q. 72, SKIP TO Q. 76)
(IF "QUITE DIFFERENT" TO Q. 72, CONTINUE)

74. What is the system of rewards that operates for a <u>manager</u>?

75. What is the system of rewards that operates for a <u>scientist/engineer</u>?

76. Thinking back over this entire interview, what would you now say are the major differences between the scientist's/engineer's and the administrator's roles? (PROBE: Any other major differences?)

77. What would you say are the primary adjustments that a scientist/engineer has to make to become a successful manager? (PROBE: Any other primary adjustments?)

78. What kind of help should be provided to the scientist/engineer who is moving into his first managerial position? (PROBE: Anything else?)

THANK YOU FOR YOUR COOPERATION.

It is clearly understood by the undersigned that this interview is being paid for by the United States Government. I swear that I have conducted the entire interview with the respondent whose name appears on this questionnaire at the address shown according to the instructions of National Analysts, Inc. I have signed my name hereto knowing that in the event this statement is false, my payment will be withheld and I will be responsible to reimburse National Analysts, Inc. for all costs involved, as well as being subjected to any legal action deemed necessary by the company aforesaid.

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